902B Absolute Piezo Vacuum Pressure Transducer RS232 / RS485 / Display

Operation and Installation Manual

P/N: 100017633
902B Absolute Piezo Transducer
Operation and Installation Manual
Revision: C, March 2016

Extent of the Warranty

MKS Instruments, Inc., Granville-Phillips Division, and MKS Denmark ApS. warrants the 902B Absolute Piezo Transducer and its accessories to be free from defects in materials and workmanship for one (1) year from the date of shipment by MKS or authorized representative to the original purchaser (PURCHASER). Any product or parts of the product repaired or replaced by MKS under this warranty are warranted only for the remaining unexpired part of its one (1) year original warranty period. After expiration of the applicable warranty period, the PURCHASER shall be charged MKS's current prices for parts and labour, plus any transportation for any repairs or replacement.
ALL EXPRESS AND IMPLIED WARRANTIES, INCLUDING THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE, ARE LIMITED TO THE WARRANTY PERIOD. NO WARRANTIES, EXPRESS OR IMPLIED, WILL APPLY AFTER THIS PERIOD.

Warranty Service
The obligations of MKS under this warranty shall be at its option: (1) to repair, replace, or adjust the product so that it meets applicable product specifications published by MKS or (2) to refund the purchase price.

What Is Not Covered
The product is subject to above terms only if located in the country of the seller from whom the product was purchased. The above warranties do not apply to:
I. Damages or malfunctions due to failure to provide reasonable and necessary maintenance in accordance with MKS operating instructions.
II. Damages or malfunctions due to chemical or electrolytic influences or use of the product in working environments outside the specification.
III. Fuses and all expendable items which by their nature or limited lifetime may not function for a year. If such items fail to give reasonable service for a reasonable period of time within the warranty period of the product; they will, at the option of MKS, be repaired or replaced.
IV. Defects or damages caused by modifications and repairs effected by the original PURCHASER or third parties not authorized in the manual.

Condition of Returned Products
MKS will not accept for repair, replacement, or credit any product which is asserted to be defective by the PURCHASER, or any product for which paid or unpaid service is desired, if the product is contaminated with potentially corrosive, reactive, harmful, or radioactive materials, gases, or chemicals.
When products are used with toxic chemicals, or in an atmosphere that is dangerous to the health of humans, or is environmentally unsafe, it is the responsibility of the PURCHASER to have the product cleaned by an independent agency skilled and approved in the handling and cleaning of contaminated materials before the product will be accepted by MKS for repair and/or replacement.
In the course of implementing this policy, MKS Customer Service Personnel may inquire of the PURCHASER whether the product has been contaminated with or exposed to potentially corrosive, reactive, harmful, or radioactive materials, gases, or chemicals when the PURCHASER requests a return authorization. Notwithstanding such inquiries, it is the responsibility of the PURCHASER to ensure that no products are returned to MKS which have been contaminated in the aforementioned manner.

Other Rights and Remedies
I. These remedies are exclusive. MKS SHALL NOT BE LIABLE FOR CONSEQUENTIAL DAMAGES, FOR ANTICIPATED OR LOST PROFITS, INCIDENTAL DAMAGES OR LOSS OF TIME, OR OTHER LOSSES INCURRED BY THE PURCHASER OR BY ANY THIRD PARTY IN CONNECTION WITH
THE PRODUCT COVERED BY THIS WARRANTY, OR OTHERWISE. Some states do not allow exclusion or limitation of incidental or consequential damage or do not allow the limitation on how long an implied warranty lasts. If such laws apply, the limitations or exclusions expressed herein may not apply to PURCHASER.
II. Unless otherwise explicitly agreed in writing, it is understood that these are the only written warranties given by MKS. Any statements made by any persons, including representatives of MKS, which are inconsistent or in conflict with the terms of the warranty shall not be binding on MKS unless reduced to writing and approved by an authorized officer of MKS.
III. This warranty gives PURCHASER specific legal rights, and PURCHASER may also have other rights which vary from state to state.
IV. For MKS products sold outside of the U.S., contact your MKS representative for warranty information and service.

Warranty Performance
To obtain warranty satisfaction, contact the following:

US & ASIA:
MKS Instruments, Granville-Phillips® Division, 6450 Dry Creek Parkway, Longmont, CO 80503, USA, Phone: +1 (303) 652-4400
EUROPE:
MKS Denmark ApS, Ndr. Strandvej 119G, DK3150 Hellebaek, Denmark, Phone: +45 44 92 92 99, E-mail: mksdenmark@mksinst.com

Statement of Export Control

These commodities, technology or software were provided in accordance with the US Export Administration Regulations and Export regulations of the European Union. Diversion or transfer contrary to U.S. or European Union law is prohibited.

Part number: 902B-_ _ _ _ _ _ _ _ _ _
Serial number: _ _ _ _ _ _ _ _ _ _ _ _ _ _ _
Please fill in these numbers and have them readily available when calling for service or additional information. The part number can be found on your packing slip, and both the part number and serial number are located on the side of the housing.

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For more information contact:
MKS Denmark ApS.
Ndr. Strandvej 119G
DK-3150 Hellebaek
Denmark
Tel: +45 44 92 92 99 – Fax: +45 44 92 94 99
E-mail: mksdenmark@mksinst.com

MKS Instruments, Granville-Phillips® Division
6450 Dry Creek Parkway
Longmont, CO 80503
USA
Tel: +1 303 652 4400 – Fax: + 1 303 652 2844
E-mail: mks@mksinst.com

Safety information:

Symbols used:

The first symbol below is used throughout this manual to further define the safety concerns associated with the product. The last two symbols identify other information in this manual that is essential or useful in achieving optimal performance from the 902B Absolute Piezo transducer.

Caution:	**Refer to manual.** Failure to read message could result in personal injury or serious damage to the equipment or both.
Critical:	Failure to read message could result in damage to the equipment.
Attention:	Calls attention to important procedures, practices or conditions.

General safety information

The safety instructions should always be followed during installation and operation of the 902B Absolute Piezo transducer. Pass safety information to all users.

Safety Precautions:

Electrical connections. The 902B must be properly electrically connected in order to perform according to the specifications. Output pins are not protected against wrong electrical connections. Wrong electrical connections can cause permanent damage to the transducer or interference to measuring performance. Refer to Electrical connections description page 7.
Fuse. The 902B power supply input has an internal thermal fuse. The fuse is self-recoverable and should not be changed.
Explosive Environments. Do not use the 902B in presence of flammable gases or other explosive environments. **Corrosive Environments.** The 902B is not intended for use in corrosive environments. Refer to Transducer installation page 6.
Service and Repair. Do not substitute parts or modify the 902B transducer other than described in Service and Repair page 50. Do not install substituted parts or perform any unauthorized modification to the transducer. Return the instrument to a MKS Calibration and Service Center for service and repair to ensure all of the safety features are maintained.
CE marking The 902B transducer complies with European standards for CE marking. Refer to Declaration of Conformity page 54.

Unpacking

Before unpacking your 902B Absolute Piezo transducer, check all surfaces of the packing material for shipping damage. Inspect for visible damage. If found, notify the carrier immediately.
Please be sure that your 902B package contains these items:

Part number	Description
902B-xxxxx	902B Transducer
100017632/100017729	Short form manual (15 pin version)/Short form manual (9 pin version)
100017096	Documentation & Software DVD

If any items are missing, please call MKS Customer Service at +1 800 345-1967 or +1 303 449-9861 or your local MKS sales office or distributor.

Part number

The 902B Absolute Piezo part number system has 5 digits that identify flange, communication interface, analog output type, I/O connector and sensor sealing type. Transducers can be delivered with customer configuration of various parameters like setpoint settings. These specials have an additional 4 digits after the regular part number.

	Flange	Interface	Analog out	Connector Relays	Enclosure sealing
902B-	1	1	0	2	0

Enclosure sealing:

0	Standard
2	IP54
4	Display
6	Display SI

Connector Relays:

1	SUBD 9 pin male / one relay
2	SUBD 15 pin HD male / no relay
3	SUBD 15 pin HD male / three relays
5	SUBD 15 pin HD male / three relays / Dual analog out
8	RJ45/FCC68 8 pin (Edwards, Oerlikon type)
9	Hirschmann 6 pin (Pfeiffer / Inficon type)

Analog out:

0	0-10 V (Linear 10 mV/Torr)
1	0-5 V (Linear 5 mV/Torr)
2	2-10 V (LOG10)
3	1-5 V (LOG5)
4	1 V/decade
5	0-10 V (100 mV/Torr)
6	1-9.8 V

Interface:

1	RS232 / Analog
2	RS485 / Analog

Flange:

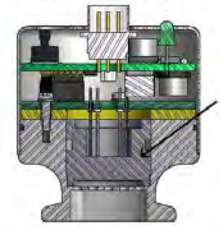
0	Custom
1	KF16
3	NPT 1/8”
4	VCR4
5	VCR8

Description

The 902B Absolute Piezo vacuum transducer offers a wide measuring range from 0.1 to 1000 Torr and is based on measurement of thermal conductivity and measurement of mechanical deflection of a silicon membrane.

The 902B can be used in a variety of applications as a standalone unit or with the PDR900 display and controller unit.
The transducer has RS232 or RS485 digital communication interface for setup of transducer parameters and to provide real time pressure measurement.

The 902B has up to three mechanical relays which can be used for process control such as interlocking valves or pumps. The analog voltage output can be interfaced to external analog equipment for pressure readout or control.



Sensor technology

The 902B transducer contains one sensor element. The Piezo sensor is based on measurement of the mechanical deflection of a stainless steel 316 membrane relative to an integrated reference vacuum. The Piezo measures true absolute pressure independent of gas composition and concentration.

Sensor element is very robust and can withstand high G-forces and instant air inrush.

Applications

The 902B can be used in many different vacuum applications within the semiconductor, analytical and coating industries:

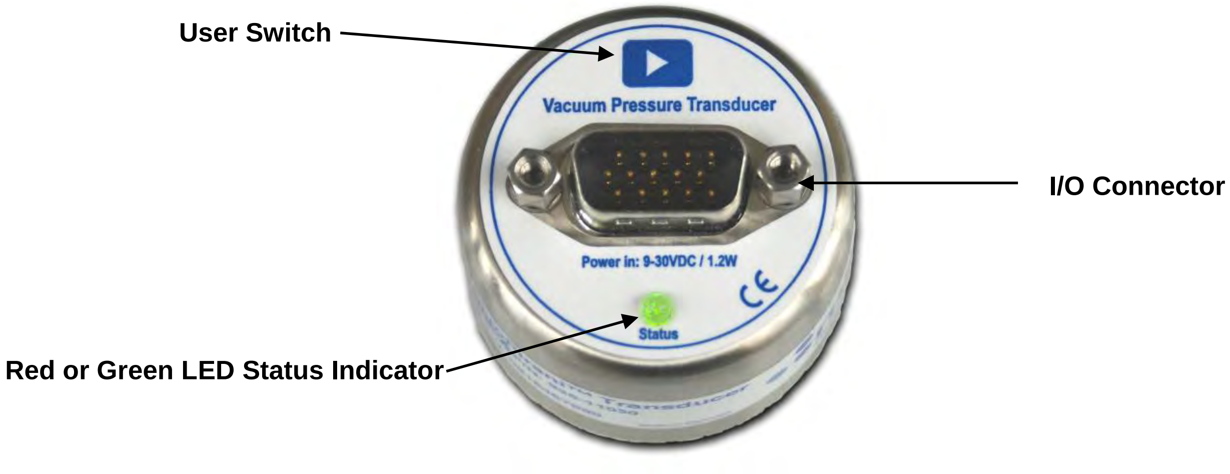
- General vacuum pressure measurement
- Vacuum pressure measurement in dirty and corrosive environment
- Fore line and roughing pressure measurement
- Gas backfilling measurement and controlling
- System process control
- Sense abnormal pressure and take appropriate security measure using set point relays
- Control system pressure

Disposal (European Union only)

The 902B transducer is manufactured according to the RoHS directive.

For the benefit of the environment, at the end of life of the 902B, it should not be disposed in the normal unsorted waste stream. It should be deposited at an appropriate collection point or facility to enable recovery or recycling.

902B Functions



User Switch

The user switch has the following functions:

1. Vacuum Zero adjustment (ZER! Command)
2. Transducer firmware upgrade mode

Refer to pages 17, 18 and 48 for operation procedure.

If the user switch is activated by accident and vacuum Zero or Atmospheric adjustment is executed the original factory adjustment can be recovered using the FD!ZER or FD!SPN command. (See Factory default page 20).

If the transducer is delivered with customer specified parameters the User Switch is disabled. For enabling the switch see page 21.

LED Status Indicator

The red/green LED status indicator has the following stages:

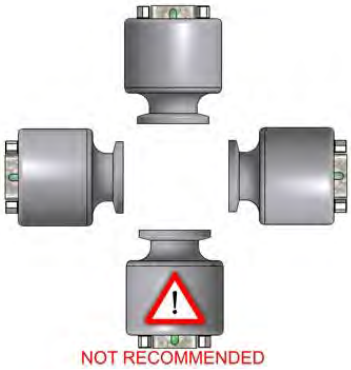
1.	GREEN	Normal operation
2.	2 sec. RED	Power on sequence
3.	GREEN 1 sec. flash cycle	Test mode TST!ON (see page 21)
4.	3 × GREEN flash	User Adjustment executed successfully
5.	3 × RED flash	User Adjustment failed
6.	2 sec. RED	User switch disabled
7.	RED	Transducer defect
8.	OFF	Firmware upgrade mode (see page 48) or Power off

Transducer installation (mechanical)

Process compatibility
The 902B transducer is intended for use in relatively clean environments. The transducer cannot be used in corrosive environments like a semiconductor etch process chamber where aggressive gases like fluorine are used.

If the 902B transducer is located close to a gas source connection like a flow controller or leak valve the transducer pressure measurement can be higher than the actual chamber pressure. Location close to a pumping system connection can cause a lower pressure measurement than actual chamber pressure.

The 902B transducer and its sensor design can be mounted in any orientation without compromising accuracy.



Temperature
The 902B has an active and individual sensor temperature compensation circuit that ensures accurate measurement in a wide temperature range. For best measuring performance avoid large temperature gradients and direct cooling like air-condition air stream or direct heating like a pump exhaust stream.

Bake-out
The transducer electronics can withstand 85 °C (185 °F) when the power is turned off.

Contamination
Locate and orient the 902B where contamination is least likely.

Vibrations and instant air inrush
The 902B sensor element is extremely robust to mechanical forces like vibration and G-forces.
The sensor element cannot be damaged by fast and repeated pressure cycles or instant inrush of air.

Vacuum connections
The 902B transducer is available with different types of vacuum fittings. When mounting the transducer always ensure that all vacuum sealing items and surfaces are clean, without damage and free of particles. Do not touch the vacuum flange sealing surface.

If the transducer will be exposed to pressures above atmospheric pressure make sure that proper vacuum fittings are used. Ensure that the internal system pressure is at ambient pressure conditions before opening the vacuum system and removing any connections.

Transducer installation (electrical)

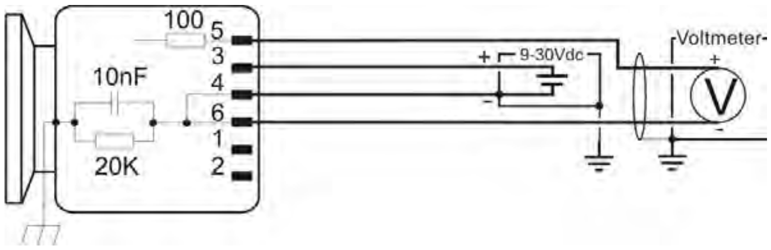
The 902B is available with different input/output connectors. Use a cable with strain relief to ensure proper electrical connection and to reduce stress on the connectors.

☞ **Ensure a low impedance electrical connection between the 902B transducer body and the grounded vacuum system to shield the sensor from external electromagnetic sources.**

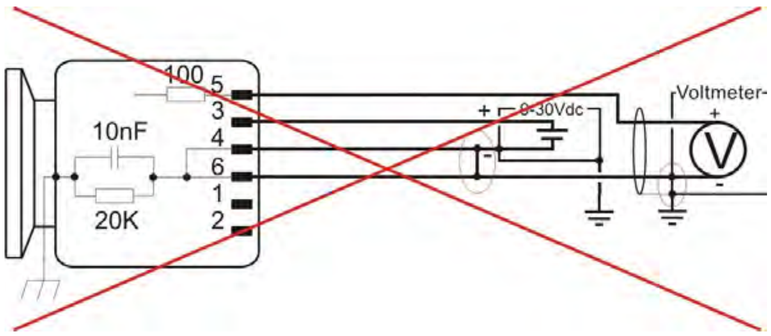
Ensure that the analog output is connected to a floating input.

The power supply input is 9 to 30 VDC. The power supply input is protected by an internal thermal fuse. The fuse is self-recoverable; do not replace it. Damage may occur to the circuitry if excessive voltage is applied, polarity reversed or if a wrong connection is made.

If using the analog voltage output, connect the positive analog out and negative analog out pins to a differential input voltmeter or an analog-to-digital (A/D) converter. Do not connect the negative side of the analog output to the negative side of the power supply input or to any other ground. Doing so will cause half of the power current to flow through this wire. Measurement errors in the output voltage may be seen due to the voltage drop from this current. The longer the cable, the worse the error will be. Do not connect the set point relay terminals to the analog output.



Correct connection of analog output to floating input

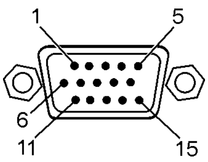


Incorrect connection of analog output to non floating input

Input/Output Wiring

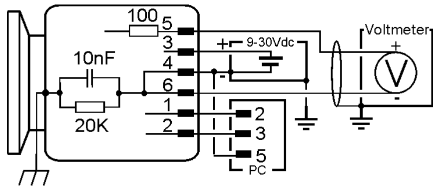
To comply with EN61326-1 immunity requirements, use a braided shielded cable. Connect the braid to the metal hoods at both ends of the cable with the end for power supply connected to earth ground.

902B I/O Connector (15 pin)

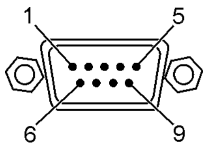


15 pin male HD DSUB

PIN	Description
1	RS485- / RS232 Transmit
2	RS485+ / RS232 Receive
3	Power + (9-30 VDC)
4	Power return -
5	Analog Output +
6	Analog Output -
7	Relay 1, Normally Open
8	Relay 1, Common
9	Relay 1, Normally Closed
10	Relay 2, Normally Closed
11	Relay 2, Common
12	Relay 2, Normally Open
13	Relay 3, Normally Closed or Analog Out 2 (Hardware option)
14	Relay 3, Common
15	Relay 3, Normally Open

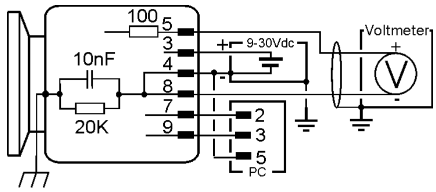


925 I/O Connector (9 pin)

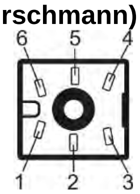


9 pin male DSUB

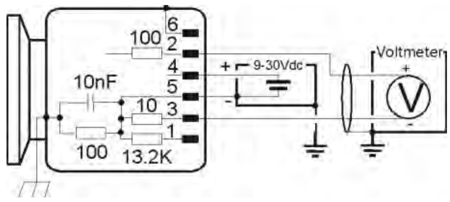
PIN	Description
1	Relay, Normally Open
2	Relay, Normally Closed
3	Power + (9-30 VDC)
4	Power return -
5	Analog Output +
6	Relay, Common
7	RS485- / RS232 Transmit
8	Analog Output -
9	RS485+ / RS232 Receive



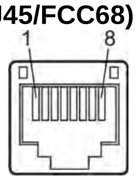
902B I/O Connector (6 pin Hirschmann)



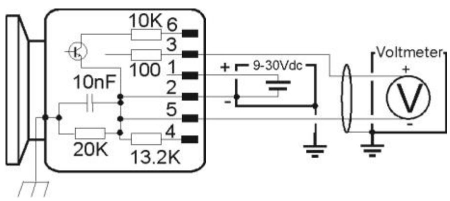
PIN	Description
1	Identification resistor (13.2 KΩ)
2	Analog Output +
3	Analog Output –
4	Power + (9-30 VDC)
5	Power return -
6	Chassis



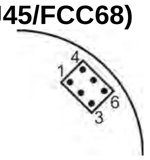
902B I/O Connector (8 pin RJ45/FCC68)



PIN	Description
1	Power + (9-30 VDC)
2	Power return -
3	Analog Output +
4	Identification resistor (13.2 KΩ)
5	Analog Output -
6	Set point output
7	Not Connected
8	Not Connected



902B RS232 connector (6 pin Hirschmann + 8 pin RJ45/FCC68)



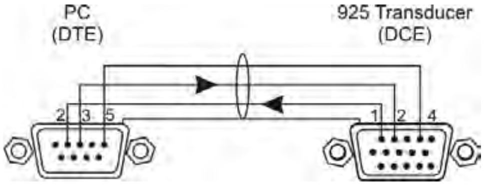
PIN	Description
1	RS232 Transmit
2	RS232 Ground
3	RS232 Receive
4	RS232 Receive
5	RS232 Ground
6	RS232 Transmit

P/N: 10001367 RS232 Cable for Hirschmann and RJ45/FCC68 Transducers.

Serial user interface

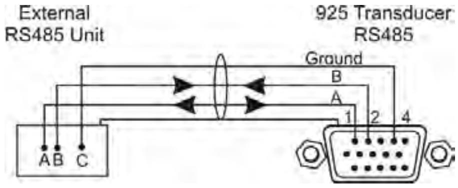
The 902B is as standard supplied with RS232 or RS485 user interface. The user interface allows change of transducer parameters like set point settings and calibration.
The serial interface uses the following data format: 8 data bits, 1 stop bit and no parity bit.

RS232 user interface



The 902B is DCE (Data Communication Equipment) and can be connected to DTE (Data Terminal Equipment), typically a PC.
The serial communication does not use hardware handshake.
The RS232 standard does not specify the maximum cable length, but length depends on environment, cable quality and communication speed. In general cable spans shorter than 15m (50ft.) does not require any extra precautions.
The RS232 connection on transducers delivered with 6 pin Hirschmann and 8 pin RJ45/FCC68 connector is available at a separate connector. Refer to Accessories and Replacement part number page 51 for RS232 programming cable. The connector is located under the label on the top of the transducer.

