Model 4500HT

High Temperature

Vibrating Wire Piezometer

Instruction Manual

Document Revision: G.1 | Release date: 3/25/25

WARRANTY STATEMENT

GEOKON warrants its products to be free of defects in materials and workmanship, under normal use and service for a period of 13 months from date of purchase. If the unit should malfunction, it must be returned to the factory for evaluation, freight prepaid. Upon examination by GEOKON, if the unit is found to be defective, it will be repaired or replaced at no charge. However, the WARRANTY IS VOID if the unit shows evidence of having been tampered with or shows evidence of being damaged as a result of excessive corrosion or current, heat, moisture or vibration, improper specification, misapplication, misuse or other operating conditions outside of GEOKON's control. Components that wear or are damaged by misuse are not warranted. This includes fuses and batteries.

GEOKON manufactures scientific instruments whose misuse is potentially dangerous. The instruments are intended to be installed and used only by qualified personnel. There are no warranties except as stated herein. There are no other warranties, expressed or implied, including but not limited to the implied warranties of merchantability and of fitness for a particular purpose. GEOKON is not responsible for any damages or losses caused to other equipment, whether direct, indirect, incidental, special or consequential which the purchaser may experience as a result of the installation or use of the product. The buyer's sole remedy for any breach of this agreement by GEOKON or any breach of any warranty by GEOKON shall not exceed the purchase price paid by the purchaser to GEOKON for the unit or units, or equipment directly affected by such breach. Under no circumstances will GEOKON reimburse the claimant for loss incurred in removing and/or reinstalling equipment.

Every precaution for accuracy has been taken in the preparation of manuals and/or software, however, GEOKON neither assumes responsibility for any omissions or errors that may appear nor assumes liability for any damages or losses that result from the use of the products in accordance with the information contained in the manual or software.

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1. INTRODUCTION

GEOKON Model 4500HT Series High Temperature Piezometers are designed for monitoring downhole pressures and temperatures in oil recovery systems and geothermal applications. Each 4500HT Piezometer is equipped with an internal Model 4700 Vibrating Wire Temperature Sensor which gives a varying resistance output as the temperature changes.

Model 4500HT Piezometers are capable of operation under extreme conditions and at temperatures up to 250 °C. In thermal recovery applications such as Steam Assisted Gravity Drainage (SAGD) and Cyclic Steam Stimulation (CSS) they provide accurate, real-time, continuous monitoring of pressures in production and injection wells, thereby optimizing the recovery rate and reducing the cost of the steam injection process. In geothermal applications, they offer a means for in situ, continuous monitoring of pressures and temperatures over extended periods of time.

GEOKON vibrating wire piezometers utilize a sensitive stainless steel diaphragm to which a vibrating wire element is connected. During use, changing pressures on the diaphragm cause it to deflect. This deflection is measured as a change in tension and frequency of vibration in the vibrating wire element. The square of the vibration frequency is directly proportional to the pressure applied to the diaphragm. A filter is used to keep out solid particles and prevent damage to the sensitive diaphragm. Standard filters are 50 micron stainless steel.

Two coils, one with a magnet insert, the other with a pole piece insert, are installed near the vibrating wire. In use, a pulse of varying frequency (swept frequency) is applied to these coils, causing the wire to vibrate primarily at its resonant frequency. When the excitation ends, the wire continues to vibrate. During vibration a sinusoidal signal is induced in the coils and transmitted to the readout box where it is conditioned and displayed. The Model 4500HT Piezometers are designed for static measurements only; at least one second is required to excite and read the sensor.

All exposed components are made of corrosion resistant stainless steel. If proper installation techniques are used, the device should have an unlimited life. In salt water it may be necessary to use special materials for the diaphragm and housing.

Portable readout units are available to provide the excitation, signal conditioning, and readout of the instrument. Datalogging systems are also available for remote unattended data collection of multiple sensors. Contact GEOKON for additional information.

2. INSTALLATION CONSIDERATIONS

2.1 CABLES

Sensors may be delivered with four conductor 24-gauge Teflon® insulated cable inside stainless steel tubing **or** four conductor 22-gauge mineral insulated cable in a magnesium oxide jacket with 316 stainless steel sheath. (Sheath wall = 0.76 mm [0.03"]. Nominal O.D. = 4.76 mm [0.1875"]). Both cable types are delivered in coils, and can be terminated in bare leads (Figure 1), with a connector, a transition to a regular instrumentation cable (Figure 2), or other termination as determined by the customer. See Table 1 for standard wiring.

