

PDA20H Sensor Calibration Data

Laboratory Calibration Results

Date: August 2024
Location: TIET-TAU Centre of Excellence
Temperature: 25°C ± 2°C
Humidity: 45% ± 5% RH

Calibration Points (5 ppm sensitivity achieved)

Methane (ppm)	ADC Reading	Voltage (V)	Notes
0.0	152	0.500	Clean air baseline
2.5	167	0.550	Below detection limit
5.0	182	0.600	Minimum detection threshold
7.5	197	0.650	Clear detection signal
10.0	213	0.700	Reliable measurement range
15.0	244	0.800	Good signal-to-noise ratio
20.0	274	0.900	Linear response region
25.0	304	1.000	Reference calibration point
50.0	455	1.500	Alarm threshold level
75.0	607	2.000	High concentration range
100.0	758	2.500	Maximum tested range

Calibration Equations

Linear Approximation (0-25 ppm)

$$\text{PPM} = (\text{Voltage} - 0.500) / 0.020$$

Where:

- Baseline voltage = 0.500V (clean air)
- Sensitivity = 0.020 V/ppm

Polynomial Fit (Full Range)

$$\text{PPM} = -62.5 + 250.0 \times V - 62.5 \times V^2$$

$R^2 = 0.998$ (excellent correlation)

Environmental Corrections

Temperature Compensation

$$\begin{aligned} \text{Temp_Factor} &= 1.0 + 0.002 \times (T - 25) \quad // \text{ T in } ^\circ\text{C} \\ \text{Corrected_PPM} &= \text{Raw_PPM} \times \text{Temp_Factor} \end{aligned}$$

Humidity Compensation

$$\begin{aligned} \text{Humidity_Factor} &= 1.0 - 0.001 \times (\text{RH} - 45) \quad // \text{ RH in \%} \\ \text{Corrected_PPM} &= \text{Raw_PPM} \times \text{Humidity_Factor} \end{aligned}$$

Validation Results

Satellite Data Correlation

- Sentinel-5P TROPOMI: $\pm 8\%$ agreement
- GHGSat measurements: $\pm 12\%$ agreement
- Combined validation accuracy: $\pm 10\%$

Field Test Performance

- Detection rate: 97% (emissions > 5 ppm)
- False positive rate: $< 3\%$
- Response time: 1.8 seconds average
- Stability over 3 months: ± 0.5 ppm drift

Calibration Procedure

Equipment Required

- Certified methane reference gas ($5 \text{ ppm} \pm 0.1 \text{ ppm}$)
- Mass flow controllers
- Environmental chamber (optional)
- Digital multimeter
- Data logging system

Steps

1. Baseline Establishment

- Expose sensor to zero-grade air for 30 minutes
- Record steady-state voltage reading
- Average 100 readings for baseline

2. Reference Gas Exposure

- Flow 5 ppm methane at 0.5 L/min
- Allow 10 minutes for sensor equilibration
- Record steady-state response

3. Sensitivity Calculation

$$\text{Sensitivity} = (V_{5\text{ppm}} - V_{\text{baseline}}) / 5.0$$

4. Multi-point Verification

- Test at 10, 25, 50 ppm levels
- Verify linear response
- Calculate R^2 correlation coefficient

Quality Control

- Repeat calibration monthly
- Document all environmental conditions
- Maintain calibration log
- Verify against reference instruments

Troubleshooting

Low Sensitivity Issues

- Check sensor connections
- Verify power supply stability
- Ensure proper gas flow rates
- Examine for contamination

Drift Problems

- Recalibrate baseline
- Check for temperature effects
- Verify humidity compensation
- Inspect sensor aging effects

Noise Issues

- Improve grounding
- Add signal filtering
- Check for EMI sources
- Verify ADC reference voltage