RS485 user interface

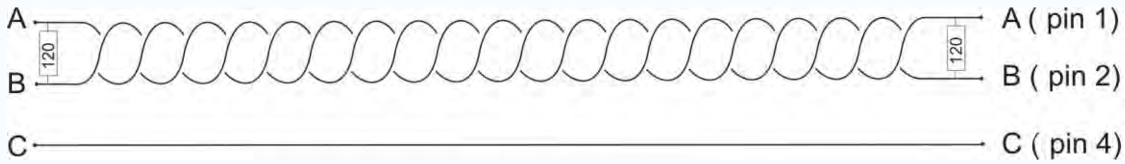


RS485 is a network communication system that enables the user to communicate with several units on the same communication line.
RS485 is a balanced communication system, because signal on one wire is ideally the exact opposite of the signal on the second wire. Compared to RS232 communication RS485 allows significantly longer cable span. The maximum length of cable span depends on the environment, cable quality and communication speed, but relative long cable spans up to 1,200m (4,000 ft.) is possible.
There are 2 wires other than ground that are used to transmit the digital RS485 signal. The 902B uses half duplex communication.

Always use high quality shielded data cables for serial communication. For long cable runs use twisted pairs. See also Accessory and Replacement part number page 51.

The EIA-485 and NMEA standards specification states that signal A is the inverting "-" and signal B is the non inverting or "+". This is in conflict with the A/B naming used by a number of differential transceiver manufacturers which is incorrect, but their practice is used throughout the industry. Therefore care must be taken when using A/B naming. In addition to the A and B connections, the EIA standard also specifies a third interconnection point called C, which is the common ground.

At high communication baud rates and when using long cable runs, a termination resistor of typical 120 Ohm should be connected between pin 1 and 2 at the 902B DSUB connector and between pin A and B at the data communication equipment. The termination resistors provide low impedance that reduces the sensitivity to electrical noise and prevents data reflection that can cause data communication corruption.



RS485 twisted pair cable run with 120 Ω terminator resistors (902B with 15 pin connector)

When connecting multiple devices in a RS485 network make sure that proper guidelines and specifications are followed to ensure optimal communication performance of the 902B. Improper network design can cause data communication interruption and data collision.

Communication Protocol

The 902B transducer command set allows the user to change transducer parameters and receive pressure measurements. Settings and parameters like set point values, set point configurations and calibration data are stored in the transducers non volatile memory.

Communication software

Communication software is required to communicate from a PC via RS232/485 interface to the transducer. In Microsoft Windows XP package the hyper terminal software can be used to type and transmit serial commands to the transducer. To the right is illustrated the Windows communication port properties for communicating with transducer factory default settings.
MKS also offers communication software examples that can be downloaded at: www.mksinst.com/vtsw/

In OEM applications transducer communication software routines are normally integrated with other system control software.

Query and Command Syntax

Queries return current parameter settings; commands change the parameter setting according to the value the user enters into the command syntax. Each query or command must begin with the attention character @ and end with the termination ;FF.

Command syntax for an information query:

@<device address><query>?;FF

Command syntax for a command:

@<device address><command>!<parameter>;FF

The command set allows upper and lower case ASCII characters.

Response Syntax (ACK/NAK)

The ASCII characters 'ACK' or 'NAK' preface the query or command response string. The ACK sequence signifies the message was processed successfully. The NAK sequence indicates there was an error.

The response to a query or a successful command is:

@<device address>ACK<data>;FF

The response to a message with an error is:

@<device address>NAK<NAK code>;FF

Examples:

ACK response: @253ACK9600;FF (baud rate changed to 9600)
NAK response: @253NAK160;FF (command had an error—possible typo)

The following list provides descriptions of the NAK codes that may be returned.

NAK Code	Error description	Example
8	Zero adjustment at too high pressure	@253ZER!;FF
9	Atmospheric adjustment at too low pressure	@253ATM!760;FF
160	Unrecognized message	@253S%;FF
169	Invalid argument	@253EN1!of;FF
172	Value out of range	@253SP1!50000000;FF
175	Command/query character invalid	@253FV!;FF
180	Not in setup mode (locked)	-

Baud rate
The baud rate represents the communication speed. The 902B supports 4800, 9600, 19200, 38400, 57600, 115200 and 230400 baud rates. The transducer is always delivered with 9600 bps factory default baud rate.

Change of Baud rate:

Command:	@253BR!19200;FF
Command values:	4800, 9600, 19200, 38400, 57600, 115200, 230400
Command reply:	@253ACK19200;FF
Factory default:	9600

The transducer will reply in the current baud rate and then change to the new value.

Addressing
The transducer uses an addressable communication protocol that allows multiple MKS 900 Series transducer devices to be connected in a RS485 network. The address is required in both RS232 and RS485 communication.
The address can be set from 001 to 253. Address 254 and 255 are universal addresses, which can be used to broadcast a command to all devices on the network. Commands sent with address 254 will be executed by all transducers on the network and all transducers will transmit a reply. Commands sent with address 255 will be executed by all transducers on the network, but the transducers will not transmit replies. For example, use address 254 to communicate with a device if its address is unknown.

Change of Address:

Command:	@253AD!123;FF
Command values:	001 to 253
Command reply:	@253ACK123;FF
Query:	@253AD?;FF
Query reply:	@253ACK253;FF
Factory default:	253

Communication delay (RS485)
The 902B half duplex RS485 interface requires that data is transmitted and received on the same communication line. Some RS485 transceiver equipment has a settling time when changing from transmit to receive mode. If the transducer replies too fast the first character(s) will not be received as the following example illustrates:

Sending pressure request:	@254PR1?;FF
Receiving data:.	64;FF (Correct data: @253ACK764;FF)

The RS delay introduces a baud rate dependent delay between receive and transmit sequence to prevent loss of data in the receiving string.

Communication delay:

Command:	@253RSD!ON;FF
Command values:	ON, OFF
Command reply:	@253ACKON;FF
Query:	@253RSD?;FF
Query reply:	@253ACKON;FF
Factory default:	ON

Setpoint relays

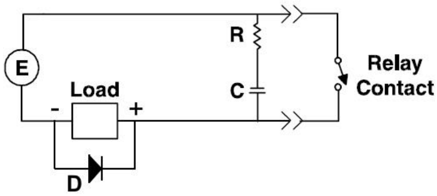
The 902B can be ordered with either 0, 1 or 3 mechanical relays that can be used for controlling external process equipment. Each relay has closing and breaking contacts and the contacts are rated 30 VDC, 1A resistive load. If the transducer is supplied without setpoint relays, the setpoint commands can still be accessed. Refer to part number definition page 3 to verify if setpoint relays are included.

Inductive relay load

Special precautions should be taken when driving inductive loads with the relay contact. When an inductive load like a solenoid is energized, the in-rush current is significantly higher than the regular load current. In-rush currents exceeding the relay contact rating can cause reduction of relay contact life time or contact reliability.
When a solenoid is de-energized, the collapsing magnetic field can cause significant voltage spikes. These spikes can couple capacitively from cable to cable and interfere with measuring electronics or transducer signals.

STOP **Driving inductive loads via the setpoint relay contacts requires de-energizing spike protection. Inadequate protection can cause permanent damage to the transducer or interfere with the analog output signal.**
Always ensure that inductive in-rush currents do not exceed relay contact rating.

An arc suppression network as shown schematically to the right is recommended. The values of the capacitance C and the resistance R can be calculated by the following equations:



$C = I^2/(1 \times 10^7)$ $R = E/I^a$

where:

C is in Farad. R is in Ohm
I is DC or AC_{peak} load current in Ampere. E is DC or AC_{peak} source voltage in Volt
$a = 1 + (50/E)$

Note that $R_{min} = 0.5\ \Omega$ and $C_{min} = 1\times10^{-9}$ F. D is a fast transient suppression diode.

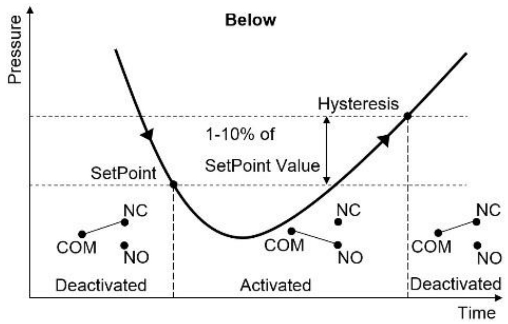
PDR900 controller relays

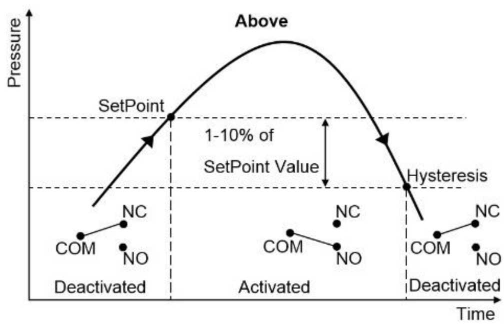
The PDR900 controller has power relays that can drive higher current loads and voltages than the transducer relays. If the transducer is used with the PDR900 controller refer to PDR900 manual for setup of relay output.

STOP **Do not connect any external sources to the transducer relay pins when using it together with the PDR900 controller. Always use the PDR900 relay outputs.**

Setpoint functionality

The set point relays can be activated either above or below the set point values. The graphs below show the different relays stages in either below or above configuration. The NC contact will always be closed in case of power failure.





When using the setpoint relay to control process equipment, always take appropriate precautions to prevent system damage in case of transducer power failure. The NC contact will be closed in case of transducer power failure.

If the transducer is supplied as a special version (P/N: 902B-xxxxx-xxxx) with pre-configured parameters such as setpoint settings, the setup is per default locked. The transducer will reply with error code “NAK180” if the user tries to change parameters. To change pre-configured parameters refer to unlock procedure page 21.

Setpoint setup by Serial interface
The correct procedure for setting up set point parameters are:

1. Enter set point value 50 Torr
   Command: @253SP1!50;FF — Reply: @253ACK50;FF

2. Select set point direction (ABOVE/BELOW)
   Command: @253SD1!BELOW;FF — Reply: @253ACKBELOW;FF

3. Enter set point hysteresis value, if other than default ±10% of set point value is required.
   Command: @253SH1!40;FF — Reply: @253ACK40;FF

4. Enable set point (OFF, ON)
   Command: @253EN1!ON;FF — Reply: @253ACKON;FF

Setpoint setup by PDR900 Controller

1. Edit > Setpoint > Setpoint Value 1
   Enter set point value 50 Torr
   Display: Setpoint 1 value / 50 Torr

2. Edit > Setpoint > Direction 1
   Select set point direction
   Display: Setp.1 Direction / Below

3. Edit > Setpoint > Hysteresis 1
   Enter set point hysteresis value
   Only if other than default ±10% of set point value is required.
   Display: Hysteresis 1 / 40 Torr

4. Edit > Setpoint > Enable 1
   Enable set point
   Display: Setp.1 Enable / ON

Setpoint value
The setpoint value is the pressure either below or above which the setpoint relay will be energized.

Setpoint hysteresis value
The hysteresis value is the pressure value at which the setpoint relay will be de-energized.

Setpoint direction
The setpoint direction determines whether the relay is energized above or below the set point value.

Enable setpoint
The enable setpoint command enables, disables or assigns the setpoint relay to absolute Piezo measurement.

The 902B transducer has an auto hysteresis setting of 10% of the set point value that overwrites the current hysteresis value whenever the set point value or set point direction is changed. If other hysteresis value than 10% is required, first set the set point value and set point direction before setting hysteresis value.

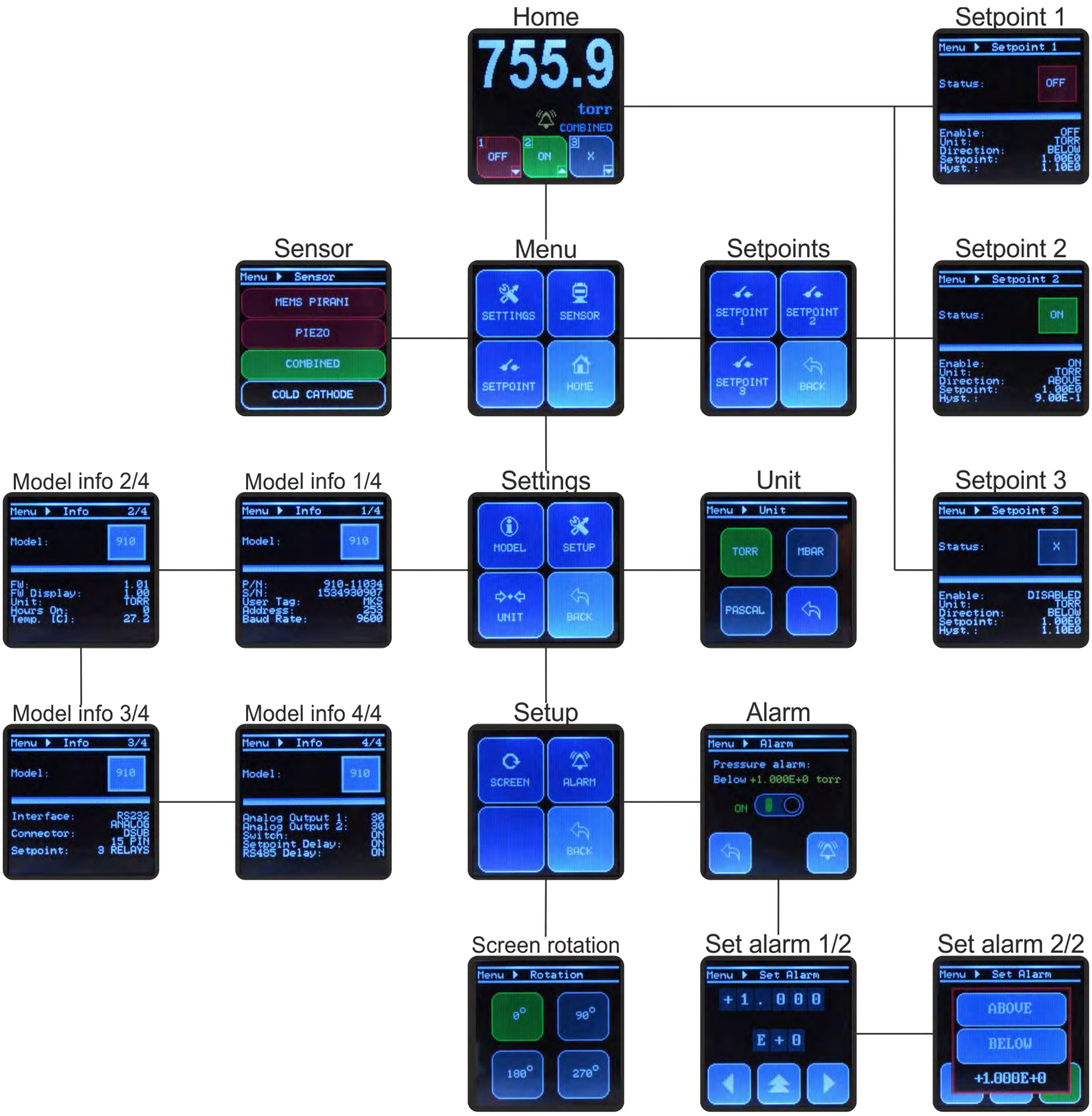
Setpoint safety delay
The setpoint safety delay function requires 5 continuously measurements that exceeds setpoint value before the relay is tripped. This feature prevents false trigging of the setpoint relay due to noise. If fast setpoint response is required the setpoint safety delay can be disabled.

Setpoint safety delay

Command:	@253SPD!ON;FF
Command values:	ON, OFF
Command reply:	@253ACKON;FF
Query:	@253SPD?;FF
Query reply:	@253ACKON;FF
Factory default:	ON

Integrated Touch Display

For 902B transducer versions with integrated touch display it is possible to see information about setpoints, sensors, model, and measurements unit. A pressure threshold alarm can be set and for transmitters with multiple sensors, it is possible to choose which sensor pressure value is displayed on the screen. All of this is accessible by the following menu structure:



Using the integrated touch display:
When the transducer is turned on, the initializing screen shows the transducer name while starting up. After start-up, the screen automatically switches to the Main screen. To access the Menu, push anywhere on the Main screen. The following table shows the different menus and options available:

<table>
<tr><th>Display-screen</th><th colspan="4">Information</th></tr>
<tr><td>Start-up</td><td colspan="4">MKS logo and transducer model</td></tr>
<tr><td>Home</td><td colspan="4">The Home screen shows the current pressure, the transducer model, the status of the setpoints, the triggering direction of each setpoint and shows if an alarm is enabled.
The setpoint buttons and unit text give quick access to the separate Setpoint-screens and Unit screen respectively.</td></tr>
<tr><td>Menu</td><td colspan="4">The general Menu contains 4 buttons which lead to:
Settings, Sensor, Setpoints menu and Home.</td></tr>
<tr><td>Settings</td><td colspan="4">The Settings menu contains 4 buttons which lead to:
Model info, Setup menu, Unit and Back</td></tr>
<tr><td>Setup</td><td colspan="4">The Setup menu contains 3 buttons which lead to:
Screen rotation, Alarm and Back</td></tr>
<tr><td>Sensor</td><td colspan="4">The Sensor screen shows which sensor’s measurement is displayed on the Home screen (green marked sensor).</td></tr>
<tr><td>Setpoints menu</td><td colspan="4">The Setpoint menu contains 4 buttons which lead to:
Setpoint 1, Setpoint 2, Setpoint 3 and Back (to Menu)</td></tr>
<tr><td rowspan="6">Setpoint screen</td><td colspan="4">Setpoint 1,2 or 3</td></tr>
<tr><td colspan="4">Each Setpoint screen shows the setpoint status, the pressure unit, pressure triggering direction, setpoint value and hysteresis value.</td></tr>
<tr><td colspan="2" rowspan="3">The setpoint status is indicated by:</td><td>X</td><td>Setpoint disabled (Grey)</td></tr>
<tr><td>ON</td><td>Setpoint enabled ON (Green)</td></tr>
<tr><td>OFF</td><td>Setpoint enabled OFF (Red)</td></tr>
<tr><td colspan="4">If the Setpoint screen is accessed via the Setpoint menu, pressing the screen will lead back to the same menu. If accessed via the quick-access buttons on the Main screen, pressing the screen will lead back to the Main screen.</td></tr>
<tr><td rowspan="8">Model info</td><td colspan="4">The Model info screen shows the transducer type and model number and each screen has different extra information. Press the screen to toggle through the different info screens and eventually go back to Settings.</td></tr>
<tr><td>Model info (1/4)</td><td>Model info (2/4)</td><td>Model info (3/4)</td><td>Model info (3/4)</td></tr>
<tr><td>Transducer P/N</td><td>Gas type</td><td>Interface type</td><td>User switch ON/OFF</td></tr>
<tr><td>Serial number</td><td>Transducer firmware version</td><td>Connector type</td><td>Setpoint delay 50ms ON/OFF</td></tr>
<tr><td>User tag</td><td>Display firmware version</td><td>Number of available relays</td><td>Relay communication delay ON/OFF</td></tr>
<tr><td>Communication adress</td><td>RS485 testing</td><td rowspan="3"></td><td rowspan="3">Temperature (°C)</td></tr>
<tr><td rowspan="2">Baud rate</td><td>Pressure unit</td></tr>
<tr><td>Transducer ON-time</td></tr>
<tr><td>Unit</td><td colspan="4">The Unit screen displays the current pressure unit and gives the possibility to change the pressure unit between Torr, Milibar or Pascal.</td></tr>
<tr><td>Screen rotation</td><td colspan="4">The Screen Rotation screen displays the current screen orientation and enables the operator to rotate the screen in four directions.</td></tr>
<tr><td rowspan="5">Alarm</td><td colspan="4">A visual alarm can be set at a certain pressure.
Press the green or red button to enable or disable the alarm.
Press Set to change the alarm pressure value and triggering direction.</td></tr>
<tr><td colspan="4">Set Alarm (1/2)</td></tr>
<tr><td colspan="4">Setting pressure threshold:
The alarm value is set by selecting a digit (left and right arrow) and cycling through the numbers 0-9 and +/- (press up arrow or screen)
To accept, press right arrow until a green checkmark appears. Press again to proceed.
To cancel, press left arrow until a red arrow appears. Press again to proceed.</td></tr>
<tr><td colspan="4">Set Alarm (2/2)</td></tr>
<tr><td colspan="4">When the alarm is set, the operator selects whether the alarm triggers above or below the given value.</td></tr>
</table>

Pressure output

The 902B transducer can provide pressure measurement output as an analog voltage or RS232/RS485 digital value. The digital value is presented as fractional number for PR1, PR2 and PR3 reading and as scientific number in PR4 reading.

Pressure request:

Query:	@253PR2?;FF
Query reply:	@253ACK0.2;FF

Pressure outputs:

PR1:	Absolute Piezo sensor reading
PR2:	Absolute Piezo sensor reading
PR3:	Absolute Piezo sensor reading
PR4:	Absolute Piezo sensor reading (scientific notation)

The analog output is per default based on the absolute Piezo reading and provides a 16 bit linear voltage output from 0 to 10 V. Refer to Analog output page 23 for details.

Resolution

The digital pressure output has a pressure resolution of 0.1 Torr/mbar/Pascal.

Measuring noise

External sources can interfere with the sensor signal and cause noise in the signal. The low measuring range is most sensitive to measuring noise due to low signal levels.

Calibration and adjustment

The 902B is factory calibrated when delivered and in most applications further calibration is not required. If the sensor element has been contaminated or damaged by process gases, adjustment of zero and full scale can be executed to compensate for measurement errors.

Accuracy and repeatability

The 902B measuring accuracy is specified as transducer reading ± a percentage of the actual pressure. The basic measuring accuracy is factory calibrated and cannot be user adjusted. The repeatability specification is the transducers ability to repeat the same measurement value after multiple pressure cycles. Refer to the transducer specification page 50 for actual values.

Gas calibration

The 902B Absolute Piezo sensor is gas independent and no gas calibration is required.

Piezo Zero Adjustment by serial interface

The Piezo zero adjustment can only be executed when the MicroPirani pressure measurement is below 0.1 Torr. The Piezo zero adjustment sets the Piezo zero reading.

Executing zero adjustment. (Evacuate the transducer to a pressure below 0.1 Torr)

Command:	@253ZER!;FF
Command values:	None
Command reply:	@253ACKZER;FF
Query:	@253ZER?;FF
Query reply:	@253ACK0;FF
Reset to default:	@253FD!ZER;FF
Factory default:	*Factory adjustment value*
Sensor value too high:	@253NAK8;FF

The query feature reads the delta value between the user offset value and factory default value. This can be used to monitor the positive and negative offset trend regardless of how many times the zero adjustment is executed.