FIGURE 1: *Cable Inside Stainless Steel Tubing*

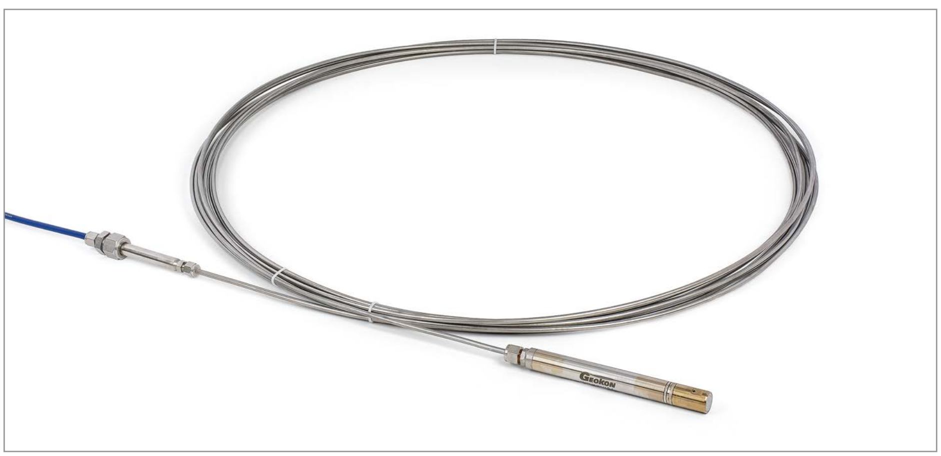


FIGURE 2: *Stainless Steel Tubing with Transition to 02-250V6 Cable*

Function	02-156T Cable	02-187MI Cable	Cables that Transition to 02-250V6 Cable
Vibrating Wire Gauge +	Red	Red	Red
Vibrating Wire Gauge -	Black	Black	Black
Temperature Sensor	White	White	White
Temperature Sensor	Blue	Green	Green
Cable Shield	Shield	Shield	Shield

TABLE 1: *Standard Wiring*

3. INSTALLATION

3.1 PRELIMINARY TESTS

Before installation, the sensor zero reading should be checked and recorded. The Model 4700 Temperature Sensor is included inside the body of the piezometer for the measurement of temperature. (See Section 4 for compatible readouts.)

Calibration data is supplied with each piezometer. Zero readings at seven different temperatures and barometric pressure is included. Zero readings at the site should coincide with the calibration zero readings within ±50 digits after barometric and temperature corrections are made. The factory elevation is +580 ft. See Appendix B for sample calibration reports.

Note: Before March 21, 1995 factory barometric pressure readings were corrected to sea level; readings after this date represent absolute pressure. (Barometric pressure changes with elevation at a rate of ≈1/2 psi per 1,000 ft.)

3.2 INSTALLATION IN BOREHOLES

Push the piezometer into the borehole by whatever means are chosen. This may include attachment to grout pipes, special installation rods, or other apparatuses being inserted into the borehole at the same time.

4. TAKING READINGS

The Model 4500HT is usually connected to a datalogger, but for initial set up it is often more convenient to use a portable readout box.

When using a readout the red and black clips are used for taking both the pressure reading and the temperature reading of the Model 4500HT piezometer. The white and green clips of the flying leads are not used.

When using a datalogger the pluck voltage must be set to 12 volts.

4.1 COMPATIBLE READOUTS AND DATALOGGERS

GEOKON can provide several readout and datalogger options. Devices compatible with this product are listed below. For further details and instruction consult the corresponding Manual(s) at geokon.com/Readouts and geokon.com/Dataloggers.

Readouts

DIGITAL READOUTS:

- **GK-404**

  The Model GK-404 VW Readout is a portable, low-power, hand-held unit capable of running for more than 20 hours continuously on two AA batteries. It is designed for the readout of all GEOKON Vibrating Wire (VW) instruments, and is capable of displaying the reading in digits, frequency (Hz), period (µs), or microstrain (µε). The GK-404 displays the temperature of the transducer (embedded thermistor) with a resolution of 0.1 °C.

- **GK-406**

  The Model GK-406 is a field-ready device able to quickly measure a sensor, save data, and communicate results with custom PDF reports and spreadsheet output. Measurements are geo-located with the integrated GPS allowing the GK-406 to verify locations and lead the user to the sensor locations. The large color display and VSPECT™ technology create confidence of getting the best measurement possible both in the field and in the office.

Dataloggers

DATALOGGERS:

- **8600 Series**

  The MICRO-6000 Datalogger is designed to support the reading of a large number of GEOKON instruments for various unattended data collection applications through the use of GEOKON Model 8032 Multiplexers. Weatherproof packaging allows the unit to be installed in field environments where inhospitable conditions prevail. The Nema 4X enclosure also has a provision for locking to limit access to responsible field personnel.

