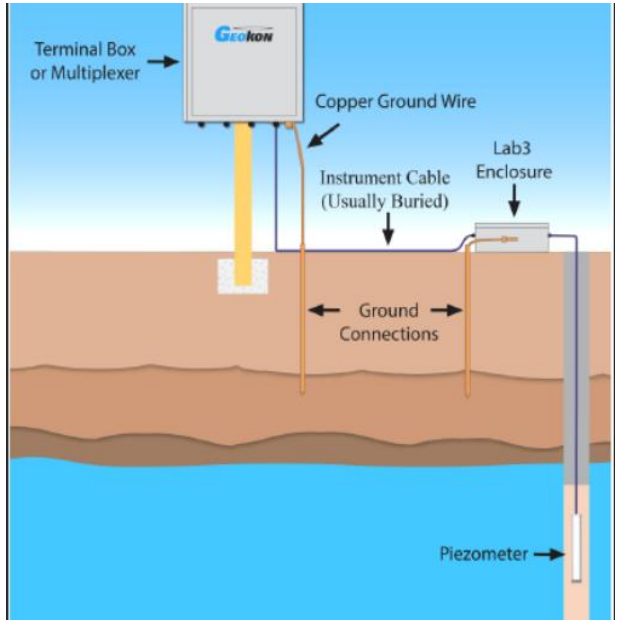
VIBRATING WIRE PIEZOMETERS

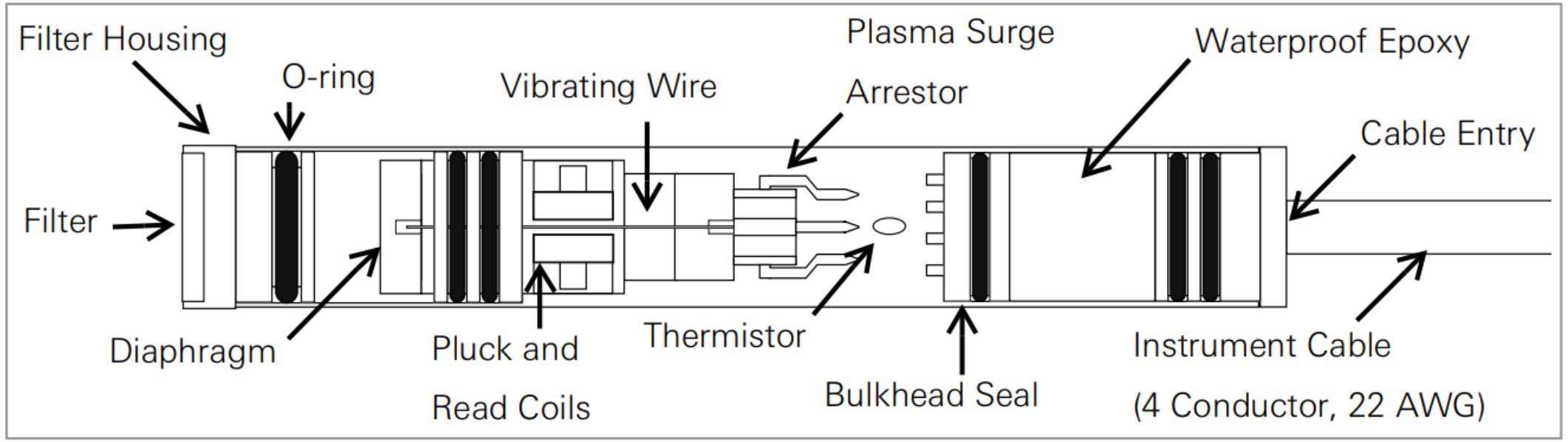
WHEN AND WHERE VWPZ ARE USED

Where its used

- Used for monitoring dams' concrete integrity
- Used in areas with high risk of sink holes
- Used for measuring ground water level in boreholes
- Used for measuring pressure in industrial water flowing pipes