Zero Adjustment by use of the User switch

The transducer can also be adjusted by activating the user switch. When using the switch the transducer must be evacuated to a pressure below 0.1 Torr. Press down the switch for 2 seconds and the LED will flash green three times to acknowledge the zero adjustment has been executed successfully. The LED will flash red three times if the adjustment has failed.

Piezo Atmospheric adjustment

The Piezo atmospheric adjustment allows the user to adjust the atmospheric reading for the Piezo measurement.

Executing Piezo atmospheric adjustment. (Place the transducer in atmospheric pressure)

Command:	@253SPN!7.60E+2;FF
Command values:	Atmospheric pressure value
Command reply:	@253ACK;FF
Query:	@253SPN?;FF
Query reply:	@253ACK7.60E+2;FF
Reset to default:	@253FD!SPN;FF
Factory default:	*Factory adjustment value*
Sensor value too high:	@253NAK8;FF

Factory default

The transducer is per factory default delivered with parameters and setup as listed below. If the transducer is delivered with customer preconfigured parameters the values are different than listed below and the parameters will be locked per default.

Communication parameters:

Description	Command	Parameter	FD!	FD!ALL
Address:	AD!	253	-	×
Baud rate:	BR!	9600	-	×
Communication delay:	RSD!	ON	-	×

Transducer parameters:

Description	Command	Parameter	FD!	FD!ALL
Test mode (LED flash):	TST!	OFF	×	×
User tag:	UT!	MKS	-	×
Set point 1 value:	SP1!	500	-	×
Set point 1 hysteresis value:	SH1!	505	-	×
Set point 1 direction:	SD1!	BELOW	-	×
Set point 1 enable:	EN1!	OFF	-	×
Set point 2 value:	SP1!	500	-	×
Set point 2 hysteresis value:	SH1!	505	-	×
Set point 2 direction:	SD1!	BELOW	-	×
Set point 2 enable:	EN1!	OFF	-	×
Set point 3 value:	SP1!	500	-	×
Set point 3 hysteresis value:	SH1!	505	-	×
Set point 3 direction:	SD1!	BELOW	-	×
Set point 3 enable:	EN1!	OFF	-	×
Setpoint safety delay	SPD!	ON	-	×
Switch enable:	SW!	ON	-	×
Analog out 1:	AO1!	235 (1)	-	×
Analog out 2:	AO2!	10	-	×

(1) If the transducer is delivered with other analog output than standard mks (part number specified), then the factory default value will be specified by the specials part number.

Calibration setup:

Description	Command	Parameter	FD!	FD!ALL
PZ atmospheric zero adjust:	ZER!	*Factory adjustment value*	×	×
PZ positive full scale adjustment:	ATS!	*Factory adjustment value*	×	×
Pressure unit:	U!	TORR	-	×

Resetting to factory default

The factory default command resets all or certain parameters of the 902B to factory default settings as listed above. If other digital communication setup than factory default values are used, then the communication will be lost after execution of factory default and the transceiver equipment should be set to transducer values.

The factory default command resets parameters to default values and consequently user adjustments, setup and factory configured parameters are lost. Use with caution!

Command: @253FD!ALL;FF
Command values: *None*, ALL, UNLOCK, LOCK, ZER, SPN

Command reply: @253ACK;FF

Transducer lock function

To ensure that no unauthorized personnel are able to change transducer setup and parameters, the transducer lock function can prevent direct access to parameter changes. Transducers delivered with pre-configured custom specified parameters (special part number) are per default locked and will reply with “NAK180”, if the user tries to change locked parameters. The unlock procedure must be executed to change these parameters.

Disable lock function command:

Command:	@253FD!UNLOCK;FF
Command reply:	@253ACK;FF

Enable lock function command:

Command:	@253FD!LOCK;FF
Command reply:	@253ACK;FF

Standard transducer (7 digits part number: 902B-xxxx)
Factory default: *Transducer unlocked*

Special configuration transducer (11 digits part number: 902B-xxxx-xxxx)
Factory default: *Transducer locked*

☞ **If the transducer is delivered with special configuration, the lock function will only be temporarily disabled and will be enabled again after cycling power cycle or executing the enable lock command.**

☞ **The 902B transducer can be delivered with factory locked tamperproof settings for safety interlock applications. This option is defined in the special settings. If delivered with factory lock the transducer settings can only by changed by return of gauge to MKS.**

User Switch Command

The User Switch function can be disabled to prevent accidental execution of zero and atmospheric adjustments.

Command:	@253SW!OFF;FF
Command values:	ON,OFF
Command reply:	@253ACK;FF
Query:	@253SW?;FF
Query reply:	@253ACKON;FF
Factory default:	ON

Transducer test

The transducer test command can be used to visually identify a transducer. If the test mode is enabled the LED will flash with a 1 sec. cycle time.

Command:	@253TST!ON;FF
Command values:	ON,OFF
Command reply:	@253ACK;FF
Query:	@253TST?;FF
Query reply:	@253ACKON;FF
Factory default:	OFF

Status Query Commands

Query replies are examples that might be different from actual transducer reply.

Device Type - DT

Specifies transducer device type name:

Query:	@253DT?;FF
Query reply:	@253ACKPiezo;FF

Firmware Version - FV

Specifies transducer firmware version:

Query:	@253FV?;FF
Query reply:	@253ACK1.00;FF

Hardware Version - HV

Specifies transducer hardware version:

Query:	@253HV?;FF
Query reply:	@253ACKA;FF

Manufacturer - MF

Specifies transducer manufacturer:

Query:	@253MF?;FF
Query reply:	@253ACKMKS;FF

Model - MD

Specifies transducer model number:

Query:	@253MD?;FF
Query reply:	@253ACK902B;FF

Part Number - PN

Specifies transducer part number:

Query:	@253PN?;FF
Query reply:	@253ACK902B-11030;FF

Serial Number - SN

Specifies transducer serial number:

Query:	@253SN?;FF
Query reply:	@253ACK0825123456;FF

Time ON - TIM

The TIM command returns the number of hours the transducer has been on:

Query:	@253TIM?;FF
Query reply:	@253ACK123;FF

Temperature - TEM

The TEM command returns the MicroPirani on chip sensor temperature °C within ±3 °C.

Query:	@253TEM?;FF
Query reply:	@253ACK25;FF

Transducer Status - T

The T command returns the MicroPirani sensor status as O for OK, M for MicroPirani fail or Z for Piezo fail.

Query:	@253T?;FF
Query reply:	@253ACKO;FF

Analog output

The 902B transducer provides a voltage output as function of pressure. The 902B is available with a selection of factory configured outputs determined by the part numbers listed below. The default analog output calibration is “14” corresponding to the Linear10 functions stated below for the units: torr, mbar and pascal.

	Flange	Interface	Analog out	Connector Relays	Enclosure sealing
902B-	1	1	0	2	0

Analog out	
0	0-10 V, (Linear 10 mV/Torr/mbar)
1	0-5 V, (Linear 5 mV/Torr/mbar)
2	2-10 V (LOG10)
3	1-5 V (LOG5)
4	1 V/decade
5	0-10 V (100 mV/Torr)
6	1-9.8 V

Analog output calibration = 0 (Linear10 10mV/Torr/mbar)

$P_{Torr} = V_{out} \times 100$

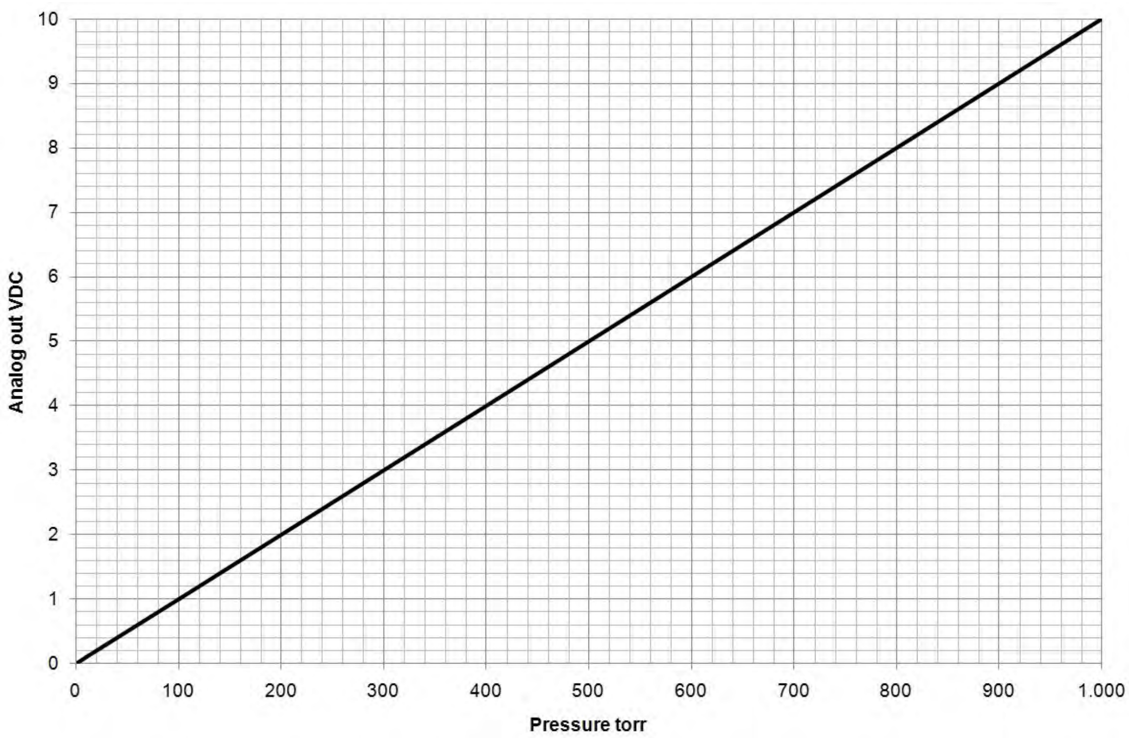
$P_{mbar} = V_{out} \times 100$

$P_{Pascal} = V_{out} \times 10{,}000$

$V_{out} = P_{Torr} / 100$

$V_{out} = P_{mbar} / 100$

$V_{out} = P_{Pascal} / 10{,}000$



Torr	mbar	Pascal	V_{out}
1.0	1.33	1.33E+2	0.010
5.0	6.66	66.66E+2	0.050
10.0	13.3	1.333E+3	0.100
50.0	66.66	6.66E+3	0.500
100.0	133.3	1.333E+4	1.000
500.0	666.6	6.666E+4	5.000
1,000	1333.2	1.3332E+5	10.000

Analog output setup

The 902B can emulate analog voltage outputs from other vacuum transducers. The 902B analog output can be assigned to the absolute Piezo sensor. The parameter digit represents the analog output calibration. The primary analog output provides 16 bit resolution.

☞ **Due to curve form and limits, some of the alternative analog outputs will cause loss of measuring range and accuracy. For best performance use the standard MKS analog output. Change of analog output setup does not interfere on digital reading.**

Change of analog output setup:

Command:	@253AO1!15;FF
Command values:	10 to 319 (xy)
First digit (x)	1 = PR1 (MicroPirani pressure value assignment)
	2 = PR2 (Piezo pressure value assignment)
	3 = PR3 (Combined pressure value assignment)
Second digit (y)	0 = MKS Standard (1 VDC/decade)
	1 = Edwards APG-L (1.99 -10 VDC)
	2 = Edwards APG100
	3 = Edwards WRG
	4 = Inficon PSG500 /Oerlikon/Leybold TTR91
	5 = Inficon MPG400 / Pfeiffer PKR251
	6 = Inficon BPG400 / MKS 999 Quattro
	7 = Brooks / Granville Phillips GP275
	8 = MKS Moducell 325
	9 = MKS Moducell 325 (x3)
	10 = MKS Baratron 0.1 Torr (0-10 VDC)
	11 = MKS Baratron 1 Torr (0-10 VDC) / Hasting 2002OBE, Channel 2
	12 = MKS Baratron 10 Torr (0-10 VDC)
	13 = MKS Baratron 100 Torr (0-10 VDC)
	14 = MKS Baratron 1000 Torr (0-10 VDC) / Linear10
	15 = Piezo differential output
	16 = Edwards AIM-S /-SL
	17 = Edwards AIM-X / XL
	18 = Pfeiffer IKR251
	19 = Pfeiffer TPR 265
	20 = OBE Channel 2 special
	21 = Edwards DV6M
	22 = Edwards APG-M
	23 = Brooks / Granville Phillips GP275 (0-9 VDC)
	24 = MT 241.1
	25 = Brooks / Granville Phillips GP275 (0-5.6 VDC)
	26 = Edwards APG100-LC
	27 = Edwards APG100M
	28 = MKS 907
	29 = K6080-06
	30 = Inficon PEG100
	31 = Varian Eyesys
	32 = Alcatel TA111
	33 = MKS 685
	34 = Linear5
	35 = Log10
	36 = Log5
Command reply:	@253ACK105;FF
Query:	@253AO1?;FF
Query reply:	@253ACK105;FF
Factory default:	35

Dual analog output

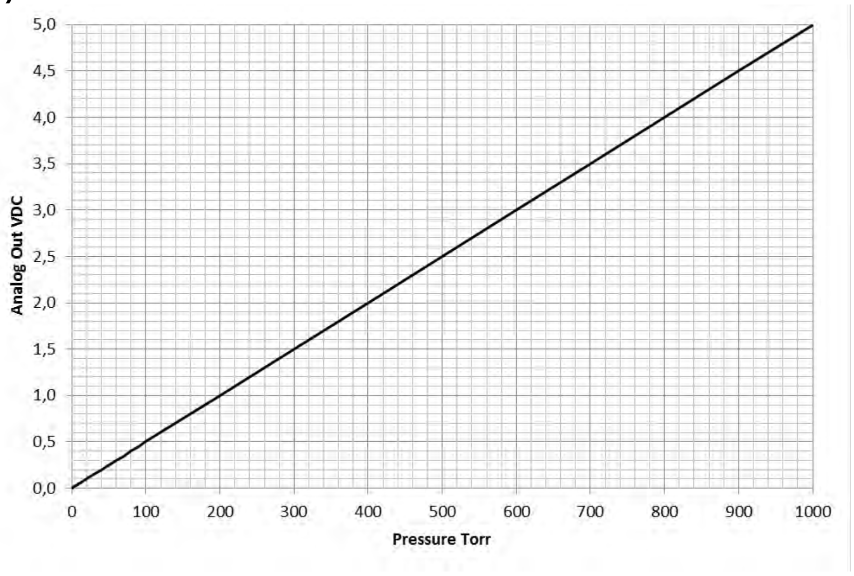
The 902B is available with dual analog output which can be used to provide an alternative output for amplification of range or to emulate another transducer type while still using the MKS standard output.
This feature is a hardware option and must be specially ordered. Refer to part number specifications page 3.
The secondary analog output provides 12 bit resolution.

Command:	@253AO2!15;FF
Command values:	10 to 319 (xy)
First digit (x)	*Use same parameters as primary analog output*
Second digit (y)	*Use same parameters as primary analog output*
Command reply:	@253ACK105;FF
Query:	@253AO2?;FF
Query reply:	@253ACK105;FF
Factory default:	35

Analog Output calibration = 1 (Linear5)

$P\ (Torr) = V_{out} \times 200$
$V_{out} = P\ (Torr) / 200$

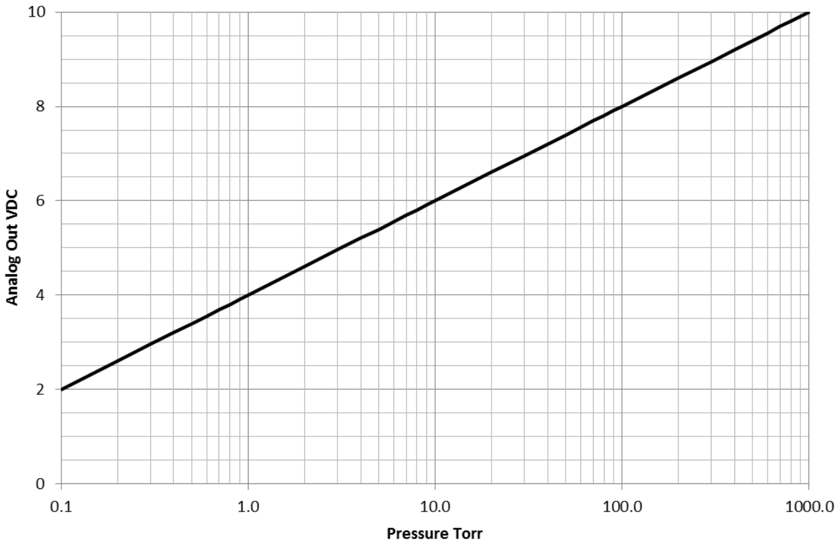
Torr	mbar	Pascal	V_{out}
	Power Off		0.0000
1.00E-01	1.33E-01	1.33E+01	0.0005
2.00E-01	2.66E-01	2.66E+01	0.0010
3.00E-01	3.99E-01	3.99E+01	0.0015
4.00E-01	5.32E-01	5.32E+01	0.0020
5.00E-01	6.65E-01	6.65E+01	0.0025
6.00E-01	7.98E-01	7.98E+01	0.0030
7.00E-01	9.31E-01	9.31E+01	0.0035
8.00E-01	1.06E+00	1.06E+02	0.0040
9.00E-01	1.20E+00	1.20E+02	0.0045
1.00E+00	1.33E+00	1.33E+02	0.0050
2.00E+00	2.66E+00	2.66E+02	0.0100
3.00E+00	3.99E+00	3.99E+02	0.0150
4.00E+00	5.32E+00	5.32E+02	0.0200
5.00E+00	6.65E+00	6.65E+02	0.0250
6.00E+00	7.98E+00	7.98E+02	0.0300
7.00E+00	9.31E+00	9.31E+02	0.0350
8.00E+00	1.06E+01	1.06E+03	0.0400
9.00E+00	1.20E+01	1.20E+03	0.0450
1.00E+01	1.33E+01	1.33E+03	0.0500
2.00E+01	2.66E+01	2.66E+03	0.1000
3.00E+01	3.99E+01	3.99E+03	0.1500
4.00E+01	5.32E+01	5.32E+03	0.2000
5.00E+01	6.65E+01	6.65E+03	0.2500
6.00E+01	7.98E+01	7.98E+03	0.3000
7.00E+01	9.31E+01	9.31E+03	0.3500
8.00E+01	1.06E+02	1.06E+04	0.4000
9.00E+01	1.20E+02	1.20E+04	0.4500
1.00E+02	1.33E+02	1.33E+04	0.5000
2.00E+02	2.66E+02	2.66E+04	1.0000
3.00E+02	3.99E+02	3.99E+04	1.5000
4.00E+02	5.32E+02	5.32E+04	2.0000
5.00E+02	6.65E+02	6.65E+04	2.5000
6.00E+02	7.98E+02	7.98E+04	3.0000
7.00E+02	9.31E+02	9.31E+04	3.5000
8.00E+02	1.06E+03	1.06E+05	4.0000
9.00E+02	1.20E+03	1.20E+05	4.5000
1.00E+03	1.33E+03	1.33E+05	5.0000



Analog Output calibration = 2 (Log10)

P (Torr) = $10^{Vout/2-2}$
V_{out} = 2*(log(P (Torr))+2)

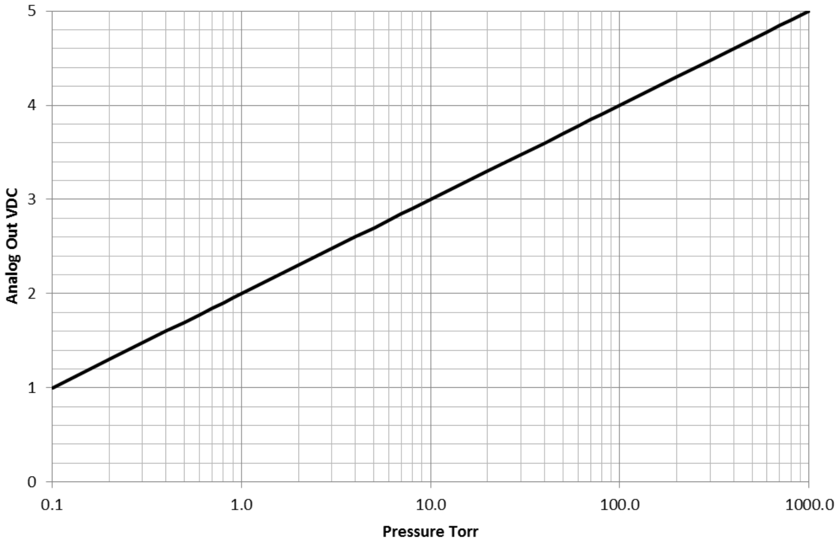
Torr	mbar	Pascal	V_{out}
	Power Off		0.0000
1.00E-01	1.33E-01	1.33E+01	2.0000
2.00E-01	2.66E-01	2.66E+01	2.6021
3.00E-01	3.99E-01	3.99E+01	2.9542
4.00E-01	5.32E-01	5.32E+01	3.2041
5.00E-01	6.65E-01	6.65E+01	3.3979
6.00E-01	7.98E-01	7.98E+01	3.5563
7.00E-01	9.31E-01	9.31E+01	3.6902
8.00E-01	1.06E+00	1.06E+02	3.8062
9.00E-01	1.20E+00	1.20E+02	3.9085
1.00E+00	1.33E+00	1.33E+02	4.0000
2.00E+00	2.66E+00	2.66E+02	4.6021
3.00E+00	3.99E+00	3.99E+02	4.9542
4.00E+00	5.32E+00	5.32E+02	5.2041
5.00E+00	6.65E+00	6.65E+02	5.3979
6.00E+00	7.98E+00	7.98E+02	5.5563
7.00E+00	9.31E+00	9.31E+02	5.6902
8.00E+00	1.06E+01	1.06E+03	5.8062
9.00E+00	1.20E+01	1.20E+03	5.9085
1.00E+01	1.33E+01	1.33E+03	6.0000
2.00E+01	2.66E+01	2.66E+03	6.6021
3.00E+01	3.99E+01	3.99E+03	6.9542
4.00E+01	5.32E+01	5.32E+03	7.2041
5.00E+01	6.65E+01	6.65E+03	7.3979
6.00E+01	7.98E+01	7.98E+03	7.5563
7.00E+01	9.31E+01	9.31E+03	7.6902
8.00E+01	1.06E+02	1.06E+04	7.8062
9.00E+01	1.20E+02	1.20E+04	7.9085
1.00E+02	1.33E+02	1.33E+04	8.0000
2.00E+02	2.66E+02	2.66E+04	8.6021
3.00E+02	3.99E+02	3.99E+04	8.9542
4.00E+02	5.32E+02	5.32E+04	9.2041
5.00E+02	6.65E+02	6.65E+04	9.3979
6.00E+02	7.98E+02	7.98E+04	9.5563
7.00E+02	9.31E+02	9.31E+04	9.6902
8.00E+02	1.06E+03	1.06E+05	9.8062
9.00E+02	1.20E+03	1.20E+05	9.9085
1.00E+03	1.33E+03	1.33E+05	10.0000