- **GeoNet Series**

  The GeoNet series is designed to collect and transfer data from vibrating wire, RS-485, and analog instruments. GeoNet offers a wide range of telemetry options, including LoRa, cellular, Wi-fi, satellite, and local. Loggers can work together to operate in a network configuration, or be used separately as standalone units. GeoNet devices arrive from the factory ready for deployment and may commence with data acquisition in minutes.

  Data is transferred to a secure cloud-based storage platform where it can be accessed through the GEOKON OpenAPI. Industry leading data visualization software, such as the free GEOKON Agent Software, can be used with the OpenAPI for data viewing and reporting. Dataloggers without network capabilities are also available.

5. DATA REDUCTION

5.1 PRESSURE CALCULATION

Each Model 4500HT sensor is supplied with a calibration report showing the output of the temperature sensor at seven different temperatures, ranging from 0 °C to 250 °C (Figure 3). Also supplied are seven calibration reports from the pressure transducer showing the output readings versus pressure change at seven temperature intervals (Figure 4 through Figure 10).

The Model 4500HT pressure transducer and incorporated Model 4700 temperature sensor both operate on the vibrating wire principle. The output of the temperature sensor will yield the operating temperature directly using a second order polynomial. Calculation of pressure is not direct. The effect of the ambient temperature on both the zero reading and gauge factor must be taken into account. In essence the data interpretation proceeds as follows, using second order polynomials for greater accuracy.

To calculate the pressure (P) from any current reading (R_1) on the pressure transducer, complete the following:

1. Calculate the temperature (T) from the VW temperature sensor using the output reading (R_T) from the temperature sensor and the polynomial expression shown on the temperature gauge calibration report.
2. Use the temperature values and the zero pressure readings shown on the calibration reports in an Excel spreadsheet to develop a polynomial that describes how the zero reading (R_0) varies with the temperature. (This polynomial will be supplied along with the calibration reports.)
3. Use the temperature values and linear gauge factors shown on the calibration reports in an Excel spreadsheet to develop a polynomial that describes how the gauge factor (G) varies with the temperature. (This polynomial will be supplied along with the calibration reports.)
4. Using the calculated polynomial values of R_0 and G at the measured temperature (T) and with the current reading (R_1) find the pressure (P) from the equation:

$$P = G(R_1 - R_0)$$

EQUATION 1: *Linear Pressure Calculation*

Where:
G = The gauge factor found on the calibration report, usually in terms of kPa, MPa, or psi per digit.
R_1 = The current readings in digits.
R_0 = The initial field zero reading in digits.

An example using an Excel Spreadsheet and the Chart Wizard Trendlines, as well as the data from the calibration reports is shown below.

$$\text{Temperature (T)} = (3.7511\text{E}{-}07 \times R_T^{\ 2}) + (0.03484 \times R_T) + (-124.98)$$

EQUATION 2: *Temperature*

$$\text{Zero Reading } (R_0) = -0.00193T^2 + 1.885T + 8367$$

EQUATION 3: *Zero Reading*

$$\text{Gauge Factor (G)} = -8.61 \times 10^{-11} T^2 + (-2.038 \times 10^{-09} T) + (-0.0002246)$$

EQUATION 4: *Gauge Factor Calculation*

For example, suppose that the reading on the temperature sensor (R_T) is 8400 and the reading on the pressure transducer (R_1) is 6500.

Then;

Temperature = 194.1 °C

Zero Reading = 8660

Gauge Factor = -0.0002282

From which Pressure = (6500 – 8660) (-0.002282) = 0.493 MPa

5.2 ENVIRONMENTAL FACTORS

Since the purpose of the piezometer installation is to monitor site conditions, factors that can affect these conditions should always be observed and recorded. Seemingly minor affects may have a real influence on the behavior of the structure being monitored and may give an early indication of potential problems. Some of these factors include, but are not limited to, blasting, rainfall, tidal levels, traffic, temperature and barometric changes, weather conditions, changes in personnel, nearby construction activities, excavation and fill level sequences, seasonal changes, etc.

6. TROUBLESHOOTING

Technical Support

Maintenance and troubleshooting of vibrating wire piezometers is confined to periodic checks of cable connections and maintenance of terminals. The transducers themselves are sealed and are not user serviceable. **Gauges should not be opened in the field.**

Should difficulties arise, consult the following list of problems and possible solutions. For additional troubleshooting and support visit geokon.com/Technical-Support.