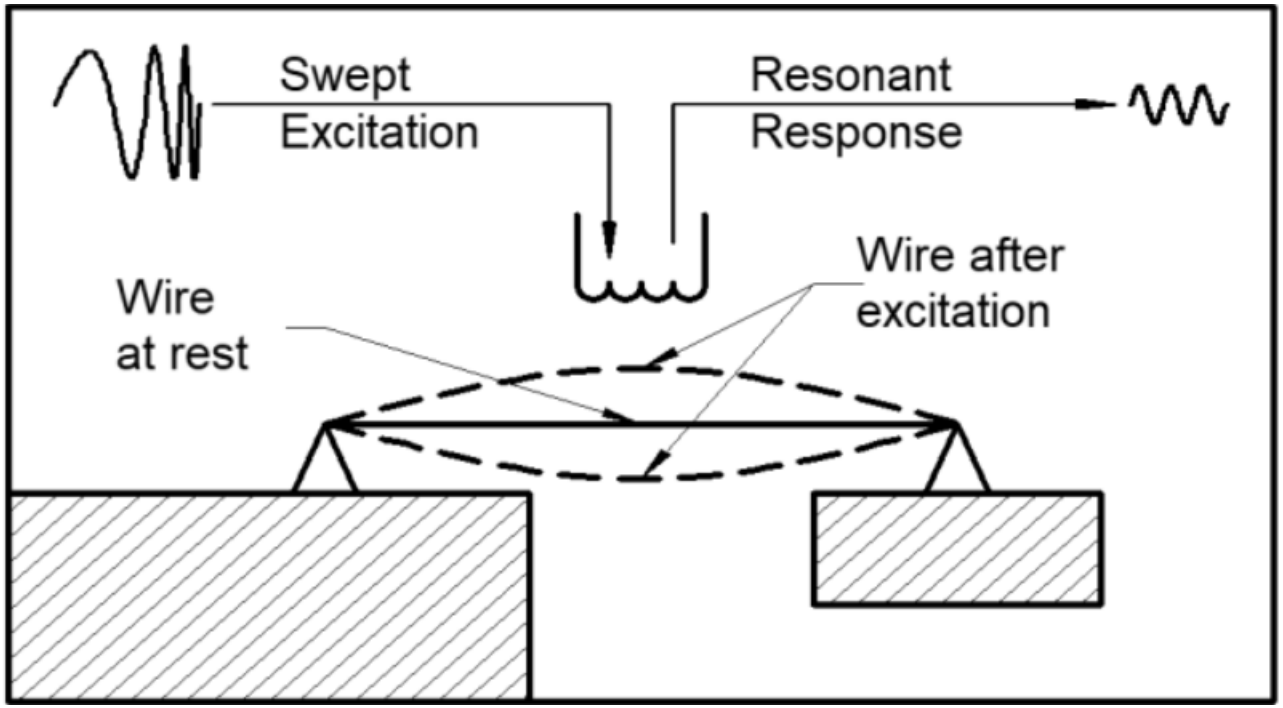
Borehole installation

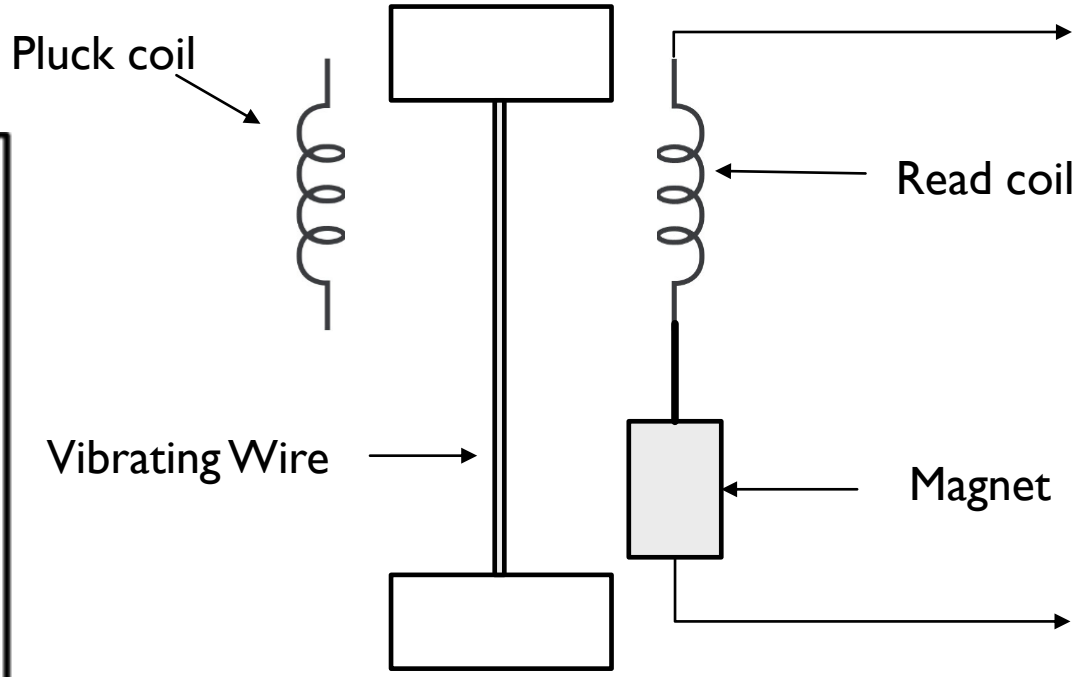




INTERNAL DIAGRAM OF VWPZ

HOW IT WORKS


Swept
Excitation
Resonant
Response
Wire after
excitation
Wire
at rest


Pluck coil
Read coil
Vibrating Wire
Magnet

EQUATIONS

frequency of the wire= $\left[\frac{\sigma \cdot g}{p}\right] \cdot \frac{\frac{1}{2}}{2 \cdot l}$