Analog Output calibration = 3 (Log5)

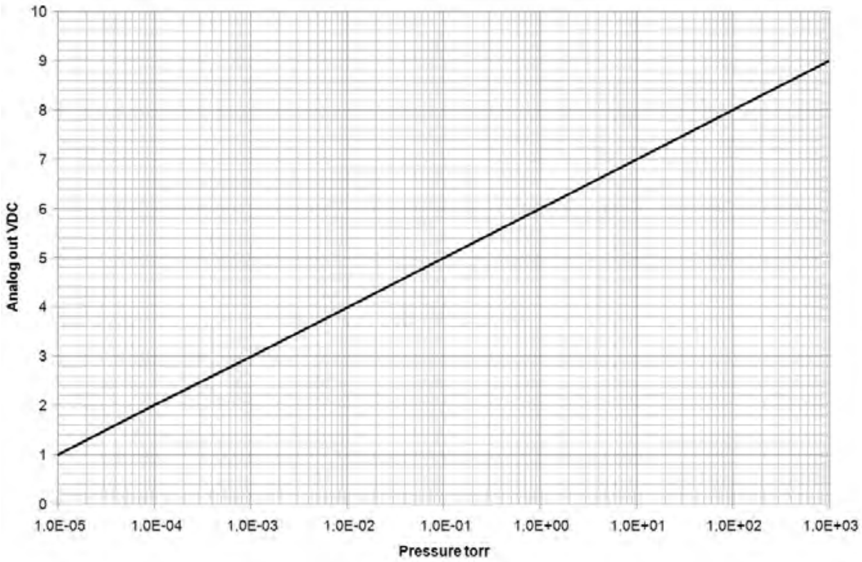
P (Torr) = 10^{Vout-2}
V_{out} = log(P (Torr))+2

Torr	mbar	Pascal	V_{out}
	Power Off		0.0000
1.00E-01	1.33E-01	1.33E+01	1.0000
2.00E-01	2.66E-01	2.66E+01	1.3010
3.00E-01	3.99E-01	3.99E+01	1.4771
4.00E-01	5.32E-01	5.32E+01	1.6021
5.00E-01	6.65E-01	6.65E+01	1.6990
6.00E-01	7.98E-01	7.98E+01	1.7782
7.00E-01	9.31E-01	9.31E+01	1.8451
8.00E-01	1.06E+00	1.06E+02	1.9031
9.00E-01	1.20E+00	1.20E+02	1.9542
1.00E+00	1.33E+00	1.33E+02	2.0000
2.00E+00	2.66E+00	2.66E+02	2.3010
3.00E+00	3.99E+00	3.99E+02	2.4771
4.00E+00	5.32E+00	5.32E+02	2.6021
5.00E+00	6.65E+00	6.65E+02	2.6990
6.00E+00	7.98E+00	7.98E+02	2.7782
7.00E+00	9.31E+00	9.31E+02	2.8451
8.00E+00	1.06E+01	1.06E+03	2.9031
9.00E+00	1.20E+01	1.20E+03	2.9542
1.00E+01	1.33E+01	1.33E+03	3.0000
2.00E+01	2.66E+01	2.66E+03	3.3010
3.00E+01	3.99E+01	3.99E+03	3.4771
4.00E+01	5.32E+01	5.32E+03	3.6021
5.00E+01	6.65E+01	6.65E+03	3.6990
6.00E+01	7.98E+01	7.98E+03	3.7782
7.00E+01	9.31E+01	9.31E+03	3.8451
8.00E+01	1.06E+02	1.06E+04	3.9031
9.00E+01	1.20E+02	1.20E+04	3.9542
1.00E+02	1.33E+02	1.33E+04	4.0000
2.00E+02	2.66E+02	2.66E+04	4.3010
3.00E+02	3.99E+02	3.99E+04	4.4771
4.00E+02	5.32E+02	5.32E+04	4.6021
5.00E+02	6.65E+02	6.65E+04	4.6990
6.00E+02	7.98E+02	7.98E+04	4.7782
7.00E+02	9.31E+02	9.31E+04	4.8451
8.00E+02	1.06E+03	1.06E+05	4.9031
9.00E+02	1.20E+03	1.20E+05	4.9542
1.00E+03	1.33E+03	1.33E+05	5.0000



Analog output calibration = 4 (MKS standard 1 VDC/decade)
The standard MKS analog output provides always 1VDC/decade. If the transducer pressure unit is changed from Torr to Pascal or mbar the analog output scaling will change as well, so it represents 1VDC/decade Torr or 1VDC/decade mbar or Pa.

$P_{Torr} = 10^{(Vout-6)}$ $V_{out} = \log(P_{Torr}) + 6$
$P_{mbar} = 10^{(Vout-6)}$ $V_{out} = \log(P_{mbar}) + 6$
$P_{Pascal} = 10^{(Vout-4)}$ $V_{out} = \log(P_{Pascal}) + 4$



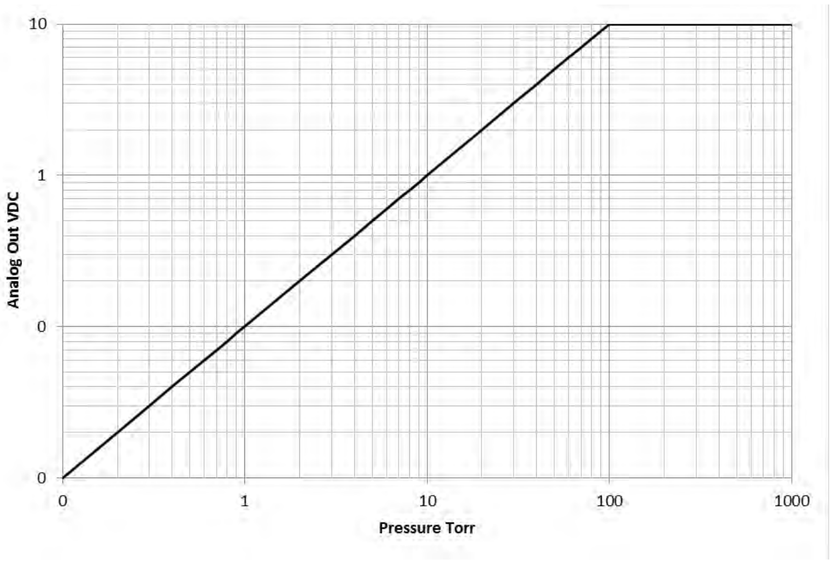
Torr/mbar	Vout	Torr/mbar	Vout	Torr/mbar	Vout	Torr/mbar	Vout
1.0E-5	1.000	1.0E-3	3.000	1.0E-1	5.000	10	7.000
2.0E-5	1.301	2.0E-3	3.301	2.0E-1	5.301	20	7.301
3.0E-5	1.477	3.0E-3	3.477	3.0E-1	5.477	30	7.477
4.0E-5	1.602	4.0E-3	3.602	4.0E-1	5.602	40	7.602
5.0E-5	1.699	5.0E-3	3.699	5.0E-1	5.699	50	7.699
6.0E-5	1.778	6.0E-3	3.778	6.0E-1	5.778	60	7.778
7.0E-5	1.845	7.0E-3	3.845	7.0E-1	5.845	70	7.845
8.0E-5	1.903	8.0E-3	3.903	8.0E-1	5.903	80	7.903
9.0E-5	1.954	9.0E-3	3.954	9.0E-1	5.954	90	7.954
1.0E-4	2.000	1.0E-2	4.000	1.0	6.000	100	8.000
2.0E-4	2.301	2.0E-2	4.301	2.0	6.301	200	8.301
3.0E-4	2.477	3.0E-2	4.477	3.0	6.477	300	8.477
4.0E-4	2.602	4.0E-2	4.602	4.0	6.602	400	8.602
5.0E-4	2.699	5.0E-2	4.699	5.0	6.699	500	8.699
6.0E-4	2.778	6.0E-2	4.778	6.0	6.778	600	8.778
7.0E-4	2.845	7.0E-2	4.845	7.0	6.845	700	8.845
8.0E-4	2.903	8.0E-2	4.903	8.0	6.903	760	8.881
9.0E-4	2.954	9.0E-2	4.954	9.0	6.954	800	8.903

Analog output calibration = 5 (linear 100 mV/Torr from 0-100 Torr)
Provides a linear analog output with 100 mV/Torr in the range 0-100 Torr. The analog output from 100-1000 Torr is at a constant value of 10 VDC.

$P_{Torr} = 10 \times V_{out}$

$V_{out} = 0.1 \times P_{Torr}$

Torr	mbar	Pascal	V_{out}
0	0	0,00E+00	0
10	13,3	1,33E+03	1
20	26,6	2,66E+03	2
30	39,9	3,99E+03	3
40	53,2	5,32E+03	4
50	66,5	6,65E+03	5
60	79,8	7,98E+03	6
70	93,1	9,31E+03	7
80	106,4	1,06E+04	8
90	119,7	1,20E+04	9
100	133	1,33E+04	10
1000	1330	1,33E+05	10

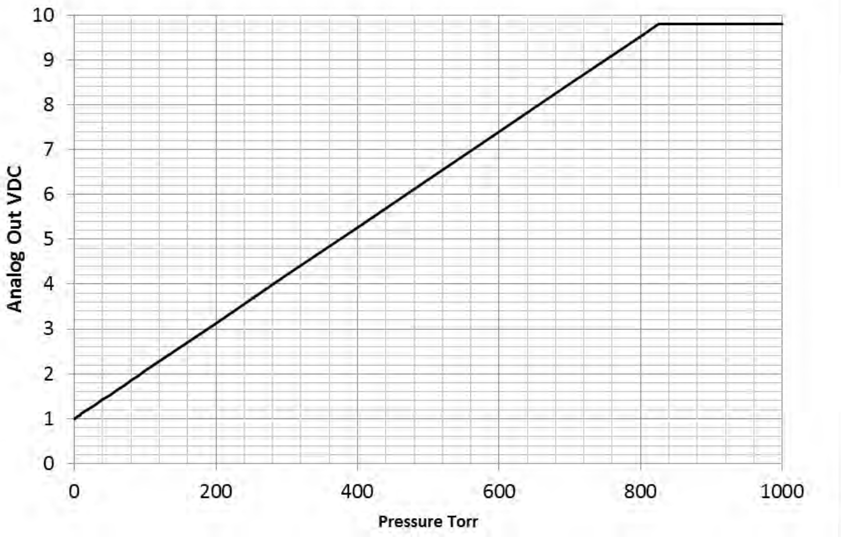


Analog output calibration = 6 (linear 1-9.8 VDC)
Provides a linear analog output in the range 0-825 Torr. The analog output from 825-1000 Torr is at a constant value of 9.8 VDC.

$P_{Torr} = 93{,}763 \times (V_{out} - 1)$

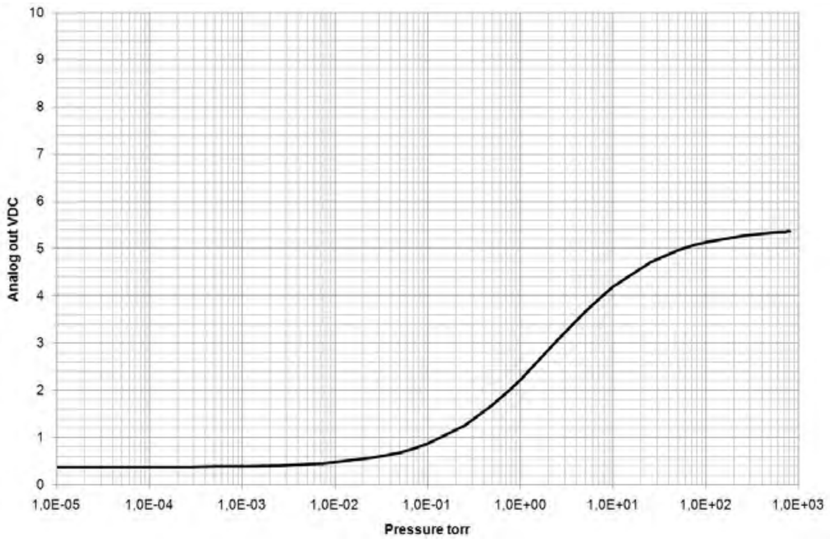
$V_{out} = 1 + 1.067 \times 10^{-2} \times P_{Torr}$

Torr	mbar	Pascal	V_{out}
0	**0**	**0,00E+00**	**1,00**
100	**133**	**1,33E+04**	**2,07**
200	**266**	**2,66E+04**	**3,13**
300	**399**	**3,99E+04**	**4,20**
400	**532**	**5,32E+04**	**5,27**
500	**665**	**6,65E+04**	**6,33**
600	**798**	**7,98E+04**	**7,40**
700	**931**	**9,31E+04**	**8,47**
800	**1064**	**1,06E+05**	**9,53**
825	**1097**	**1,10E+05**	**9,80**
1000	**1330**	**1,33E+05**	**9,80**



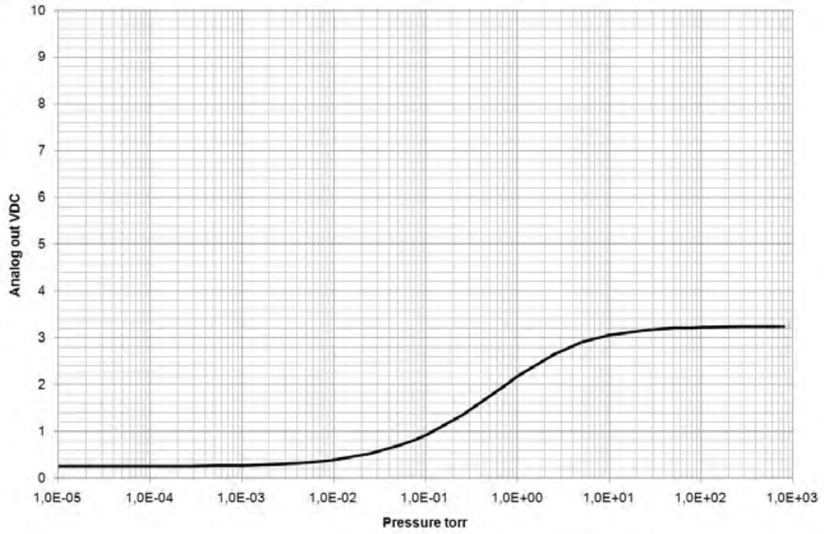
Analog output calibration = 7 (Brooks / Granville Phillips GP275 emulation)
The GP275 emulation provides a strongly non-linear output with very poor resolution in the low range and close to atmospheric pressure.

Torr	mbar	Pascal	V_{out}
1.00E-05	1.33E-05	1.33E-03	0.372
1.00E-04	1.33E-04	1.33E-02	0.372
2.50E-04	3.33E-04	3.33E-02	0.376
5.00E-04	6.67E-04	6.67E-02	0.381
7.50E-04	1.00E-03	1.00E-01	0.385
1.00E-03	1.33E-03	1.33E-01	0.388
2.50E-03	3.33E-03	3.33E-01	0.406
5.00E-03	6.67E-03	6.67E-01	0.431
7.50E-03	1.00E-02	1.00E+00	0.452
1.00E-02	1.33E-02	1.33E+00	0.470
2.50E-02	3.33E-02	3.33E+00	0.563
5.00E-02	6.67E-02	6.67E+00	0.682
7.50E-02	1.00E-01	1.00E+01	0.780
1.00E-01	1.33E-01	1.33E+01	0.867
2.50E-01	3.33E-01	3.33E+01	1.255
5.00E-01	6.67E-01	6.67E+01	1.684
7.50E-01	1.00E+00	1.00E+02	1.990
1.00E+00	1.33E+00	1.33E+02	2.228
2.50E+00	3.33E+00	3.33E+02	3.053
5.00E+00	6.67E+00	6.67E+02	3.664
7.50E+00	1.00E+01	1.00E+03	3.986
1.00E+01	1.33E+01	1.33E+03	4.191
2.50E+01	3.33E+01	3.33E+03	4.706
5.00E+01	6.67E+01	6.67E+03	4.965
7.50E+01	1.00E+02	1.00E+04	5.075
1.00E+02	1.33E+02	1.33E+04	5.137
2.50E+02	3.33E+02	3.33E+04	5.274
5.00E+02	6.67E+02	6.67E+04	5.333
6.00E+02	8.00E+02	8.00E+04	5.345
7.00E+02	9.33E+02	9.33E+04	5.353
7.60E+02	1.01E+03	1.01E+05	5.357
8.00E+02	1.07E+03	1.07E+05	5.360



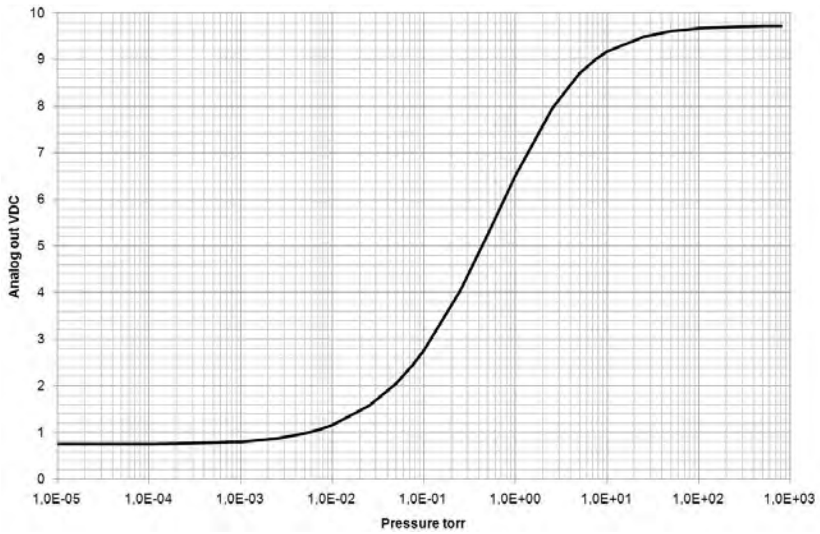
Analog output calibration = 8 (MKS Moducell 325)
The Moducell emulation provides a strongly non-linear output.

Torr	mbar	Pascal	V_{out}
1.00E-05	1.33E-05	1.33E-03	0.2509
1.00E-04	1.33E-04	1.33E-02	0.2524
2.50E-04	3.33E-04	3.33E-02	0.2550
5.00E-04	6.67E-04	6.67E-02	0.2592
7.50E-04	1.00E-03	1.00E-01	0.2633
1.00E-03	1.33E-03	1.33E-01	0.2674
2.50E-03	3.33E-03	3.33E-01	0.2905
5.00E-03	6.67E-03	6.67E-01	0.3251
7.50E-03	1.00E-02	1.00E+00	0.3561
1.00E-02	1.33E-02	1.33E+00	0.3845
2.50E-02	3.33E-02	3.33E+00	0.5215
5.00E-02	6.67E-02	6.67E+00	0.6868
7.50E-02	1.00E-01	1.00E+01	0.8144
1.00E-01	1.33E-01	1.33E+01	0.9205
2.50E-01	3.33E-01	3.33E+01	1.3489
5.00E-01	6.67E-01	6.67E+01	1.7504
7.50E-01	1.00E+00	1.00E+02	1.9986
1.00E+00	1.33E+00	1.33E+02	2.1720
2.50E+00	3.33E+00	3.33E+02	2.6512
5.00E+00	6.67E+00	6.67E+02	2.9012
7.50E+00	1.00E+01	1.00E+03	3.0022
1.00E+01	1.33E+01	1.33E+03	3.0569
2.50E+01	3.33E+01	3.33E+03	3.1639
5.00E+01	6.67E+01	6.67E+03	3.2023
7.50E+01	1.00E+02	1.00E+04	3.2154
1.00E+02	1.33E+02	1.33E+04	3.2221
2.50E+02	3.33E+02	3.33E+04	3.2342
5.00E+02	6.67E+02	6.67E+04	3.2382
6.00E+02	8.00E+02	8.00E+04	3.2389
7.00E+02	9.33E+02	9.33E+04	3.2394
7.60E+02	1.01E+03	1.01E+05	3.2396
8.00E+02	1.07E+03	1.07E+05	3.2398



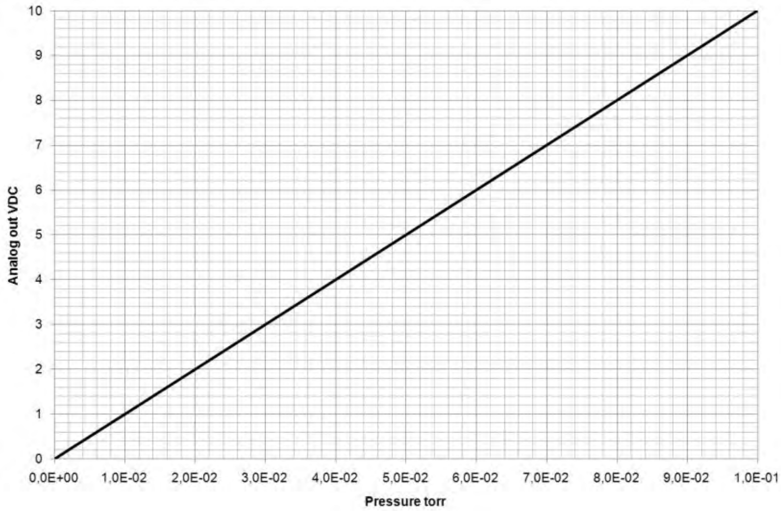
Analog out calibration = 9 (MKS Moducell 325, amplified three times)
The Moducell x3 emulation is in curve form identical with the standard Moducell, however, to provide better signal resolution the signal is amplified by a factor of three.