SYMPTOM: PIEZOMETER READING UNSTABLE

- ☐ Make sure the shield drain wire is connected to the blue clip on the flying leads.
- ☐ Isolate the readout from the ground by placing it on a piece of wood or another insulator.
- ☐ Check for sources of nearby electrical noise such as motors, generators, antennas, or electrical cables. Move the piezometer cable away from these sources if possible. Contact the factory for available filtering and shielding equipment.
- ☐ The piezometer may have been damaged by over-ranging or shock. Inspect the diaphragm and housing for damage.
- ☐ The body of the piezometer may be shorted to the shield. Check the resistance between the shield drain wire and the piezometer housing. If the resistance is very low, the gauge conductors may be shorted.

SYMPTOM: PIEZOMETER FAILS TO GIVE A READING

- ☐ Check the readout with another gauge to ensure it is functioning properly.
- ☐ The piezometer may have been over-ranged or shocked. Inspect the diaphragm and housing for damage.
- ☐ Check the resistance of the cable by connecting an ohmmeter to the sensor leads. If the resistance is very high or infinite, the cable is probably broken. If the resistance is very low, the gauge conductors may be shorted.

APPENDIX A. SPECIFICATIONS

A.1 4500HT SPECIFICATIONS

Available Ranges	350, 700 kPa; 1, 2, 3, 5, 7.5, 10, 20, 35, 50, 75, 100 MPa
Over Range	1.5 × Rated Pressure
Resolution	0.025% F.S. (minimum)
Accuracy[1]	±0.1% F.S.
Linearity	< 0.5% F.S. (±0.1% F.S. optional)
Temperature Range	0 °C to + 250 °C
Thermal Zero Shift	<0.05% F.S./°C
Diaphragm Displacement	< 0.001 cm^3 at F.S.
Frequency Range	1400-3500 Hz
Length x Diameter	350, 700 kPa; 1, 2, 3, 5, 7.5, 10, 20, 35, 50, 75, 100 MPa Ranges: 191 x 19 mm (7.52 x 0.75") 20, 35, 50, 75, 100 MPa Ranges: Please contact GEOKON for dimensions

TABLE 2: *4500HT High Temperature Vibrating Wire Piezometer Specifications*

Note:

PSI = kPa × 0.14503, or MPa × 145.03.

Piezometers with a range of 350 kPa and higher are capable of reading negative pressures to -100 kPa. Contact GEOKON for more information.

Pressure connections are female 7/16-20 UNF medium pressure 60° cone.

[1] Accuracy established under laboratory conditions.

A.2 CABLE SPECIFICATIONS

Cable Type	**Mineral Insulated Cable**	**Tubular Encapsulated Cable (TEC)**
Conductors	4-conductors, 22 AWG, solid copper	4-conductors, 24 AWG, stranded, tinned, copper
Insulation	N/A	PFA
Sheath Material	Stainless Steel	316L Stainless Steel
Sheath Wall	0.76 mm	0.76 mm
Nominal Outer Diameter	4.76 mm	4 mm
Coil Diameter	1 m (3')	1 m (3')

TABLE 3: *Cable Specifications*

GEOKON®

Vibrating Wire Temperature Gauge Calibration Report

Model Number: 4500HT-7.5 MPa

Calibration Date: January 29, 2025

This calibration has been verified/validated as of 03/20/2025

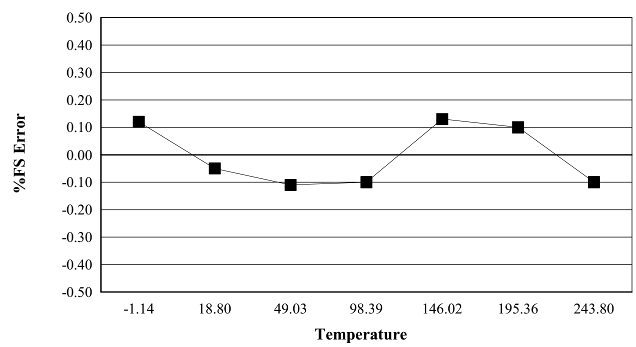
Serial Number: 2501669

Technician:

Calibration Data

Reading (digits)	Reading^2	Temperature°C	Calc. Temperature	%FS Error
3407.1	11608651	-1.14	-0.847	0.12
3902.4	15228437	18.80	18.68	-0.05
4655.5	21673447	49.03	48.76	-0.11
5866.2	34412478	98.39	98.14	-0.10
7020.3	49284612	146.02	146.4	0.13
8172.5	66790165	195.36	195.6	0.10
9269.8	85929785	243.80	243.6	-0.10

Error Plot



Temperature(°C) = (A*R^2) + (B*R) + C

Where: **R= Reading in Digits**

A= 4.226E-07

B= 0.03633

C= -129.55

The above instrument was found to be In Tolerance in all operating ranges.