- L = original length of the wire
- P = volumetric weight of the wire
- g = gravitational constant
- σ = strain of the wire

Linear Units (Digits calculation) = $\frac{H_Z^2}{1000}$

- Hz = resonant frequency of the wire
- Use this equation for converting to pressure

Pressure conversion from digits calculation = $(digits_1 - digits_0) * G$

- G = linear gauge factor (dependent on manufacturer)

B.1 3KΩ THERMISTOR RESISTANCE

Thermistor Types include YSI 44005, Dale #1C3001–B3, Alpha #13A3001–B3, and Honeywell 192–302LET–A01

Resistance to Temperature Equation:

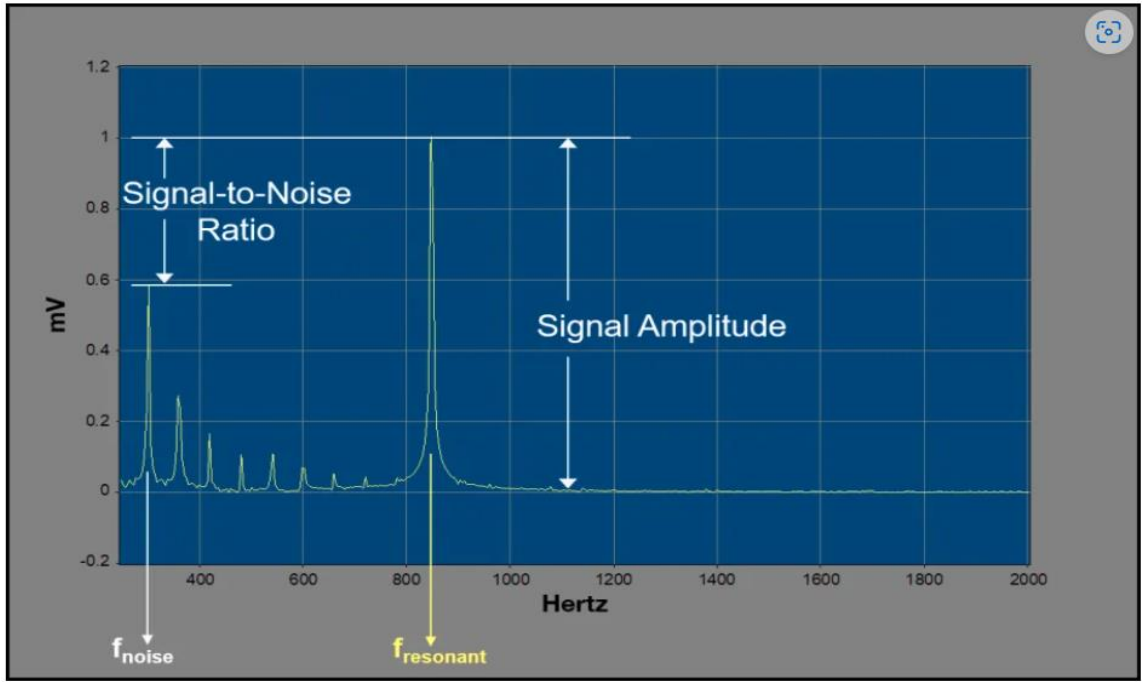
$$T = \frac{1}{A + B(LnR) + C(LnR)^3} - 273.15$$