Torr	mbar	Pascal	V_{out}
1.00E-05	1.33E-05	1.33E-03	0.753
1.00E-04	1.33E-04	1.33E-02	0.757
2.50E-04	3.33E-04	3.33E-02	0.765
5.00E-04	6.67E-04	6.67E-02	0.778
7.50E-04	1.00E-03	1.00E-01	0.790
1.00E-03	1.33E-03	1.33E-01	0.802
2.50E-03	3.33E-03	3.33E-01	0.871
5.00E-03	6.67E-03	6.67E-01	0.975
7.50E-03	1.00E-02	1.00E+00	1.068
1.00E-02	1.33E-02	1.33E+00	1.154
2.50E-02	3.33E-02	3.33E+00	1.565
5.00E-02	6.67E-02	6.67E+00	2.060
7.50E-02	1.00E-01	1.00E+01	2.443
1.00E-01	1.33E-01	1.33E+01	2.762
2.50E-01	3.33E-01	3.33E+01	4.047
5.00E-01	6.67E-01	6.67E+01	5.251
7.50E-01	1.00E+00	1.00E+02	5.996
1.00E+00	1.33E+00	1.33E+02	6.516
2.50E+00	3.33E+00	3.33E+02	7.954
5.00E+00	6.67E+00	6.67E+02	8.704
7.50E+00	1.00E+01	1.00E+03	9.007
1.00E+01	1.33E+01	1.33E+03	9.171
2.50E+01	3.33E+01	3.33E+03	9.492
5.00E+01	6.67E+01	6.67E+03	9.607
7.50E+01	1.00E+02	1.00E+04	9.646
1.00E+02	1.33E+02	1.33E+04	9.666
2.50E+02	3.33E+02	3.33E+04	9.702
5.00E+02	6.67E+02	6.67E+04	9.715
6.00E+02	8.00E+02	8.00E+04	9.717
7.00E+02	9.33E+02	9.33E+04	9.718
7.60E+02	1.01E+03	1.01E+05	9.719
8.00E+02	1.07E+03	1.07E+05	9.719



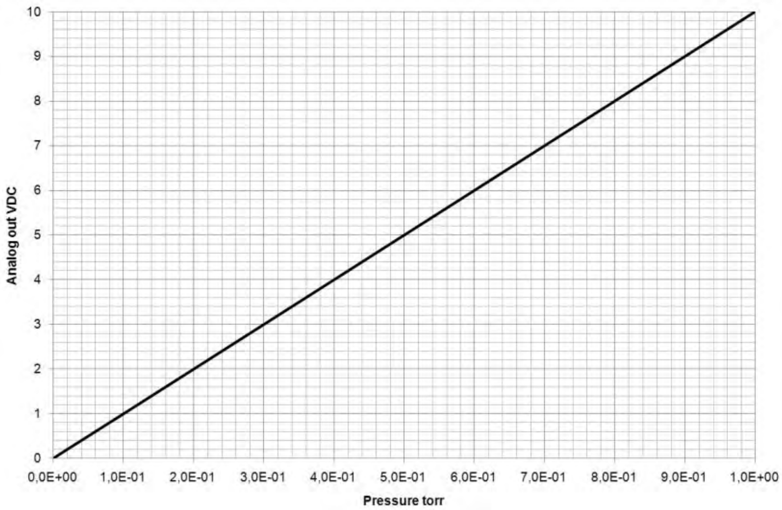
Analog output calibration = 10 (MKS Baratron 0.1 Torr)
The 0.1 Torr Baratron emulation provides a signal directly proportional with pressure with a full scale reading of 10 VDC at 0.1 Torr.

Torr	mbar	Pascal	V_{out}
1.00E-3	1.33E-3	1.33E-1	0.100
5.00E-3	6.66E-3	6.66E-1	0.500
1.00E-2	1.33E-2	1.33E0	1.000
5.00E-2	6.66E-2	6.66E0	5.000
1.00E-1	1.33E-1	1.33E+1	10.000



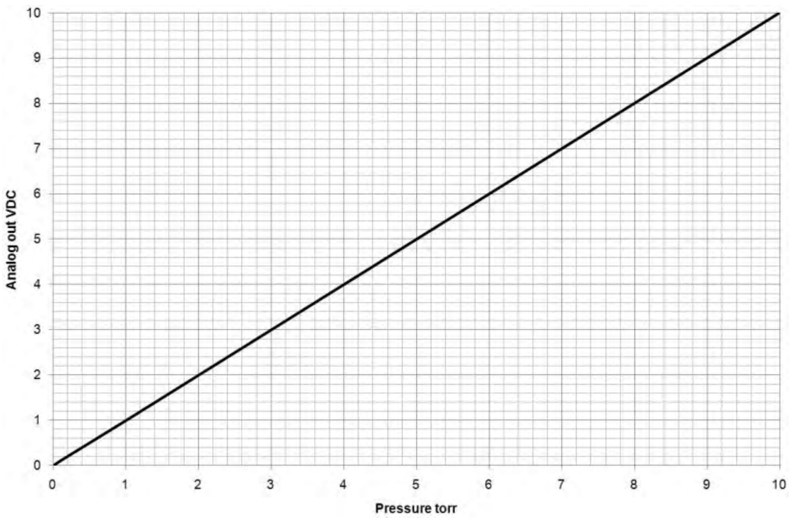
Analog output calibration = 11 (MKS Ba
The 1 Torr Baratron emulation provides a s
10 VDC at 1 Torr.

Torr	mbar	Pascal	V_{out}
1.00E-2	1.33E-2	1.33E0	0.100
5.00E-2	6.66E-2	6.66E0	0.500
1.00E-1	1.33E-1	1.33E+1	1.000
5.00E-1	6.66E-1	6.66E+1	5.000
1.00E0	1.33E0	1.33E+2	10.000



Analog output calibration = 12 (MKS Baratron 10 Torr)
The 10 Torr Baratron emulation provides a signal directly proportional with pressure with a full scale reading of 10 VDC at 10 Torr.

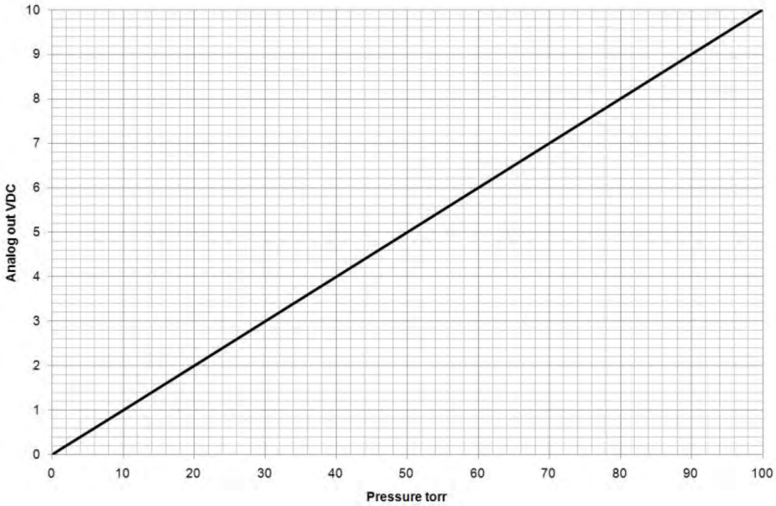
Torr	mbar	Pascal	V_{out}
1.00E-1	1.33E-1	1.33E+1	0.100
5.00E-1	6.66E-1	6.66E+1	0.500
1.00E0	1.33E0	1.33E+2	1.000
5.00E0	6.66E0	6.66E+2	5.000
1.00E+1	1.33E+1	1.33E+3	10.000



Analog output calibration = 13 (MKS Baratron 100 Torr)

The 100 Torr Baratron emulation provides a signal directly proportional with pressure with a full scale reading of 10 VDC at 100 Torr.

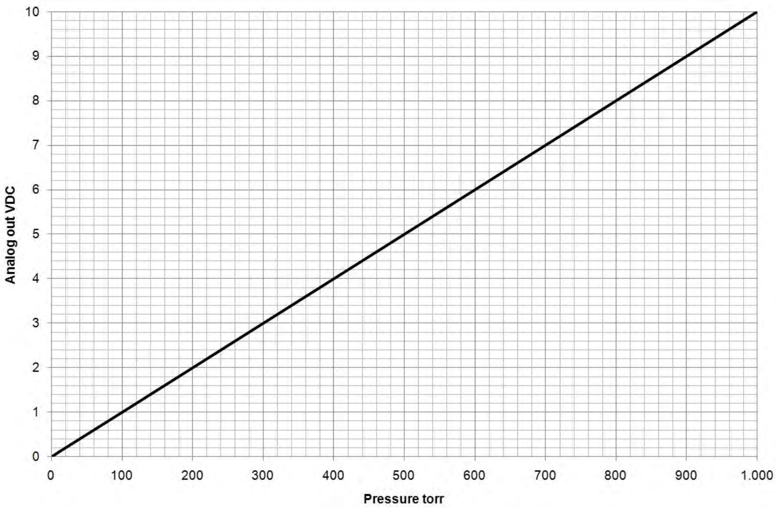
Torr	mbar	Pascal	V_{out}
1.0	1.33	1.333E+2	0.100
5.0	6.66	6.66E+2	0.500
10.0	13.3	1.333E+3	1.000
50.0	66.66	6.66E+3	5.000
100.0	133.3	1.333E+4	10.000



Analog output calibration = 14 (MKS Baratron 1000 Torr, 902B Linear10)

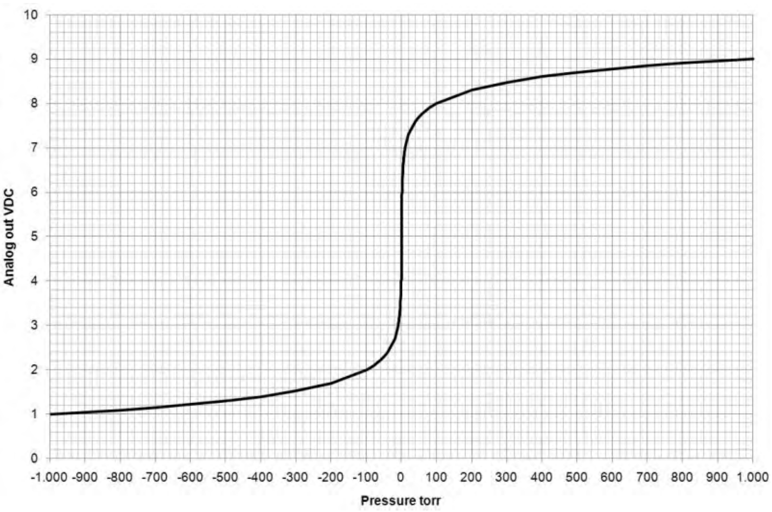
The 1000 Torr Baratron emulation provides a signal directly proportional with pressure with a full scale reading of 10 VDC at 1000 Torr.

Torr	mbar	Pascal	V_{out}
10.0	13.3	1.333E+3	0.100
50.0	66.66	6.66E+3	0.500
100.0	133.3	1.333E+4	1.000
500.0	666.6	6.666E+4	5.000
1,000	1333.2	1.3332E+5	10.000



Analog output calibration = 15 (Piezo analog output)

Torr	mbar	Pascal	V_{out}
-8.00E+2	-1.07E+3	-1.07E+5	1.10
-7.00E+2	-9.33E+2	-9.33E+4	1.15
-6.00E+2	-8.00E+2	-8.00E+4	1.22
-5.00E+2	-6.67E+2	-6.67E+4	1.30
-4.00E+2	-5.33E+2	-5.33E+4	1.40
-3.00E+2	-4.00E+2	-4.00E+4	1.52
-2.00E+2	-2.67E+2	-2.67E+4	1.70
-1.00E+2	-1.33E+2	-1.33E+4	2.00
-9.00E+1	-1.20E+2	-1.20E+4	2.05
-8.00E+1	-1.07E+2	-1.07E+4	2.10
-7.00E+1	-9.33E+1	-9.33E+3	2.15
-6.00E+1	-8.00E+1	-8.00E+3	2.22
-5.00E+1	-6.67E+1	-6.67E+3	2.30
-4.00E+1	-5.33E+1	-5.33E+3	2.40
-3.00E+1	-4.00E+1	-4.00E+3	2.52
-2.00E+1	-2.67E+1	-2.67E+3	2.70
-1.00E+1	-1.33E+1	-1.33E+3	3.00
-9.00E+0	-1.20E+1	-1.20E+3	3.05
-8.00E+0	-1.07E+1	-1.07E+3	3.10
-7.00E+0	-9.33E+0	-9.33E+2	3.15
-6.00E+0	-8.00E+0	-8.00E+2	3.22
-5.00E+0	-6.67E+0	-6.67E+2	3.30
-4.00E+0	-5.33E+0	-5.33E+2	3.40
-3.00E+0	-4.00E+0	-4.00E+2	3.52
-2.00E+0	-2.67E+0	-2.67E+2	3.70
-1.00E+0	-1.33E+0	-1.33E+2	4.00
-9.00E-1	-1.20E+0	-1.20E+2	4.05
-8.00E-1	-1.07E+0	-1.07E+2	4.10
-7.00E-1	-9.33E-1	-9.33E+1	4.15
-6.00E-1	-8.00E-1	-8.00E+1	4.22
-5.00E-1	-6.67E-1	-6.67E+1	4.30
-4.00E-1	-5.33E-1	-5.33E+1	4.40
-3.00E-1	-4.00E-1	-4.00E+1	4.52
-2.00E-1	-2.67E-1	-2.67E+1	4.70
-1.00E-1	-1.33E-1	-1.33E+1	5.00
1.00E-1	1.33E-1	1.33E+1	5.00
2.00E-1	2.67E-1	2.67E+1	5.30
3.00E-1	4.00E-1	4.00E+1	5.48
4.00E-1	5.33E-1	5.33E+1	5.60
5.00E-1	6.67E-1	6.67E+1	5.70
6.00E-1	8.00E-1	8.00E+1	5.78
7.00E-1	9.33E-1	9.33E+1	5.85
8.00E-1	1.07E+0	1.07E+2	5.90
9.00E-1	1.20E+0	1.20E+2	5.95
1.00E+0	1.33E+0	1.33E+2	6.00
2.00E+0	2.67E+0	2.67E+2	6.30
3.00E+0	4.00E+0	4.00E+2	6.48
4.00E+0	5.33E+0	5.33E+2	6.60
5.00E+0	6.67E+0	6.67E+2	6.70
6.00E+0	8.00E+0	8.00E+2	6.78
7.00E+0	9.33E+0	9.33E+2	6.85
8.00E+0	1.07E+1	1.07E+3	6.90
9.00E+0	1.20E+1	1.20E+3	6.95
1.00E+1	1.33E+1	1.33E+3	7.00
2.00E+1	2.67E+1	2.67E+3	7.30
3.00E+1	4.00E+1	4.00E+3	7.48
4.00E+1	5.33E+1	5.33E+3	7.60
5.00E+1	6.67E+1	6.67E+3	7.70
6.00E+1	8.00E+1	8.00E+3	7.78
7.00E+1	9.33E+1	9.33E+3	7.85
8.00E+1	1.07E+2	1.07E+4	7.90
9.00E+1	1.20E+2	1.20E+4	7.95
1.00E+2	1.33E+2	1.33E+4	8.00
2.00E+2	2.67E+2	2.67E+4	8.30
3.00E+2	4.00E+2	4.00E+4	8.48
4.00E+2	5.33E+2	5.33E+4	8.60
5.00E+2	6.67E+2	6.67E+4	8.70
6.00E+2	8.00E+2	8.00E+4	8.78
7.00E+2	9.33E+2	9.33E+4	8.85
8.00E+2	1.07E+3	1.07E+5	8.90
9.00E+2	1.20E+3	1.20E+5	8.95
1.00E+3	1.33E+3	1.33E+5	9.00



For positive pressure (V_{out}>5 V)

Piezo pressure = $10^{(PZVout-6)}$

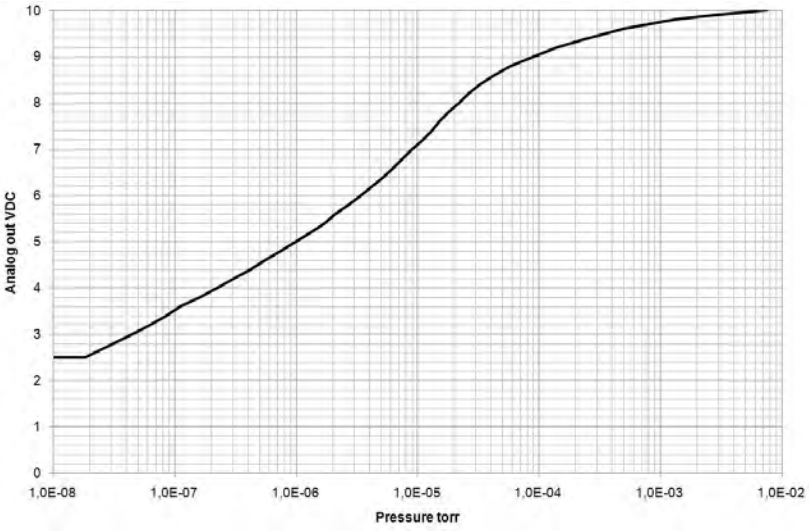
For negative pressure (V_{out}<=5V):

$$\text{Piezo pressure} = \frac{-1}{10^{(PZVout-4)}}$$

Analog output calibration = 16 (Edwards AIM-S /-SL)

The Edwards AIM-S / SL emulation provides a strongly non linear output.
The 902B provides only values above 1.00E-5 Torr.

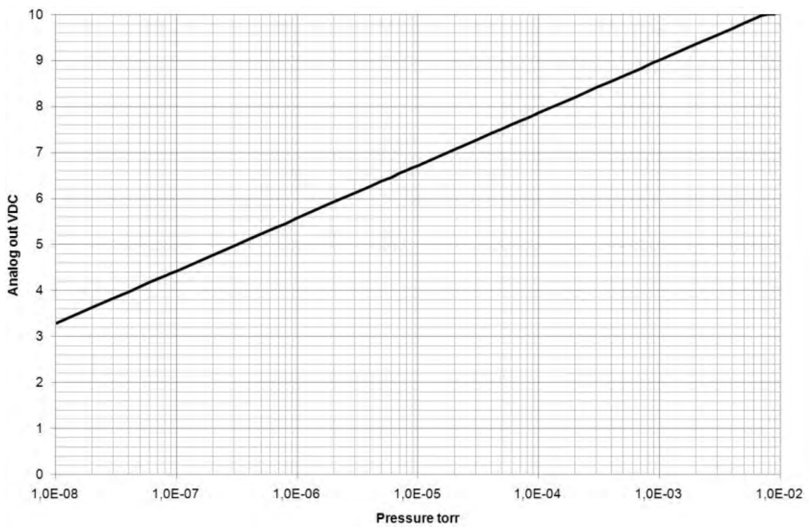
Torr	mbar	Pascal	V_{out}
1.00E-8	1.33E-8	1.33E-6	2.5
1.80E-8	2.40E-8	2.40E-6	2.5
4.40E-8	5.87E-8	5.87E-6	3
6.10E-8	8.13E-8	8.13E-6	3.2
8.30E-8	1.11E-7	1.11E-5	3.4
1.10E-7	1.47E-7	1.47E-5	3.6
2.20E-7	2.93E-7	2.93E-5	4
5.50E-7	7.33E-7	7.33E-5	4.6
7.40E-7	9.87E-7	9.87E-5	4.8
9.80E-7	1.31E-6	1.31E-4	5
1.30E-6	1.73E-6	1.73E-4	5.2
2.10E-6	2.80E-6	2.80E-4	5.6
3.40E-6	4.53E-6	4.53E-4	6
4.20E-6	5.60E-6	5.60E-4	6.2
5.20E-6	6.93E-6	6.93E-4	6.4
7.50E-6	1.00E-5	1.00E-3	6.8
9.00E-6	1.20E-5	1.20E-3	7
1.10E-5	1.47E-5	1.47E-3	7.2
2.20E-5	2.93E-5	2.93E-3	8
3.20E-5	4.27E-5	4.27E-3	8.4
4.30E-5	5.73E-5	5.73E-3	8.6
5.90E-5	7.87E-5	7.87E-3	8.8
9.00E-5	1.20E-4	1.20E-2	9
1.40E-4	1.87E-4	1.87E-2	9.2
2.5E-4	3.33E-4	3.33E-2	9.4
5.0E-4	6.67E-4	6.67E-2	9.6
1.3E-3	1.73E-3	1.73E-1	9.8
2.7E-3	3.60E-3	3.60E-1	9.9
7.5E-3	1.00E-2	1.00E+0	10



Analog output calibration = 17 (Edwards AIM-X /-XL)

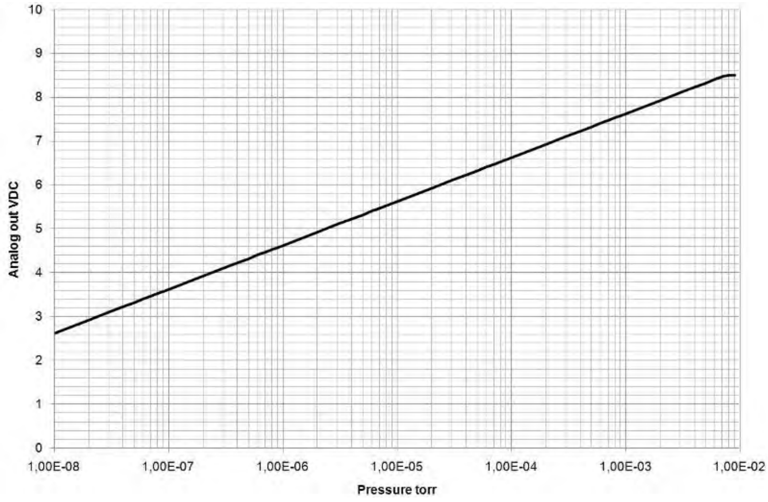
The Edwards AIM-X / XL emulation provides a log linear output.
The 902B provides only values above 1.00E-5 Torr.

Torr	mbar	Pascal	V_{out}
1.00E-8	1.33E-8	1.33E-6	3.286
5.00E-8	6.67E-8	6.67E-6	4.084
1.00E-7	1.33E-7	1.33E-5	4.428
5.00E-7	6.67E-7	6.67E-5	5.227
1.00E-6	1.33E-6	1.33E-4	5.571
5.00E-6	6.67E-6	6.67E-4	6.370
1.00E-5	1.33E-5	1.33E-3	6.714
5.00E-5	6.67E-5	6.67E-3	7.513
1.00E-4	1.33E-4	1.33E-2	7.857
5.00E-4	6.67E-4	6.67E-2	8.656
1.00E-3	1.33E-3	1.33E-1	9.000
5.00E-3	6.67E-3	6.67E-1	9.799



Analog output calibration = 18 (Pfeiffer IKR251)
The Pfeiffer IKR251 emulation provides a log linear output.
The 902B provides provide only values above 1E-5 Torr.