The above named instrument has been calibrated by comparison with standards traceable to the NIST, in compliance with ANSI Z540-1.

FIGURE 3: *Typical Internal Model 4700 Temperature Sensor Calibration Report*

GEOKON

Vibrating Wire Pressure Transducer Calibration Report

Model Number: 4500HT-7.5 MPa

Date of Calibration: January 29, 2025

This calibration has been verified/validated as of 03/20/2025

Serial Number: 2501669

Temperature: -1.14 °C

Calibration Instruction: CI-4500HT (5 MPa~50 MPa)

Barometric Pressure: 972.6 mbar

Technician:

Applied Pressure (MPa)	Gauge Reading 1st Cycle	Gauge Reading 2nd Cycle	Average Gauge Reading	Calculated Pressure (Linear)	Error Linear (%FS)	Calculated Pressure (Polynomial)	Error Polynomial (%FS)
0.0000	8864.2	8866.1	8865.14	0.0114	0.152	0.0010	0.013
1.5000	8232.2	8232.7	8232.43	1.4971	-0.039	1.4994	-0.008
3.0000	7597.1	7597.8	7597.47	2.9881	-0.159	2.9968	-0.042
4.5000	6955.5	6956.2	6955.84	4.4947	-0.071	4.5035	0.047
6.0000	6315.7	6315.9	6315.82	5.9975	-0.033	6.0000	0.000
7.5000	5671.9	5671.7	5671.82	7.5097	0.130	7.4993	-0.010

(MPa) Linear Gauge Factor **-0.002348** **(MPa/ digit)**

Regression Zero: **8870**

Polynomial Gauge factors: **A:** **-7.878E-09** **B:** **-0.002234** **C:**

Calculate C by setting P=0 and R_1 = initial field zero reading into the polynomial equation

(psi) Linear Gauge Factor (G): **-0.3406** **(psi/ digit)**

Polynomial Gauge Factors: **A:** **-1.143E-06** **B:** **-0.3240** **C:**

Calculate C by setting P=0 and R_1 = initial field zero reading into the polynomial equation

Calculated Pressures:

Linear, $P = G(R_1 - R_0)$*

Polynomial, $P = AR_1^2 + BR_1 + C$*

*Barometric pressures expressed in MPa or psi. Barometric compensation is not required with vented transducers.

Factory Zero Reading: **8903** **Temperature:** **22.9** **°C** **Barometer:** **996.7** **mbar**

Factory Zero Reading was taken at ambient temperature.

The above instrument was found to be in tolerance in all operating ranges.
The above named instrument has been calibrated by comparison with standards traceable to the NIST, in compliance with ANSI Z540-1.

FIGURE 4: *Typical Model 4500HT Pressure Transducer Calibration Report at First Temperature*

GEOKON®

Vibrating Wire Pressure Transducer Calibration Report

Model Number: 4500HT-7.5 MPa

Date of Calibration: January 29, 2025

This calibration has been verified/validated as of 03/20/2025

Serial Number: 2501669

Temperature: 18.80 °C

Calibration Instruction: CI-4500HT (5 MPa~50 MPa)

Barometric Pressure: 974.4 mbar

Technician:

Applied Pressure (MPa)	Gauge Reading 1st Cycle	Gauge Reading 2nd Cycle	Average Gauge Reading	Calculated Pressure (Linear)	Error Linear (%FS)	Calculated Pressure (Polynomial)	Error Polynomial (%FS)
0.0000	8900.4	8901.9	8901.14	0.0114	0.152	0.0011	0.015
1.5000	8269.4	8270.2	8269.83	1.4963	-0.049	1.4991	-0.012
3.0000	7635.4	7636.0	7635.70	2.9878	-0.163	2.9972	-0.037
4.5000	6995.3	6995.9	6995.60	4.4933	-0.089	4.5028	0.038
6.0000	6355.9	6356.0	6355.95	5.9978	-0.029	6.0008	0.010
7.5000	5713.3	5713.4	5713.32	7.5093	0.124	7.4990	-0.014

(MPa) Linear Gauge Factor **-0.002352** **(MPa/ digit)**

Regression Zero: **8906**

Polynomial Gauge factors: **A:** **-8.125E-09** **B:** **-0.002233** **C:**

Calculate C by setting P=0 and R_1 = initial field zero reading into the polynomial equation

(psi) Linear Gauge Factor (G): **-0.3411** **(psi/ digit)**

Polynomial Gauge Factors: **A:** **-1.178E-06** **B:** **-0.3239** **C:**

Calculate C by setting P=0 and R_1 = initial field zero reading into the polynomial equation

Calculated Pressures:

Linear, $P = G(R_1 - R_0)$*

Polynomial, $P = AR_1^2 + BR_1 + C$*

*Barometric pressures expressed in MPa or psi. Barometric compensation is not required with vented transducers.