EQUATION 6: *3KΩ Thermistor Resistance*

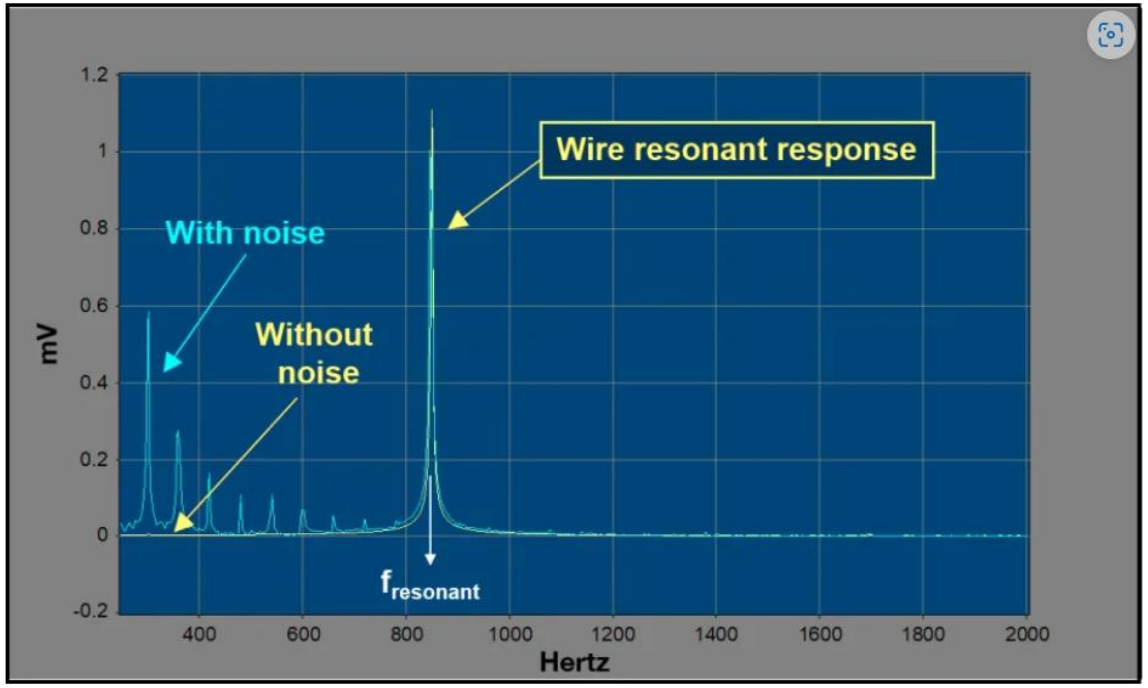
Where:
T = Temperature in °C
LnR = Natural Log of Thermistor Resistance
A = 1.4051×10^{-3}
B = 2.369×10^{-4}
C = 1.019×10^{-7}
Note: Coefficients calculated over the –50 to +150 °C span.

HOW ITS READ

Frequency Response and SNR Comparison



Frequency Response and SNR Comparison



CALIBRATION EXAMPLE

Vibrating Wire Pressure Transducer Calibration Report

Model Number: 4500S-350 kPa

Date of Calibration: November 09, 2023

This calibration has been verified/validated as of 11/13/2023

Serial Number: 2317618

Temperature: 20.80 °C

Calibration Instruction: CI-Pressure Transducer (7 kPa~3.5 MPa)

Barometric Pressure: 990.5 mbar

Cable Length: 40 feet

Technician: Dean O. Cowdery

Applied Pressure (kPa)	Gauge Reading 1st Cycle	Gauge Reading 2nd Cycle	Average Gauge Reading	Calculated Pressure (Linear)	Error Linear (%FS)	Calculated Pressure (Polynomial)	Error Polynomial (%FS)
0.0	8888	8888	8888	0.467	0.13	0.008	0.00
70.0	8293	8293	8293	69.96	-0.01	69.99	0.00
140.0	7696	7696	7696	139.7	-0.07	140.0	0.01
210.0	7096	7097	7097	209.7	-0.09	210.0	-0.01
280.0	6494	6495	6495	280.0	0.00	280.1	0.01
350.0	5891	5892	5892	350.5	0.13	350.0	-0.01

(kPa) Linear Gauge Factor (G): -0.1168 **(kPa/ digit)**

Polynomial Gauge factors: **A:** -3.415E-07 **B:** -0.1118 **C:**

Thermal Factor (K): -0.1028 **(kPa/ °C)**

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

(psi) Linear Gauge Factor (G): -0.01694 **(psi/ digit)**

Polynomial Gauge Factors: **A:** -4.953E-08 **B:** -0.01621 **C:**

Pressure calculation Example:

Pressure conversion = $(digits_1 - digits_0) * G$

↓

(8293 - 8888) * (-0.1168) = 69.5 kPa

WORK CITED

- *Model 4500 Series Vibrating Wire Piezometer - GEOKON*, www.geokon.com/content/manuals/4500_Piezometer.pdf. Accessed 21 Mar. 2024.
- "Reading Vibrating Wire Sensors: Spectral Analysis a Method to Determine the Resonant Frequency of Vibrating Wire Sensors with Improved Noise Immunity." Reading Vibrating Wire Sensors: Spectral Analysis: A Method To..., www.campbellsci.com/vspect/spectral-analysis. Accessed 21 Mar. 2024.
- "André Coyne." *Wikipedia*, Wikimedia Foundation, 24 Aug. 2022, en.wikipedia.org/wiki/Andr%C3%A9_Coyne.