Torr	mbar	Pascal	V_{out}
5.00E-9	6.67E-9	6.67E-7	2.3240
1.00E-8	1.33E-8	1.33E-6	2.6250
5.00E-8	6.67E-8	6.67E-6	3.3240
1.00E-7	1.33E-7	1.33E-5	3.6250
5.00E-7	6.67E-7	6.67E-5	4.3240
1.00E-6	1.33E-6	1.33E-4	4.6250
5.00E-6	6.67E-6	6.67E-4	5.3240
1.00E-5	1.33E-5	1.33E-3	5.6250
5.00E-5	6.67E-5	6.67E-3	6.3240
1.00E-4	1.33E-4	1.33E-2	6.6250
5.00E-4	6.67E-4	6.67E-2	7.3240
1.00E-3	1.33E-3	1.33E-1	7.6250
5.00E-3	6.67E-3	6.67E-1	8.3240
9.00E-3	1.20E-2	1.20E+0	8.5000



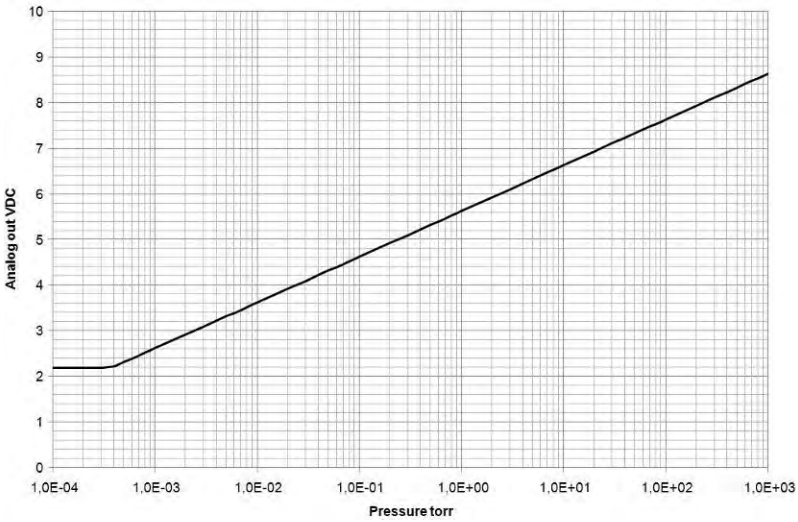
$P = 10^{(V_{out} - c)}$

$V_{out} = c + \log_{10}(P)$

	c
mbar	10.5
Torr	10.625
Pascal	8.5

Analog output calibration = 19 (Pfeiffer TPR265, Pfeiffer TPR280, Inficon TPR280)
The Pfeiffer TPR265 emulation provides a log linear output.

Torr	mbar	Pascal	V_{out}
1.00E-4	1.33E-4	1.33E-2	2.199
4.00E-4	5.33E-4	5.33E-2	2.227
5.00E-4	6.67E-4	6.67E-2	2.324
1.00E-3	1.33E3	1.33E-1	2.625
5.00E-3	6.67E-3	6.67E-1	3.324
1.00E-2	1.33E-2	1.33E+0	3.625
5.00E-2	6.67E2	6.67E+0	4.324
1.00E-1	1.33E-1	1.33E+1	4.625
5.00E-1	6.67E-1	6.67E+1	5.324
1.00E+0	1.33E+0	1.33E+2	5.625
5.00E+0	6.67E+0	6.67E+2	6.324
1.00E+1	1.33E+1	1.33E+3	6.625
5.00E+1	6.67E+1	6.67E+3	7.324
1.00E+2	1.33E+2	1.33E+4	7.625
5.00E+2	6.67E+2	6.67E+4	8.324
9.00E+2	1.20E+3	1.20E+5	8.579
1.00E+3	1.33E+3	1.33E+5	8.625



$P = 10^{(V_{out} - c)}$

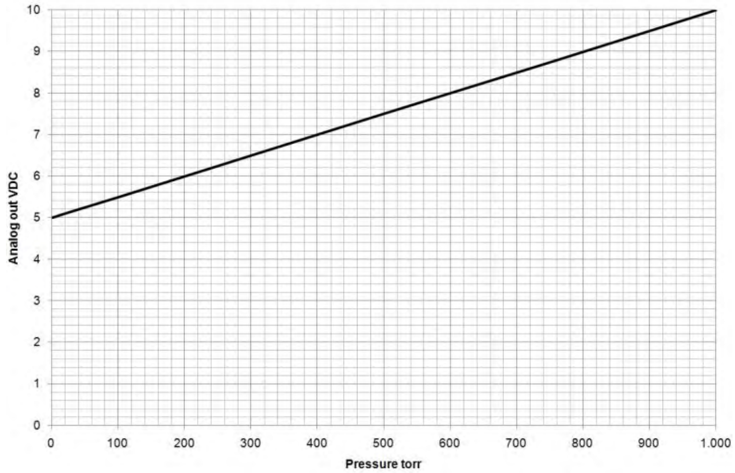
$V_{out} = c + \log_{10}(P)$

	c
mbar	5.5
Torr	5.625
Pascal	3.5

Analog output calibration = 20 (OBE Special)

The OBE special emulation provides a linear output from 1 to 1000 Torr.

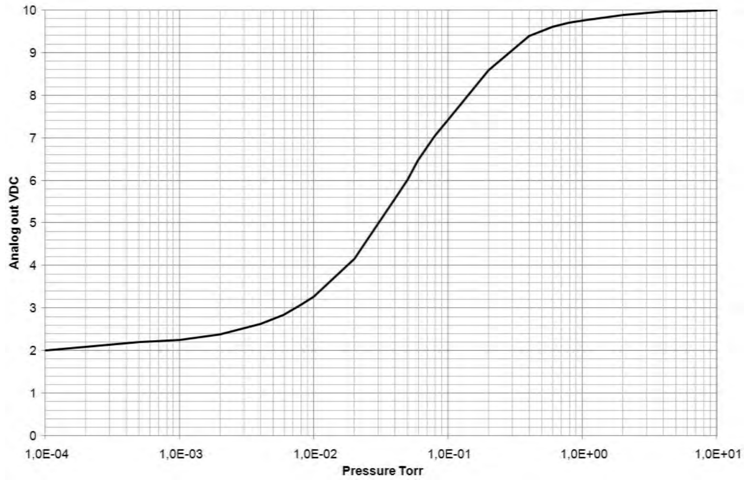
Torr	mbar	Pascal	V_{out}
0.1	1.33E-01	1.33E+01	5
1	1.33E+00	1.33E+02	5
2	2.67E+00	2.67E+02	5.005
4	5.33E+00	5.33E+02	5.015
5	6.67E+00	6.67E+02	5.02
10	1.33E+01	1.33E+03	5.045
25	3.33E+01	3.33E+03	5.12
50	6.67E+01	6.67E+03	5.245
75	1.00E+02	1.00E+04	5.37
100	1.33E+02	1.33E+04	5.495
250	3.33E+02	3.33E+04	6.245
500	6.67E+02	6.67E+04	7.495
750	1.00E+03	1.00E+05	8.745
1000	1.33E+03	1.33E+05	9.995



Analog output calibration = 21 (Edwards DV6M)

The Edwards DV6M emulation provides a strongly non linear output with up to 10 Torr.

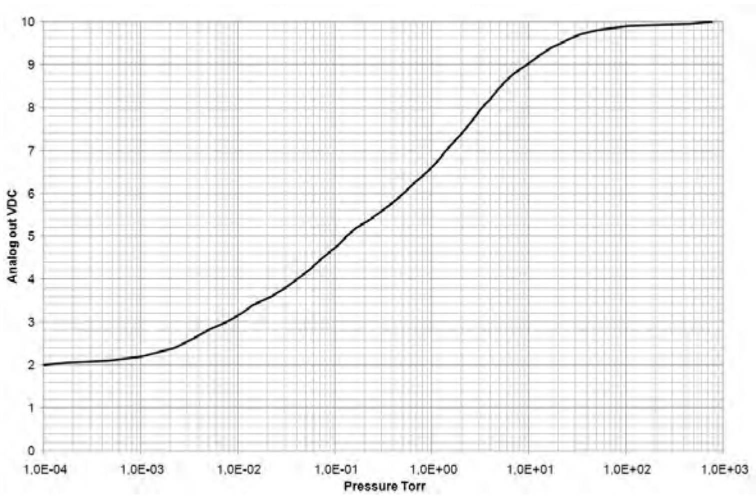
Torr	mbar	Pascal	V_{out}
0.0001	1.33E-04	1.33E-02	2
0.0005	6.67E-04	6.67E-02	2.19
0.001	1.33E-03	1.33E-01	2.25
0.002	2.67E-03	2.67E-01	2.38
0.004	5.33E-03	5.33E-01	2.62
0.006	8.00E-03	8.00E-01	2.84
0.008	1.07E-02	1.07E+00	3.06
0.01	1.33E-02	1.33E+00	3.27
0.02	2.67E-02	2.67E+00	4.16
0.04	5.33E-02	5.33E+00	5.56
0.05	6.67E-02	6.67E+00	6.01
0.06	8.00E-02	8.00E+00	6.46
0.08	1.07E-01	1.07E+01	7.04
0.1	1.33E-01	1.33E+01	7.42
0.2	2.67E-01	2.67E+01	8.59
0.4	5.33E-01	5.33E+01	9.4
0.5	6.67E-01	6.67E+01	9.5
0.6	8.00E-01	8.00E+01	9.6
0.8	1.07E+00	1.07E+02	9.71
1	1.33E+00	1.33E+02	9.76
2	2.67E+00	2.67E+02	9.89
4	5.33E+00	5.33E+02	9.96
5	6.67E+00	6.67E+02	9.97
10	1.33E+01	1.33E+03	10



Analog output calibration = 22 (Edwards APG-M)

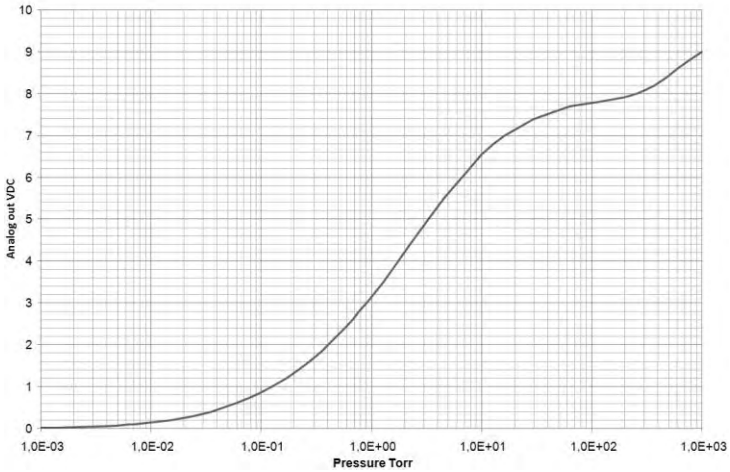
The Edwards APG-M emulation provides a strongly non linear output.

Torr	mbar	Pascal	V_{out}
1.00E-4	1.33E-4	1.33E-1	2.0
1.02E-3	1.36E-03	1.36E-01	2.2
7.65E-3	1.02E-02	1.02E+00	3
4.12E-2	5.49E-02	5.49E+00	4
1.32E-1	1.76E-01	1.76E+01	5
5.12E-1	6.83E-01	6.83E+01	6
1.4	1.87E+00	1.87E+02	7
3.29	4.39E+00	4.39E+02	8
9.53	1.27E+01	1.27E+03	9
16.8	2.24E+01	2.24E+03	9.4
26.5	3.53E+01	3.53E+03	9.6
49.9	6.65E+01	6.65E+03	9.8
106	1.41E+02	1.41E+04	9.9
462	6.16E+02	6.16E+04	9.95
760	1.01E+03	1.01E+05	10



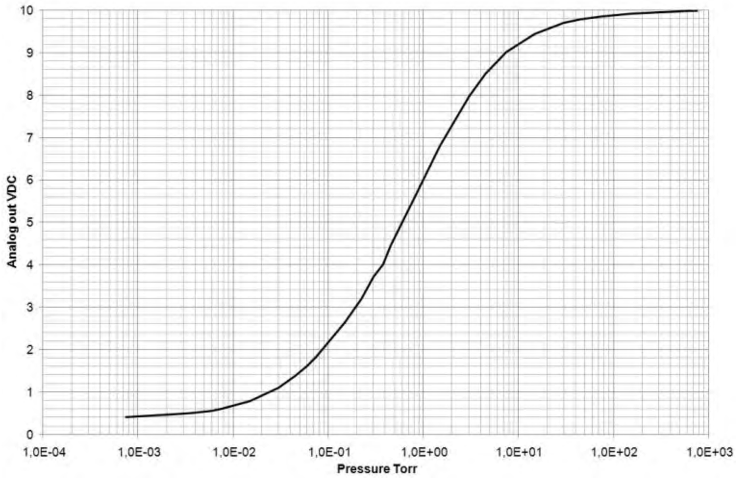
Analog output calibration = 23 (Brooks / Granville Phillips GP275 Emulation 9 VDC FS)
The GP275 emulation with 9VDC full scale provides a strongly non linear output with very poor resolution in the low range and close to atmospheric pressure.

Torr	mbar	Pascal	V_{out}
1.00E-03	1.34E-03	1.34E-01	0.015
1.32E-03	1.76E-03	1.76E-01	0.020
3.38E-03	4.51E-03	4.51E-01	0.050
4.81E-03	6.41E-03	6.41E-01	0.070
6.28E-03	8.37E-03	8.37E-01	0.090
7.03E-03	9.37E-03	9.37E-01	0.100
1.52E-02	2.02E-02	2.02E+00	0.200
2.45E-02	3.26E-02	3.26E+00	0.300
3.50E-02	4.66E-02	4.66E+00	0.400
4.67E-02	6.23E-02	6.23E+00	0.500
5.98E-02	7.97E-02	7.97E+00	0.600
7.42E-02	9.90E-02	9.90E+00	0.700
9.01E-02	1.20E-01	1.20E+01	0.800
1.07E-01	1.43E-01	1.43E+01	0.900
1.26E-01	1.68E-01	1.68E+01	1.000
1.69E-01	2.25E-01	2.25E+01	1.200
2.18E-01	2.90E-01	2.90E+01	1.400
2.74E-01	3.65E-01	3.65E+01	1.600
3.53E-01	4.71E-01	4.71E+01	1.846
0.4092	5.46E-01	5.46E+01	2.000
0.4879	6.51E-01	6.51E+01	2.200
0.5755	7.67E-01	7.67E+01	2.400
0.6734	8.98E-01	8.98E+01	2.600
0.7836	1.04E+00	1.04E+02	2.800
0.9076	1.21E+00	1.21E+02	3.000
1.02	1.36E+00	1.36E+02	3.164
1.28	1.71E+00	1.71E+02	3.500
1.77	2.37E+00	2.37E+02	4.000
2.24	2.98E+00	2.98E+02	4.390
3.26	4.34E+00	4.34E+02	5.000
4.57	6.09E+00	6.09E+02	5.500
6.65	8.86E+00	8.86E+02	6.000
10.1	1.34E+01	1.34E+03	6.548
12.9	1.71E+01	1.71E+03	6.800
16.1	2.15E+01	2.15E+03	7.000
29.4	3.92E+01	3.92E+03	7.383
56.6	7.55E+01	7.55E+03	7.647
64.1	8.55E+01	8.55E+03	7.700
114.1	1.52E+02	1.52E+04	7.800
200.7	2.68E+02	2.68E+04	7.910
257.0	3.43E+02	3.43E+04	8.000
314.3	4.19E+02	4.19E+04	8.100
368.5	4.91E+02	4.91E+04	8.200
478.0	6.37E+02	6.37E+04	8.400
606.0	8.08E+02	8.08E+04	8.600
773.1	1.03E+03	1.03E+05	8.800



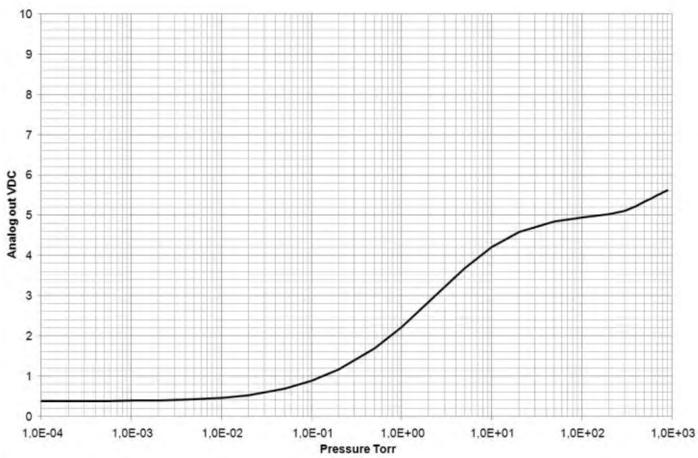
Analog output calibration = 24 (Thyracont MT241.1-5)
The MT241 emulation provides a strongly nonlinear output with limited resolution in the low range and close to atmospheric pressure.

Torr	mbar	Pascal	V_{out}
7.50E-4	1.00E-03	1.00E-01	0.41
3.00E-3	4.00E-03	4.00E-01	0.48
3.75E-3	5.00E-03	5.00E-01	0.5
6.00E-3	8.00E-03	8.00E-01	0.55
7.50E-3	1.00E-02	1.00E+00	0.61
1.50E-2	2.00E-02	2.00E+00	0.79
3.00E-2	4.00E-02	4.00E+00	1.1
4.50E-2	6.00E-02	6.00E+00	1.37
6.00E-2	8.00E-02	8.00E+00	1.6
7.50E-2	1.00E-01	1.00E+01	1.83
1.50E-1	2.00E-01	2.00E+01	2.64
2.25E-1	3.00E-01	3.00E+01	3.2
3.00E-1	4.00E-01	4.00E+01	3.71
3.75E-1	5.00E-01	5.00E+01	4
4.50E-1	6.00E-01	6.00E+01	4.45
6.00E-1	8.00E-01	8.00E+01	5
7.50E-1	1.00E+00	1.00E+02	5.44
3	4.00E+00	4.00E+02	7.96
5	6.00E+00	6.00E+02	8.5
8	1.00E+01	1.00E+03	9.01
15	2.00E+01	2.00E+03	9.45
30	4.00E+01	4.00E+03	9.7
45	6.00E+01	6.00E+03	9.78
75	1.00E+02	1.00E+04	9.85
150	2.00E+02	2.00E+04	9.92
300	4.00E+02	4.00E+04	9.95
450	6.00E+02	6.00E+04	9.96
600	8.00E+02	8.00E+04	9.98
750	1.00E+03	1.00E+05	9.99



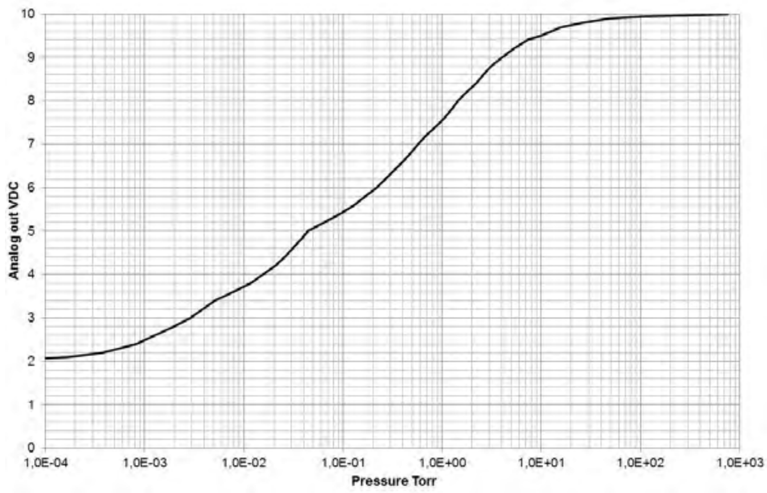
Analog output calibration = 25 (Brooks / Granville Phillips GP275 Emulation 5.6 VDC FS)
The GP275 emulation with 5.6VDC full scale provides a strongly non linear output with very poor resolution in the low range and close to atmospheric pressure.

Torr	mbar	Pascal	V_{out}
1.00E-04	1.33E-04	1.33E-02	0.375
2.00E-04	2.67E-04	2.67E-02	0.377
5.00E-04	6.67E-04	6.67E-02	0.379
1.00E-03	1.33E-03	1.33E-01	0.384
2.00E-03	2.67E-03	2.67E-01	0.392
5.00E-03	6.67E-03	6.67E-01	0.417
1.00E-02	1.33E-02	1.33E+00	0.455
2.00E-02	2.67E-02	2.67E+00	0.523
5.00E-02	6.67E-02	6.67E+00	0.682
1.00E-01	1.33E-01	1.33E+01	0.878
2.00E-01	2.67E-01	2.67E+01	1.155
5.00E-01	6.67E-01	6.67E+01	1.683
1.00E+00	1.33E+00	1.33E+02	2.217
2.00E+00	2.67E+00	2.67E+02	2.842
5.00E+00	6.67E+00	6.67E+02	3.675
1.00E+01	1.33E+01	1.33E+03	4.206
2.00E+01	2.67E+01	2.67E+03	4.577
5.00E+01	6.67E+01	6.67E+03	4.846
1.00E+02	1.33E+02	1.33E+04	4.945
2.00E+02	2.67E+02	2.67E+04	5.019
3.00E+02	4.00E+02	4.00E+04	5.111
4.00E+02	5.33E+02	5.33E+04	5.224
5.00E+02	6.67E+02	6.67E+04	5.329
6.00E+02	8.00E+02	8.00E+04	5.419
7.00E+02	9.33E+02	9.33E+04	5.495
7.60E+02	1.01E+03	1.01E+05	5.534
8.00E+02	1.07E+03	1.07E+05	5.558
9.00E+02	1.20E+03	1.20E+05	5.614



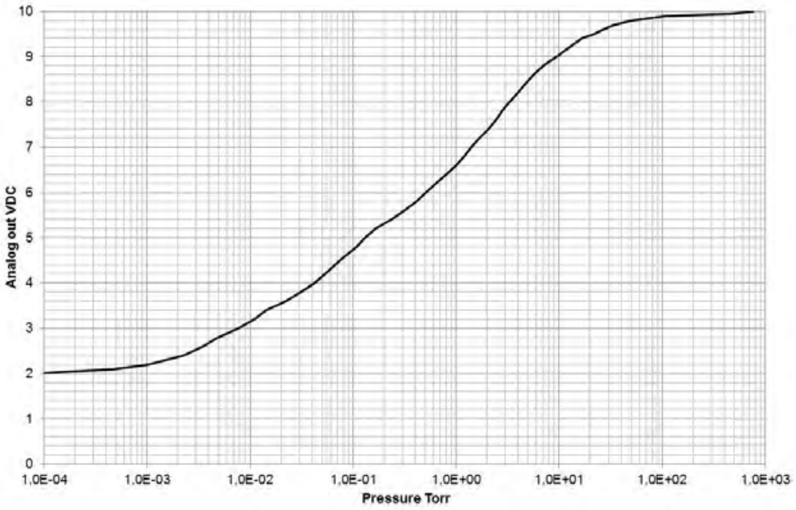
Analog output calibration = 26 (Edwards APG100-LC)
The APG100-L emulation provides a strongly nonlinear output with limited resolution in the low range and close to atmospheric pressure.