Factory Zero Reading: **8903** **Temperature:** **22.9** **°C** **Barometer:** **996.7** **mbar**

Factory Zero Reading was taken at ambient temperature.

The above instrument was found to be in tolerance in all operating ranges.
The above named instrument has been calibrated by comparison with standards traceable to the NIST, in compliance with ANSI Z540-1.

***FIGURE 5:** Typical Model 4500HT Pressure Transducer Calibration Report at Second Temperature*

GEOKON®

Vibrating Wire Pressure Transducer Calibration Report

Model Number: 4500HT-7.5 MPa

Date of Calibration: January 29, 2025

This calibration has been verified/validated as of 03/20/2025

Serial Number: 2501669

Temperature: 49.03 °C

Calibration Instruction: CI-4500HT (5 MPa~50 MPa)

Barometric Pressure: 976.9 mbar

Technician:

Applied Pressure (MPa)	Gauge Reading 1st Cycle	Gauge Reading 2nd Cycle	Average Gauge Reading	Calculated Pressure (Linear)	Error Linear (%FS)	Calculated Pressure (Polynomial)	Error Polynomial (%FS)
0.0000	8955.1	8956.1	8955.61	0.0127	0.169	0.0006	0.008
1.5000	8326.0	8326.6	8326.30	1.4965	-0.046	1.4997	-0.005
3.0000	7693.4	7694.0	7693.71	2.9881	-0.159	2.9989	-0.014
4.5000	7057.2	7057.7	7057.43	4.4884	-0.155	4.4993	-0.009
6.0000	6416.3	6416.7	6416.47	5.9996	-0.005	6.0030	0.039
7.5000	5775.5	5775.8	5775.63	7.5106	0.142	7.4985	-0.019

(MPa) Linear Gauge Factor **-0.002358** **(MPa/ digit)**

Regression Zero: **8961**

Polynomial Gauge factors: **A: -9.478E-09** **B: -0.002218** **C:**

Calculate C by setting P=0 and R_1 = initial field zero reading into the polynomial equation

(psi) Linear Gauge Factor (G): **-0.3420** **(psi/ digit)**

Polynomial Gauge Factors: **A: -1.375E-06** **B: -0.3217** **C:**

Calculate C by setting P=0 and R_1 = initial field zero reading into the polynomial equation

Calculated Pressures:

Linear, $P = G(R_1 - R_0)$*

Polynomial, $P = AR_1^2 + BR_1 + C$*

*Barometric pressures expressed in MPa or psi. Barometric compensation is not required with vented transducers.

Factory Zero Reading: **8903** **Temperature:** **22.9** **°C** **Barometer:** **996.7** **mbar**

Factory Zero Reading was taken at ambient temperature.

The above instrument was found to be in tolerance in all operating ranges.
The above named instrument has been calibrated by comparison with standards traceable to the NIST, in compliance with ANSI Z540-1.

FIGURE 6: *Typical Model 4500HT Pressure Transducer Calibration Report at Third Temperature*

GEOKON

Vibrating Wire Pressure Transducer Calibration Report

Model Number: 4500HT-7.5 MPa

Date of Calibration: January 29, 2025

This calibration has been verified/validated as of 03/20/2025

Serial Number: 2501669

Temperature: 98.39 °C

Calibration Instruction: CI-4500HT (5 MPa~50 MPa)

Barometric Pressure: 979.2 mbar

Technician:

Applied Pressure (MPa)	Gauge Reading 1st Cycle	Gauge Reading 2nd Cycle	Average Gauge Reading	Calculated Pressure (Linear)	Error Linear (%FS)	Calculated Pressure (Polynomial)	Error Polynomial (%FS)
0.0000	9028.9	9029.7	9029.29	0.0135	0.180	0.0010	0.013
1.5000	8402.7	8403.2	8402.94	1.4975	-0.033	1.4991	-0.012
3.0000	7773.2	7773.7	7773.42	2.9890	-0.146	2.9978	-0.029
4.5000	7138.3	7138.6	7138.46	4.4934	-0.088	4.5023	0.031
6.0000	6502.8	6503.3	6503.06	5.9989	-0.015	6.0007	0.009
7.5000	5864.5	5864.5	5864.54	7.5117	0.156	7.4991	-0.012

(MPa) Linear Gauge Factor **-0.002369** **(MPa/ digit)**

Regression Zero: **9035**

Polynomial Gauge factors: **A: -8.911E-09** **B: -0.002237** **C:**

Calculate C by setting P=0 and R_1 = initial field zero reading into the polynomial equation

(psi) Linear Gauge Factor (G): **-0.3436** **(psi/ digit)**

Polynomial Gauge Factors: **A: -1.292E-06** **B: -0.3244** **C:**

Calculate C by setting P=0 and R_1 = initial field zero reading into the polynomial equation

Calculated Pressures:

Linear, $P = G(R_1 - R_0)$*

Polynomial, $P = AR_1^2 + BR_1 + C$*

*Barometric pressures expressed in MPa or psi. Barometric compensation is not required with vented transducers.

Factory Zero Reading: **8903** **Temperature:** **22.9** **°C** **Barometer:** **996.7** **mbar**

Factory Zero Reading was taken at ambient temperature.

The above instrument was found to be in tolerance in all operating ranges.
The above named instrument has been calibrated by comparison with standards traceable to the NIST, in compliance with ANSI Z540-1.

FIGURE 7: *Typical Model 4500HT Pressure Transducer Calibration Report at Fourth Temperature*

GEOKON®

Vibrating Wire Pressure Transducer Calibration Report

Model Number: 4500HT-7.5 MPa

Date of Calibration: January 28, 2025

This calibration has been verified/validated as of 03/20/2025

Serial Number: 2501669

Temperature: 146.02 °C

Calibration Instruction: CI-4500HT (5 MPa~50 MPa)

Barometric Pressure: 982 mbar

Technician:

Applied Pressure (MPa)	Gauge Reading 1st Cycle	Gauge Reading 2nd Cycle	Average Gauge Reading	Calculated Pressure (Linear)	Error Linear (%FS)	Calculated Pressure (Polynomial)	Error Polynomial (%FS)
0.0000	9087.5	9088.7	9088.11	0.0117	0.155	0.0005	0.006
1.5000	8464.9	8465.4	8465.16	1.4966	-0.045	1.4993	-0.009
3.0000	7838.8	7839.0	7838.88	2.9895	-0.140	2.9993	-0.009
4.5000	7208.5	7209.2	7208.84	4.4914	-0.115	4.5012	0.016
6.0000	6577.2	6577.3	6577.24	5.9969	-0.041	5.9999	-0.002
7.5000	5942.0	5942.2	5942.10	7.5110	0.146	7.4998	-0.003

(MPa) Linear Gauge Factor **-0.002384** **(MPa/ digit)**

Regression Zero: **9093**

Polynomial Gauge factors: **A: -8.838E-09** **B: -0.002251** **C:**

Calculate C by setting P=0 and R_1 = initial field zero reading into the polynomial equation

(psi) Linear Gauge Factor (G): **-0.3457** **(psi/ digit)**

Polynomial Gauge Factors: **A: -1.282E-06** **B: -0.3265** **C:**

Calculate C by setting P=0 and R_1 = initial field zero reading into the polynomial equation

Calculated Pressures:

Linear, $P = G(R_1 - R_0)$*

Polynomial, $P = AR_1^2 + BR_1 + C$*

*Barometric pressures expressed in MPa or psi. Barometric compensation is not required with vented transducers.

Factory Zero Reading: **8903** **Temperature:** **22.9** **°C** **Barometer:** **996.7** **mbar**

Factory Zero Reading was taken at ambient temperature.

The above instrument was found to be in tolerance in all operating ranges.
The above named instrument has been calibrated by comparison with standards traceable to the NIST, in compliance with ANSI Z540-1.