Torr	mbar	Pascal	V_{out}
7.50E-06	1.00E-05	1.00E-03	2
1.70E-04	2.27E-04	2.27E-02	2.1
3.75E-04	5.00E-04	5.00E-02	2.2
8.10E-04	1.08E-03	1.08E-01	2.4
1.26E-03	1.68E-03	1.68E-01	2.6
1.95E-03	2.60E-03	2.60E-01	2.8
2.88E-03	3.84E-03	3.84E-01	3
3.86E-03	5.15E-03	5.15E-01	3.2
5.15E-03	6.87E-03	6.87E-01	3.4
7.88E-03	1.05E-02	1.05E+00	3.6
1.17E-02	1.56E-02	1.56E+00	3.8
1.58E-02	2.10E-02	2.10E+00	4
2.08E-02	2.77E-02	2.77E+00	4.2
2.59E-02	3.45E-02	3.45E+00	4.4
3.12E-02	4.16E-02	4.16E+00	4.6
3.78E-02	5.04E-02	5.04E+00	4.8
4.44E-02	5.92E-02	5.92E+00	5
6.56E-02	8.74E-02	8.74E+00	5.2
9.53E-02	1.27E-01	1.27E+01	5.4
1.28E-01	1.71E-01	1.71E+01	5.6
1.67E-01	2.23E-01	2.23E+01	5.8
2.18E-01	2.90E-01	2.90E+01	6
2.68E-01	3.57E-01	3.57E+01	6.2
3.26E-01	4.35E-01	4.35E+01	6.4
4.00E-01	5.33E-01	5.33E+01	6.6
4.80E-01	6.40E-01	6.40E+01	6.8
5.75E-01	7.67E-01	7.67E+01	7
6.92E-01	9.23E-01	9.23E+01	7.2
8.55E-01	1.14E+00	1.14E+02	7.4
1.05E+00	1.40E+00	1.40E+02	7.6
1.25E+00	1.66E+00	1.66E+02	7.8
1.44E+00	1.92E+00	1.92E+02	8
1.79E+00	2.38E+00	2.38E+02	8.2
2.21E+00	2.95E+00	2.95E+02	8.4
2.63E+00	3.51E+00	3.51E+02	8.6
3.13E+00	4.17E+00	4.17E+02	8.8
4.05E+00	5.40E+00	5.40E+02	9
5.30E+00	7.06E+00	7.06E+02	9.2
7.27E+00	9.69E+00	9.69E+02	9.4
9.68E+00	1.29E+01	1.29E+03	9.5
1.25E+01	1.66E+01	1.66E+03	9.6
1.55E+01	2.07E+01	2.07E+03	9.7
2.54E+01	3.39E+01	3.39E+03	9.8
4.74E+01	6.32E+01	6.32E+03	9.9
1.08E+02	1.44E+02	1.44E+04	9.95
7.60E+02	1.00E+03	1.00E+05	10



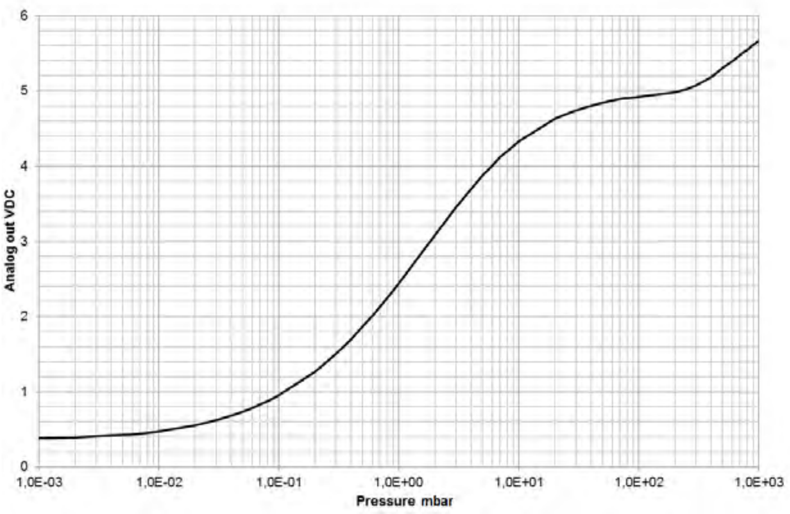
Analog output calibration = 27 (Edwards APG100-M)
The APG100-M emulation provides a strongly non-linear output with limited resolution in the low range and close to atmospheric pressure

Torr	mbar	Pascal	V_{out}
7.50E-05	1.00E-04	1.00E-02	2
1.73E-04	2.31E-04	2.31E-02	2.05
4.66E-04	6.21E-04	6.21E-02	2.1
1.02E-03	1.36E-03	1.36E-01	2.2
2.23E-03	2.97E-03	2.97E-01	2.4
3.46E-03	4.61E-03	4.61E-01	2.6
4.88E-03	6.51E-03	6.51E-01	2.8
7.65E-03	1.02E-02	1.02E+00	3
1.10E-02	1.47E-02	1.47E+00	3.2
1.43E-02	1.91E-02	1.91E+00	3.4
2.21E-02	2.95E-02	2.95E+00	3.6
3.12E-02	4.16E-02	4.16E+00	3.8
4.21E-02	5.61E-02	5.61E+00	4
5.40E-02	7.20E-02	7.20E+00	4.2
6.71E-02	8.94E-02	8.94E+00	4.4
8.48E-02	1.13E-01	1.13E+01	4.6
1.09E-01	1.45E-01	1.45E+01	4.8
1.32E-01	1.76E-01	1.76E+01	5
1.67E-01	2.22E-01	2.22E+01	5.2
2.37E-01	3.16E-01	3.16E+01	5.4
3.10E-01	4.13E-01	4.13E+01	5.6
4.05E-01	5.40E-01	5.40E+01	5.8
5.12E-01	6.82E-01	6.82E+01	6
6.31E-01	8.41E-01	8.41E+01	6.2
7.95E-01	1.06E+00	1.06E+02	6.4
9.98E-01	1.33E+00	1.33E+02	6.6
1.20E+00	1.60E+00	1.60E+02	6.8
1.40E+00	1.87E+00	1.87E+02	7
1.70E+00	2.26E+00	2.26E+02	7.2
2.06E+00	2.75E+00	2.75E+02	7.4
2.43E+00	3.24E+00	3.24E+02	7.6
2.80E+00	3.73E+00	3.73E+02	7.8
3.29E+00	4.39E+00	4.39E+02	8
3.97E+00	5.29E+00	5.29E+02	8.2
4.70E+00	6.27E+00	6.27E+02	8.4
5.72E+00	7.63E+00	7.63E+02	8.6
7.04E+00	9.39E+00	9.39E+02	8.8
9.53E+00	1.27E+01	1.27E+03	9
1.25E+01	1.67E+01	1.67E+03	9.2
1.68E+01	2.24E+01	2.24E+03	9.4
2.16E+01	2.88E+01	2.88E+03	9.5
2.65E+01	3.53E+01	3.53E+03	9.6
3.36E+01	4.48E+01	4.48E+03	9.7
4.99E+01	6.65E+01	6.65E+03	9.8
1.06E+02	1.41E+02	1.41E+04	9.9
4.62E+02	6.16E+02	6.16E+04	9.95
7.60E+02	1.00E+03	1.00E+05	10



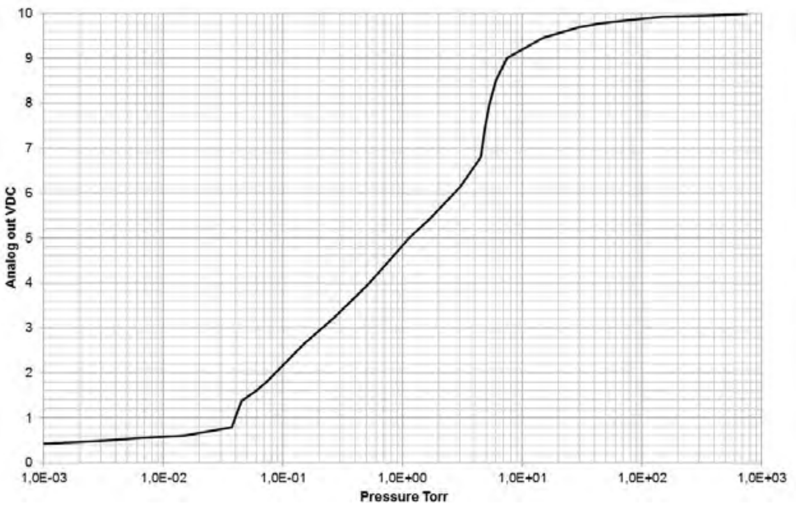
Analog output calibration = 28 (MKS 907)

Torr	mbar	Pascal	V_{out}
7.50E-04	1.00E-03	1.00E-01	0.387
1.50E-03	2.00E-03	2.00E-01	0.397
3.00E-03	4.00E-03	4.00E-01	0.418
4.50E-03	6.00E-03	6.00E-01	0.437
6.00E-03	8.00E-03	8.00E-01	0.456
7.50E-03	1.00E-02	1.00E+00	0.473
1.50E-02	2.00E-02	2.00E+00	0.551
2.25E-02	3.00E-02	3.00E+00	0.619
3.00E-02	4.00E-02	4.00E+00	0.679
3.75E-02	5.00E-02	5.00E+00	0.733
4.50E-02	6.00E-02	6.00E+00	0.783
5.25E-02	7.00E-02	7.00E+00	0.83
6.00E-02	8.00E-02	8.00E+00	0.874
6.75E-02	9.00E-02	9.00E+00	0.915
7.50E-02	1.00E-01	1.00E+01	0.955
1.50E-01	2.00E-01	2.00E+01	1.271
2.25E-01	3.00E-01	3.00E+01	1.508
3.00E-01	4.00E-01	4.00E+01	1.701
3.75E-01	5.00E-01	5.00E+01	1.864
4.50E-01	6.00E-01	6.00E+01	2.007
5.25E-01	7.00E-01	7.00E+01	2.133
6.00E-01	8.00E-01	8.00E+01	2.246
6.75E-01	9.00E-01	9.00E+01	2.348
7.50E-01	1.00E+00	1.00E+02	2.442
1.50E+00	2.00E+00	2.00E+02	3.083
2.25E+00	3.00E+00	3.00E+02	3.452
3.00E+00	4.00E+00	4.00E+02	3.698
3.75E+00	5.00E+00	5.00E+02	3.875
4.50E+00	6.00E+00	6.00E+02	4.009
5.25E+00	7.00E+00	7.00E+02	4.114
6.00E+00	8.00E+00	8.00E+02	4.198
6.75E+00	9.00E+00	9.00E+02	4.268
7.50E+00	1.00E+01	1.00E+03	4.327
1.50E+01	2.00E+01	2.00E+03	4.627
1.88E+01	2.50E+01	2.50E+03	4.695
2.25E+01	3.00E+01	3.00E+03	4.743
3.00E+01	4.00E+01	4.00E+03	4.805
3.75E+01	5.00E+01	5.00E+03	4.843
4.50E+01	6.00E+01	6.00E+03	4.872
5.25E+01	7.00E+01	7.00E+03	4.891
5.63E+01	7.50E+01	7.50E+03	4.898
6.00E+01	8.00E+01	8.00E+03	4.904
6.75E+01	9.00E+01	9.00E+03	4.914
7.50E+01	1.00E+02	1.00E+04	4.923
1.50E+02	2.00E+02	2.00E+04	4.987
1.88E+02	2.50E+02	2.50E+04	5.025
2.25E+02	3.00E+02	3.00E+04	5.071
3.00E+02	4.00E+02	4.00E+04	5.183
3.75E+02	5.00E+02	5.00E+04	5.301
4.50E+02	6.00E+02	6.00E+04	5.397
5.25E+02	7.00E+02	7.00E+04	5.478
5.63E+02	7.50E+02	7.50E+04	5.514
6.00E+02	8.00E+02	8.00E+04	5.548
6.75E+02	9.00E+02	9.00E+04	5.61
7.60E+02	1.00E+03	1.00E+05	5.666



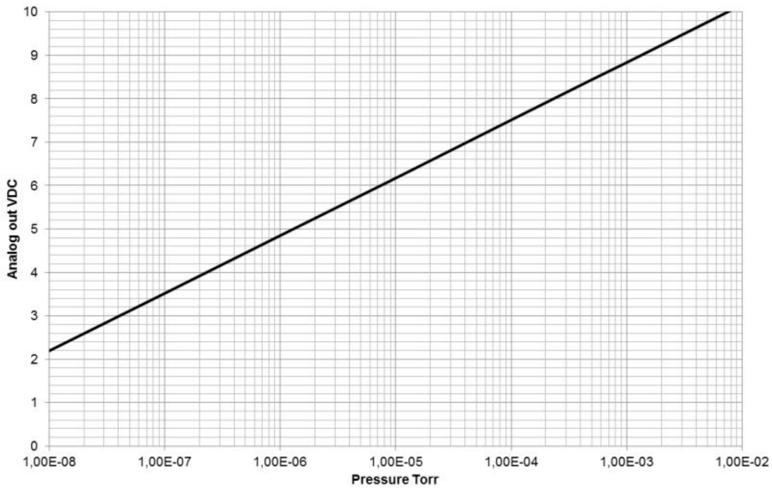
Analog output calibration = 29 (K6080)

Torr	mbar	Pascal	V_{out}
7.50E-06	1.00E-05	1.00E-03	0.4
3.75E-05	5.00E-05	5.00E-03	0.4
7.50E-05	1.00E-04	1.00E-02	0.4
3.00E-04	4.00E-04	4.00E-02	0.4
6.00E-04	8.00E-04	8.00E-02	0.4
7.50E-04	1.00E-03	1.00E-01	0.41
3.00E-03	4.00E-03	4.00E-01	0.48
3.75E-03	5.00E-03	5.00E-01	0.5
6.75E-03	9.00E-03	9.00E-01	0.55
1.50E-02	2.00E-02	2.00E+00	0.61
3.75E-02	5.00E-02	5.00E+00	0.79
4.13E-02	5.50E-02	5.50E+00	1.1
4.50E-02	6.00E-02	6.00E+00	1.37
6.00E-02	8.00E-02	8.00E+00	1.6
7.50E-02	1.00E-01	1.00E+01	1.83
1.50E-01	2.00E-01	2.00E+01	2.64
2.60E-01	3.47E-01	3.47E+01	3.2
4.12E-01	5.50E-01	5.50E+01	3.71
5.31E-01	7.08E-01	7.08E+01	4
7.50E-01	1.00E+00	1.00E+02	4.45
1.14E+00	1.51E+00	1.51E+02	5
1.72E+00	2.29E+00	2.29E+02	5.44
3.00E+00	4.00E+00	4.00E+02	6.12
4.50E+00	6.00E+00	6.00E+02	6.8
4.88E+00	6.50E+00	6.50E+02	7.4
5.25E+00	7.00E+00	7.00E+02	7.96
6.00E+00	8.00E+00	8.00E+02	8.5
7.50E+00	1.00E+01	1.00E+03	9.01
1.50E+01	2.00E+01	2.00E+03	9.45
3.00E+01	4.00E+01	4.00E+03	9.7
4.50E+01	6.00E+01	6.00E+03	9.78
7.50E+01	1.00E+02	1.00E+04	9.85
1.50E+02	2.00E+02	2.00E+04	9.92
3.00E+02	4.00E+02	4.00E+04	9.95
4.50E+02	6.00E+02	6.00E+04	9.96
6.00E+02	8.00E+02	8.00E+04	9.98
7.60E+02	1.00E+03	1.00E+05	10



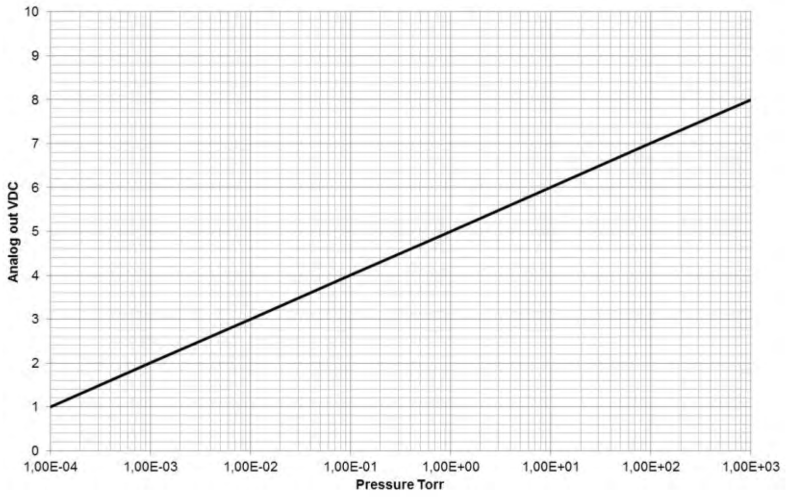
Analog output calibration = 30 (Inficon PEG100)

Torr	mbar	Pascal	V_{out}
1.00E-08	1.33E-08	1.33E-06	2.186111
1.00E-07	1.33E-07	1.33E-05	3.516111
1.00E-06	1.33E-06	1.33E-04	4.846111
1.00E-05	1.33E-05	1.33E-03	6.176111
1.00E-04	1.33E-04	1.33E-02	7.506111
5.00E-04	6.67E-04	6.67E-02	8.435741
1.00E-03	1.33E-03	1.33E-01	8.836111
1.00E-02	1.33E-02	1.33E+00	10.16611



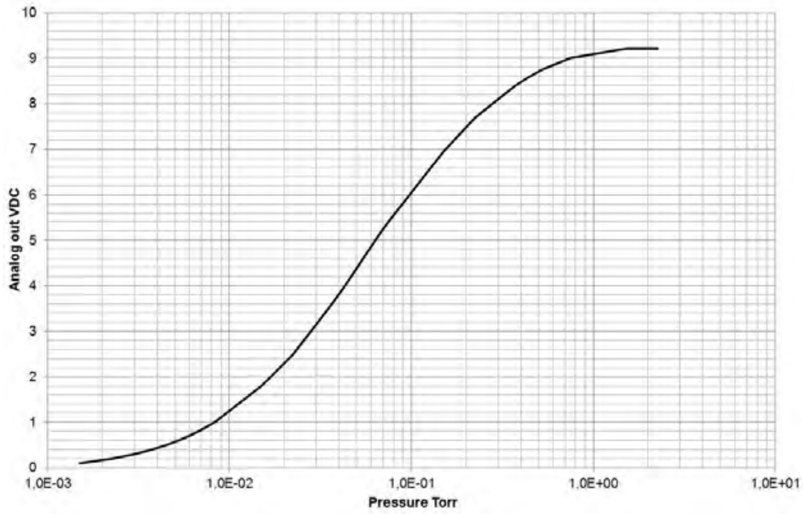
Analog output calibration = 31 (Varian Eysys)

Torr	mbar	Pascal	V_{out}
1.00E-04	1.33E-04	1.33E-02	1
1.00E-03	1.33E-03	1.33E-01	2
1.00E-02	1.33E-02	1.33E+00	3
1.00E-01	1.33E-01	1.33E+01	4
1.00E+00	1.33E+00	1.33E+02	5
1.00E+01	1.33E+01	1.33E+03	6
1.00E+02	1.33E+02	1.33E+04	7
1.00E+03	1.33E+03	1.33E+05	8



Analog output calibration = 32 (Alcatel TA111)

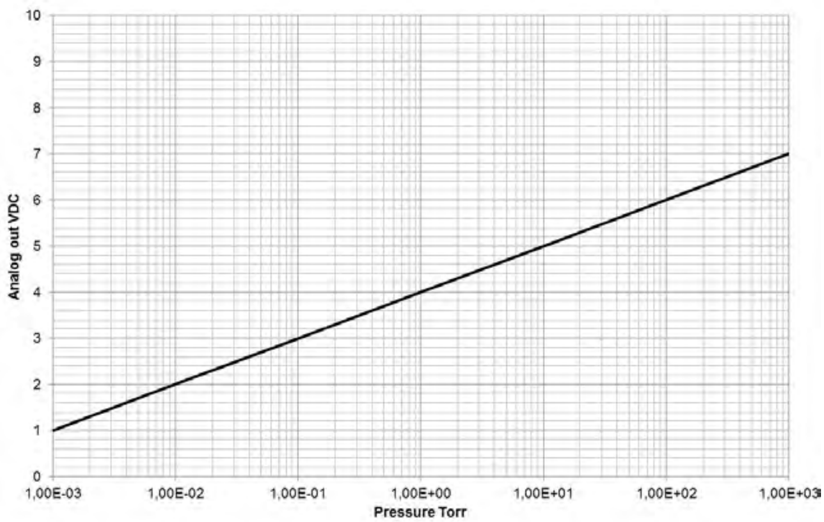
Torr	mbar	Pascal	V_{out}
1.50E-03	2.00E-03	2.00E-01	0.1
2.25E-03	3.00E-03	3.00E-01	0.2
3.00E-03	4.00E-03	4.00E-01	0.3
3.75E-03	5.00E-03	5.00E-01	0.4
4.50E-03	6.00E-03	6.00E-01	0.5
5.25E-03	7.00E-03	7.00E-01	0.6
6.00E-03	8.00E-03	8.00E-01	0.7
6.75E-03	9.00E-03	9.00E-01	0.8
7.50E-03	1.00E-02	1.00E+00	0.9
8.25E-03	1.10E-02	1.10E+00	1
1.50E-02	2.00E-02	2.00E+00	1.8
2.25E-02	3.00E-02	3.00E+00	2.5
3.00E-02	4.00E-02	4.00E+00	3.15
3.75E-02	5.00E-02	5.00E+00	3.65
4.50E-02	6.00E-02	6.00E+00	4.1
5.25E-02	7.00E-02	7.00E+00	4.5
6.00E-02	8.00E-02	8.00E+00	4.85
6.75E-02	9.00E-02	9.00E+00	5.15
7.50E-02	1.00E-01	1.00E+01	5.4
1.50E-01	2.00E-01	2.00E+01	6.95
2.25E-01	3.00E-01	3.00E+01	7.7
3.00E-01	4.00E-01	4.00E+01	8.1
3.75E-01	5.00E-01	5.00E+01	8.4
4.50E-01	6.00E-01	6.00E+01	8.6
5.25E-01	7.00E-01	7.00E+01	8.75
7.50E-01	1.00E+00	1.00E+02	9
1.50E+00	2.00E+00	2.00E+02	9.2
2.25E+00	3.00E+00	3.00E+02	9.2



Analog output calibration = 33 (MKS 685)

$P = 10^{(V_{out} - 4)}$
$V_{out} = 4 + \log_{10}(P)$

Torr	mbar	Pascal	V_{out}
1.00E-05	1.33E-05	1.33E-03	1.00
1.00E-04	1.33E-04	1.33E-02	1.00
1.00E-03	1.33E-03	1.33E-01	1.00
1.00E-02	1.33E-02	1.33	2.00
1.00E-01	1.33E-01	13.3	3.00
1.00	1.33	133.3	4.00
10.0	13.3	1333.2	5.00
100	133.3	1.33E+04	6.00
1000	1333.2	1.33E+05	7.00



Query Command list

Communication information

Command	Response	Explanation
@xxxBR?;FF	@xxxACK9600;FF	Communication baud rate (4800, 9600, 19200, 38400, 57600, 115200,230400)
@xxxAD?;FF	@xxxACK253;FF	Transducer communication address (001 to 253)
@xxxRSD?;FF	@xxxACKON;FF	Communication delay between receive and transmit sequence

Pressure reading

Command	Response	Explanation
@xxxPR1?;FF	@xxxACK1.23;FF	Absolute Piezo sensor reading
@xxxPR2?;FF	@xxxACK1.23;FF	Absolute Piezo sensor reading
@xxxPR3?;FF	@xxxACK1.23;FF	Absolute Piezo sensor reading
@xxxPR4?;FF	@xxxACK1.234E0;FF	Absolute Piezo sensor reading (three digits scientific notation)

Setpoint information

Command	Response	Explanation
@xxxSS1?;FF @xxxSS2?;FF @xxxSS3?;FF	@xxxACKSET;FF	Set point relay 1-3 status (SET=Relay energized / CLEAR=Relay deenergized)
@xxxSP1?;FF @xxxSP2?;FF @xxxSP3?;FF	@xxxACK500;FF	Set point 1-3 switch value
@xxxSH1?;FF @xxxSH2?;FF @xxxSH3?;FF	@xxxACK505;FF	Set point 1-3 hystereses switch value
@xxxEN1?;FF @xxxEN2?;FF @xxxEN3?;FF	@xxxACKOFF;FF	Set point 1-3 enable status (OFF, ON)
@xxxSD1?;FF @xxxSD2?;FF @xxxSD3?;FF	@xxxACKBELOW;FF	Set point relay direction (ABOVE or BELOW) If set to above relay will be energized above setpoint value. If set to below relay will be energized below setpoint value
@xxxSPD?;FF	@xxxACKON;FF	Setpoint safety delay

Transducer information

Command	Response	Explanation
@xxxMD?;FF	@xxxACK902B;FF	Model number (902B)
@xxxDT?;FF	@xxxACKPiezo;FF	Device type name (Piezo)
@xxxMF?;FF	@xxxACKMKS;FF	Manufacturer name (MKS)
@xxxHV?;FF	@xxxACKA;FF	Hardware version
@xxxFV?;FF	@xxxACK1.00;FF	Firmware version
@xxxSN?;FF	@xxxACK08350123456;FF	Serial number
@xxxSW?;FF	@xxxACKON;FF	Switch enable
@xxxTIM?;FF	@xxxACK12345;FF	Time on (hours of operation)
@xxxUT?;FF	@xxxACKVACUUM1;FF	User programmed text string
@xxxT?;FF	@xxxACKO;FF	Transducer status check

Calibration and adjustment information

Command	Response	Explanation
@xxxU?;FF	@xxxACKTORR;FF	Pressure unit setup (torr, mbar or pascal)
@xxxZER?;FF	@xxxACK1.88E+3;FF	Provides delta pressure value between current vacuum zero adjustment and factory calibration
@xxxSPN?;FF	@xxxACK1.22E+1;FF	Provides delta pressure value between current atmospheric adjustment and factory calibration
@xxxAO1?;FF	@xxxACK235;FF	Analog voltage output 1: Pressure assignment and calibration. (first digit is pressure assignment, second and third digit is calibration)
@xxxAO2?;FF	@xxxACK10;FF	Analog voltage output 2: Pressure assignment and calibration. (first digit is pressure assignment, second and third digit is calibration)

xxx **= Transducer communication address (001 to 253. Broadcast addresses: 254, 255)**

Setup and configuration command list

Setpoint setup and configuration

Command	Response	Explanation
@xxxSP1!20;FF @xxxSP2!20;FF @xxxSP3!20;FF	@xxxACK20;FF	Set point 1-3 switch value
@xxxSH1!50;FF @xxxSH2!50;FF @xxxSH3!50;FF	@xxxACK50;FF	Set point 1-3 hysteresis switch value
@xxxEN1!ON;FF @xxxEN2!ON;FF @xxxEN3!ON;FF	@xxxACKON;FF	Set point 1-3 enable status (ON or OFF)
@xxxSD1!BELOW;FF @xxxSD2!BELOW;FF @xxxSD3!BELOW;FF	@xxxACKBELOW;FF	Set point relay direction (ABOVE or BELOW) If set to above relay will be energized above setpoint value If set to below relay will be energized below setpoint value
@xxxSPD!ON;FF	@xxxACKON;FF	Setpoint safety delay (prevent pulse trig of setpoint)

Communication setup

Command	Response	Explanation
@xxxBR!19200;FF	@xxxACK19200;FF	Set communication Baud rate (4800, 9600, 19200, 38400, 57600, 115200, 230400)
@xxxAD!123;FF	@xxxACK123;FF	Set Transducer communication address (001 to 253)
@xxxRSD!OFF;FF	@xxxACKOFF;FF	Turn on or off communication delay between receive and transmit sequence

Calibration and adjustment

Command	Response	Explanation
@xxxU!MBAR;FF	@xxxACKMBAR;FF	Set pressure unit setup (torr, mbar, pascal)
@xxxZER!;FF	@xxxACK;FF	Executes MicroPirani zero adjustment
@xxxSPN!;FF	@xxxACK;FF	Executes Piezo differential zero adjustment
@xxxAO1!236;FF	@xxxACK236;FF	Set analog voltage output 1 calibration
@xxxAO2!10;FF	@xxxACK10;FF	Set analog voltage output 2 calibration

Information setup

Command	Response	Explanation
@xxxUT!PIEZOABS;FF	@xxxACKPIEZOABS;FF	Set transducer user tag

User Switch

Command	Response	Explanation
@xxxSW!ON;FF	@xxxACKON;FF	Enable / disable user switch

xxx **= Transducer communication address (001 to 253. Broadcast addresses: 254, 255)**

Firmware upgrades (RS232 only)

The 902B firmware can be upgraded by the user. The following procedure should be used:

1. Install the 900 Series firmware download software from the Documentation CD or download from www.mksinst.com/vtsw/
2. Turn power off
3. Hold down the User switch while turning power on
4. Release the User switch
5. Run the 900 Series firmware download software and start download

Transducer with RS485 interface cannot be firmware upgraded by the user. Contact MKS customer service for upgrade.

FAQ (Frequently Asked Questions)

Applications
Q: *Can the transducer and sensor element continuously withstand vibrations from a mechanical fore-pump.*
A: Yes – the Piezo sensor element can withstand continuous vibrations.

Q: *Is the transducer compatible with fluorine gases?*
A: Yes – The Piezo sensor is compatible with any gas compatible with stainless steel 316.

Q: *When the transducer is pumped down and isolated by closing a valve the pressure is raising. Is the transducer leaking?*
A: Not likely - when a confined space is evacuated and the pumping is stopped the pressure will rise because of outgassing, mainly by water vapor. The pressure can easily rise to a few torr over time.

Q: *Can the transducer be mounted in any orientation?*
A: Yes - the transducer can be mounted in any orientation without compromise of performance or calibration. However it is recommended not to mount the transducer with the flange port facing upwards to avoid contamination like particulates or liquids from entering the device.

Q: *Can the transducer withstand instant ventilation?*
A: Yes - the Piezo sensor element is extremely robust to mechanical forces and can withstand continuously pressure cycles and instant air ventilation.

Q: *Can I connect a valve to be controlled by the transducer relay contact?*
A: Driving inductive loads such as valves requires special precautions. Refer to detailed description page 12.

Q: *How many pressure cycles can the transducer withstand?*
A: The Piezo sensor element is very robust to pressure changes and there are no limits on the number of pressure cycles. The setpoint relay contact endurance is minimum 2,000,000 cycles at 0.2 A @ 30 VDC load.

Analog output
Q: *What is the update rate of the analog output?*
A: 16 times per second.

Q: *What is the maximum length of analog output cable?*
A: The maximum length of the analog cable depends on cable quality and the electrical noise environment, but a cable length up to 100 m do not normally require any special precautions other than the cable must be screened.

Q: *The digital reading is correct but the analog output reading has some deviation from actual pressure?*
A: Check that the analog out is connected to a floating input and not an input that is connected to ground. If connected analog out return is connected to ground, the supply current will flow in the signal line and cause voltage drop and ground looping.

Digital output
Q: *How fast can I request pressure measurements via the digital interface?*
A: 10 times per second is the fastest recommended pressure request frequency.

Q: *How long is the waiting time from turning power on to valid measuring values?*
A: The power on sequence is approximately 2 seconds. The LED is illuminating red during power up sequence and the digital interface will not reply to commands.

Q: *The first character is sometimes lost in the transducer digital communication reply?*
A: This can be caused by too fast transducer communication reply. See RS delay command description page 11.

Q: *Is it necessary to use the ground wire between RS485 communication equipment and transducer?*
A: Yes - both RS232 and RS485 communication requires a 3 wire connection between transducer and communication equipment.

Measurement, Calibration and adjustment

Q: *How often does the transducer require calibration or Zero adjustment?*
A: It depends on the application and pressure range but in many applications user adjustment is never required. Factors that temporarily or permanently can influence the measuring performance is contamination, corrosion, heat and electronic interference.

Q: *Will the transducer retain user calibration after power is shut off?*
A: Yes - all transducer parameters including calibration data are stored internally in the transducer non volatile memory.

Service and repair
Q: *+24 VDC supply voltage has been connected to analog output+. Is the transducer damaged?*
A: Likely - the analog output is not protected against applying power to the output pin.

Q: *Reverse voltage has been connected to power supply input. Is the transducer damaged?*
A: Not likely – the transducer power supply circuit has reverse voltage and over voltage protection however. MKS cannot guarantee that the transducer will not be damaged.

Q: *If contaminated, can the transducer sensor element be cleaned?*
A: Yes – The Piezo sensor can be cleaned using any solvent compatible with stainless steel 316. <u>Do not apply any force</u> to the sensor membrane during cleaning. Even small deformation of the membrane structure will cause permanent damage to the transducers.

Troubleshooting

Symptom	Possible Cause/Remedy
No digital communication	- Check electrical connections (three wires from transducer to communication equipment) - Transducer and communication equipment baud rate matches - Use of incorrect transducer address. Try address 254 - Attention characters missing (@) - Termination characters missing (;FF)
NAK180 is received when transmitting setpoint commands	- The transducer setup is locked. Refer to disable lock procedure page 21
Incorrect pressure value	- Other gas present than transducer gas setting or trace of gas - Contaminated sensor - Transducer repair required - Corroded sensor - Transducer repair required
Incorrect pressure value at low pressure.	- Corroded sensor. Transducer repair required - Incorrect Vac adjustment has been executed - Transducer exposed to heat or cooling air stream
Incorrect pressure value at high pressure.	- Corroded sensor. Transducer repair required - Incorrect ATM adjustment has been executed - Other gas or gas trace present than transducer gas setting
Set point relay does not trip	- Setpoint not enabled - Setpoint value not set to proper value - Setpoint direction is different than the user expects - Check electrical connection - Check part number to see if transducer has setpoint relays
No analog output	- Power supply turned off - Check electrical connections
Status LED illuminating red	- Sensor element defect - Refer to Service and Repair page 50

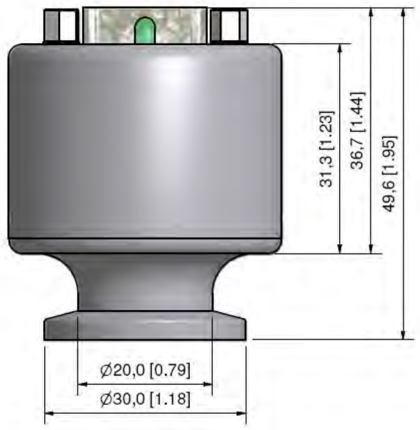
Specifications

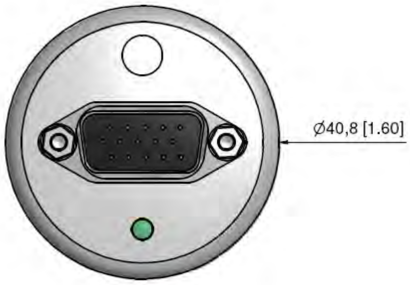
Measuring range:		0.1 to 1000 Torr (absolute)
Accuracy [1]	10-1000 Torr:	±1% of reading
Repeatability [1]		±0.3% of full scale
Maximum pressure:		1500 Torr
Supply Voltage:		9-30 VDC
Power consumption:		<1.2 watt
Fuse (thermal recoverable):		200 mA
Analog output (MKS standard):		0-10 VDC
Analog output 1 resolution:		16 bit
Analog output 2 resolution:		12 bit
Analog output impedance:		100 Ω
Analog output update rate:		16 Hz
Setpoint relay range:		1-1000 Torr
Setpoint relay contact rating:		1A @ 30 VDC/VAC (resistive load)
Setpoint relay contact resistance:		100 mΩ (max)
Setpoint relay contact endurance (1 A @ 30 VDC load):		100,000 (min)
Setpoint relay contact endurance (0.2 A @ 30 VDC load):		2,000,000 (min)
Setpoint relay response time:		<100 ms
Materials exposed to vacuum:		Stainless Steel 316
Internal volume:	KF16 flange	1.023 cm^3
	VCR4 flange	1.469 cm^3
	VCR8 flange	2.627 cm^3
Electronics casing material:		Stainless steel 304
Flange material:		Stainless steel 316
Weight:	KF16 flange	170 g
	VCR4 flange	191 g
	VCR8 flange	221 g
Operating temperature:		0 to 40 °C (32 to 104 °F)
Bake out temperature (non-operating):		100 °C (212 °F)
Humidity:		0–95% Non-condensing
Ingress Protection Rating:		IP40[2]

(1) Accuracy and repeatability are typical values measured in Nitrogen atmosphere after zero adjustment at ambient temperature.
(2) IP54 version available.

Dimensions KF16 flange (P/N: 902B-1xxx)

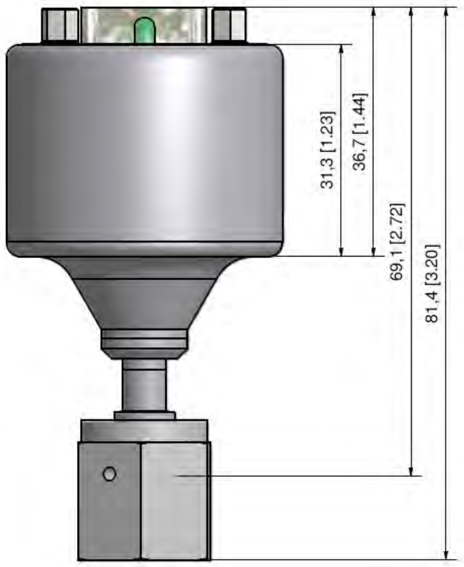
mm. [Inch.]

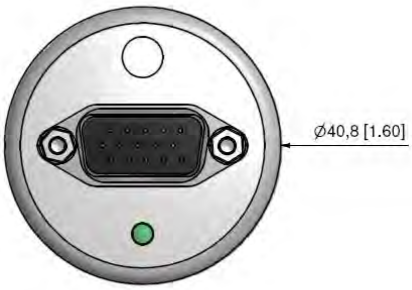




Dimensions VCR4 flange (P/N: 902B-4xxx)

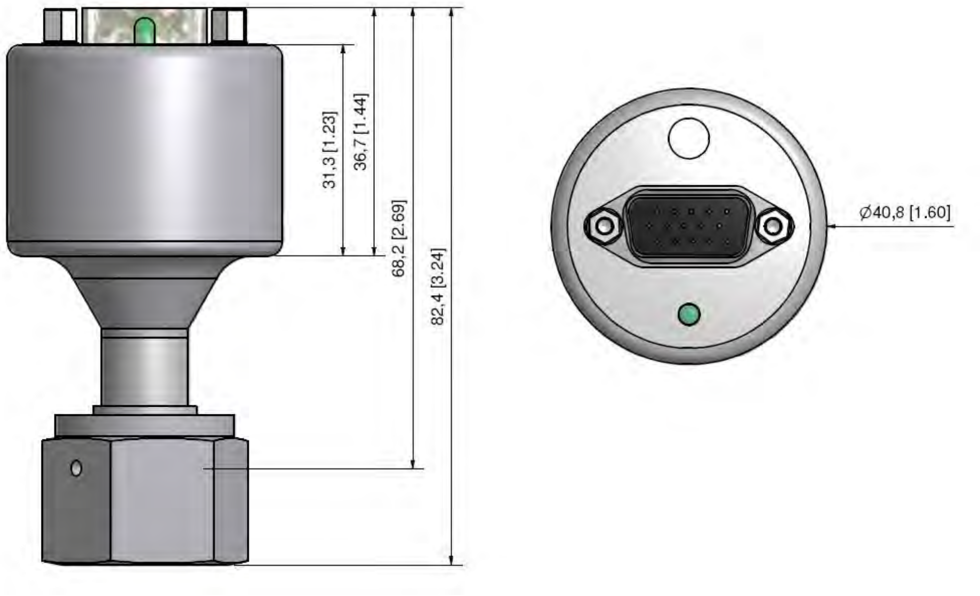
mm. [Inch.]





Dimensions VCR8 flange (P/N: 902B-5xxx)

mm. [Inch.]



Accessories and replacement part numbers

PDR900 controller

Part number	Description	Interface
PDR900-12-EU	PDR900 Controller	EU Schuko power cable
PDR900-12-US	PDR900 Controller	US power cable
PDR900-12-UK	PDR900 Controller	UK power cable
PDR900-12-JP	PDR900 Controller	JP power cable. mbar / pascal unit
PDR900-12-DK	PDR900 Controller	Danish power cable

PDR900 Transducer Cables for 902B (15 pin HD DSUB)

For transducer part number: 902B-x1x2x. 902B-x1x3x. 902B-x1x5x

Part number	Description	Interface
100013620	3 m (10ft.)	RS232
100013621	5 m (16ft.)	RS232
100013622	7.6m (25ft.)	RS232
100013623	10 m (33ft.)	RS232

For transducer part number: 902B-x2x2x. 902B-x2x3x. 902B-x2x5x

Part number	Description	Interface
100013671	3 m (10ft.)	RS485
100013672	5 m (16ft.)	RS485
100013673	7.6m (25ft.)	RS485
100013674	10 m (33ft.)	RS485

PDR900 Connectors & cables

Part number	Description
100010757	Setpoint Relay 3 pin connector
100013638	Analog output 8 pin connector
100013686	Analog output cable 3 m (10ft.)
100013693	RS232/RS485 user communication cable 3 m (10ft.)

PDR900 Mounting hardware

Part number	Description
100013689	¼.19” Rack mounting kit
100013690	Panel mounting kit
100013691	Front panel protection panel
100013692	Front panel protection panel w/key

RS232 Cable for Hirschmann and RJ45/FCC68 Transducers

Part number	Description
100013367	Cable RS232, 3 m

902B Transducer calibration certificate

Part number	Description
100013147	DKD Calibration certificate Europe

CE Declaration of Conformity

Manufacturer: **MKS Denmark ApS**
Ndr. Strandvej 119G
DK-3150 Hellebaek
Denmark

Model: **902B Absolute Piezo**

Type of Equipment: **Vacuum pressure transducer**

Application of Council Directive: **2004/108/EEC Electromagnetic Compatibility**

Standards to which conformity is declared:

EN61326-1/2006 EMC requirements for electrical equipment for measurement, control and laboratory use. (Industrial location).

Emissions

EN 55022:2006	Information technology equipment. Radio disturbance characteristics. Limits and methods of measurement

Immunity

EN 61000-4-2	Electrostatic discharge
EN 61000-4-3	Radiated RF electromagnetic fields
EN 61000-4-4	EFT/burst
EN 61000-4-6	Conducted disturbances by RF fields
EN 61000-4-8	Power frequency magnetic fields

I, the undersigned, hereby declare that the equipment above conforms to the above Directive(s) and Standard(s), when installed in accordance with specifications specified in this short form manual and Operation and Installation manual.

MKS Denmark ApS. Hellebaek. Denmark
March 18, 2013

Ole Wenzel – Managing Director

PDR 900 Display and power supply

- Plug and play readout for 900 Series transducers
- The easy way for setup and configuration
- Data logger tool for data analysing

See more on: www.mksinst.com/pdr900

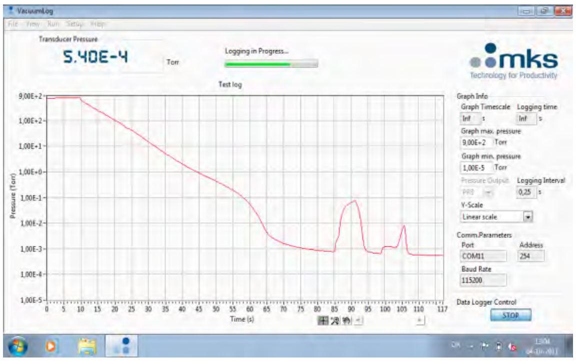
902B Absolute Piezo transducer with integrated display

- Display of real time pressure measurements
- Clear backlight display
- Easy viewing in all environments
- Readout of transducer parameters

902B Absolute Piezo transducer with IP54 enclosure

- Sealed enclosure for harsh environments
- Protected against water splash
- Supplied with SUB D connector and housing

900 Series VacuumLog software



- Data logger software
- Pressure curve plotting
- Rate of raise diagnostic tool
- Pump down monitoring
- Export of data to Excel spread sheet
- Windows 7 compatible

Free version available on:
http://www.mksinst.com/vtsw/

Index

P/N: 100017633
902B Absolute Piezo
Operation and Installation Manual
Revision: C, March 2016