FIGURE 8: *Typical Model 4500HT Pressure Transducer Calibration Report at Fifth Temperature*

GEOKON®

Vibrating Wire Pressure Transducer Calibration Report

Model Number: 4500HT-7.5 MPa

Date of Calibration: January 28, 2025

This calibration has been verified/validated as of 03/20/2025

Serial Number: 2501669

Temperature: 195.36 °C

Calibration Instruction: CI-4500HT (5 MPa~50 MPa)

Barometric Pressure: 982.5 mbar

Technician:

Applied Pressure (MPa)	Gauge Reading 1st Cycle	Gauge Reading 2nd Cycle	Average Gauge Reading	Calculated Pressure (Linear)	Error Linear (%FS)	Calculated Pressure (Polynomial)	Error Polynomial (%FS)
0.0000	9134.2	9136.4	9135.27	0.0114	0.151	0.0002	0.002
1.5000	8516.7	8517.8	8517.24	1.4970	-0.040	1.4989	-0.015
3.0000	7894.4	7895.2	7894.79	2.9932	-0.091	3.0017	0.023
4.5000	7271.2	7272.1	7271.64	4.4911	-0.119	4.4997	-0.004
6.0000	6644.7	6645.7	6645.21	5.9969	-0.042	5.9990	-0.014
7.5000	6014.7	6015.3	6015.01	7.5117	0.156	7.5005	0.007

(MPa) Linear Gauge Factor **-0.002404** **(MPa/ digit)**

Regression Zero: **9140**

Polynomial Gauge factors: **A: -8.462E-09** **B: -0.002276** **C:**

Calculate C by setting P=0 and R_1 = initial field zero reading into the polynomial equation

(psi) Linear Gauge Factor (G): -0.3486 (psi/ digit)

Polynomial Gauge Factors: **A: -1.227E-06** **B: -0.3300** **C:**

Calculate C by setting P=0 and R_1 = initial field zero reading into the polynomial equation

Calculated Pressures:

Linear, $P = G(R_1 - R_0)$*

Polynomial, $P = AR_1^2 + BR_1 + C$*

*Barometric pressures expressed in MPa or psi. Barometric compensation is not required with vented transducers.

Factory Zero Reading: 8903 **Temperature: 22.9 °C** **Barometer: 996.7 mbar**

Factory Zero Reading was taken at ambient temperature.

The above instrument was found to be in tolerance in all operating ranges.
The above named instrument has been calibrated by comparison with standards traceable to the NIST, in compliance with ANSI Z540-1.

FIGURE 9: *Typical Model 4500HT Pressure Transducer Calibration Report at Sixth Temperature*

GEOKON®

Vibrating Wire Pressure Transducer Calibration Report

Model Number: 4500HT-7.5 MPa

Date of Calibration: January 28, 2025

This calibration has been verified/validated as of 03/20/2025

Serial Number: 2501669

Temperature: 243.80 °C

Calibration Instruction: CI-4500HT (5 MPa~50 MPa)

Barometric Pressure: 981.1 mbar

Technician:

Applied Pressure (MPa)	Gauge Reading 1st Cycle	Gauge Reading 2nd Cycle	Average Gauge Reading	Calculated Pressure (Linear)	Error Linear (%FS)	Calculated Pressure (Polynomial)	Error Polynomial (%FS)
0.0000	9165.7	9168.4	9167.07	0.0120	0.160	-0.0004	-0.005
1.5000	8555.0	8556.9	8555.95	1.4976	-0.032	1.5006	0.009
3.0000	7941.9	7942.9	7942.42	2.9890	-0.147	2.9999	-0.001
4.5000	7324.8	7325.7	7325.26	4.4893	-0.143	4.5003	0.004
6.0000	6705.2	6705.9	6705.53	5.9958	-0.056	5.9991	-0.012
7.5000	6081.0	6081.9	6081.45	7.5129	0.172	7.5005	0.006

(MPa) Linear Gauge Factor **-0.002431** **(MPa/ digit)**

Regression Zero: **9172**

Polynomial Gauge factors: **A:** **-1.022E-08** **B:** **-0.002275** **C:**

Calculate C by setting P=0 and R_1 = initial field zero reading into the polynomial equation

(psi) Linear Gauge Factor (G): **-0.3526** **(psi/ digit)**

Polynomial Gauge Factors: **A:** **-1.482E-06** **B:** **-0.3300** **C:**

Calculate C by setting P=0 and R_1 = initial field zero reading into the polynomial equation

Calculated Pressures:

Linear, $P = G(R_1 - R_0)^*$

Polynomial, $P = AR_1^2 + BR_1 + C^*$

*Barometric pressures expressed in MPa or psi. Barometric compensation is not required with vented transducers.

Factory Zero Reading: **8903** **Temperature:** **22.9** **°C** **Barometer:** **996.7** **mbar**

Factory Zero Reading was taken at ambient temperature.

The above instrument was found to be in tolerance in all operating ranges.
The above named instrument has been calibrated by comparison with standards traceable to the NIST, in compliance with ANSI Z540-1.

FIGURE 10: *Typical Model 4500HT Pressure Transducer Calibration Report at Seventh Temperature*

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