



CALIBRATION AND DATA QUALITY

Calibration: from factory to field.

How Clanert Air data is made trustworthy: Sensirion factory calibration with traceability, Clanert field calibration against reference instruments, validation against US EPA targets, and continuous drift checks.

SUMMARY

Two layers of calibration

LAYER 1 · FACTORY

Sensirion calibration

Every SEN55 and SPS30 sensor is calibrated by Sensirion to its datasheet specification and individually tested after calibration. Sensirion's reference chain is maintained under an ISO 9001:2015 calibration system with traceability to national standards (NPL, PTB, NIST). The certification is attached as Appendix A.

LAYER 2 · FIELD

Clanert field calibration

In the field, each Clanert Air station can be calibrated against a reference instrument or a trusted Clanert station in the same air. The correction accounts for humidity and the local mix of dust and smoke, is validated against US EPA sensor performance targets, and is re-checked automatically every day.

Why both are needed

Optical particle sensors count and size particles by the light they scatter, then convert that to mass. The factory calibration fixes the sensor's response to a known test aerosol. Real air is different: mineral dust, smoke and sea salt have different densities and shapes, and at high humidity many particles absorb water and grow, so an uncorrected sensor reads higher in fog and humid nights. Field calibration aligns each station with a reference in its own environment and keeps it aligned as conditions and the sensor change.

Factory

Sensirion calibration and end-of-line test

Co-location

Station beside a reference

QA/QC

Bad and impossible data removed

Correction

Humidity and local aerosol

Validation

Held-out period vs EPA targets

Monitoring

Daily refit and drift alerts

LAYER 1

Factory calibration by Sensirion

Item	Statement (Sensirion)
Products covered	SEN50, SEN54, SEN55 (and SEN6x family); the SPS30 is calibrated and tested on the same principle.
Calibration	Products are calibrated to meet the specifications of the corresponding Sensirion datasheet. Each device is individually tested after its calibration.
PM2.5 reference	SEN5x PM2.5 output calibrated to a TSI DustTrak™ DRX 8533 in Ambient Mode.
Verification aerosol	3 % atomised KCl solution; deviation to the reference instrument is verified in end tests for every sensor after calibration.
Reference chain	Transfer standards are themselves subject to a scheduled calibration procedure. The reference used to calibrate the transfer standards is calibrated under an ISO 9001:2015 registered calibration system.
Traceability	The accreditation body is a full member of ILAC; this provides traceability to national standards realised at NPL, PTB or NIST.
Temperature / humidity	Factory-calibrated, compensated outputs; typical accuracy ± 0.45 °C and ± 4.5 %RH (see Data Sheet CA-DS-01).
Long-term stability	SEN55 PM long-term precision drift: max. $1.25 \mu\text{g}/\text{m}^3$ per year (0– $100 \mu\text{g}/\text{m}^3$); lifetime > 10 years.

Sources: Sensirion “Calibration Certification – Particulate Matter Sensors”, May 2026 (Appendix A); Sensirion “Datasheet SEN5x”, Version 2, March 2022.

GAS INDICES

VOC and NOx indices

The SEN55 reports VOC and NOx as **indices** from 1 to 500, not as concentrations. The sensor's on-board algorithm learns the normal level at each location: **VOC index 100** and **NOx index 1** represent that location's typical conditions, and the index rises when gases increase above it. Because the indices are self-referencing, they are not field-calibrated to $\mu\text{g}/\text{m}^3$ or ppm, and Clanert Air never converts them or uses them in the AQI. They are used to detect and compare *changes*: odours, solvent releases, combustion fumes. After each power-up the VOC index meets its specification within 1 hour and the NOx index within 6 hours.

— LAYER 2

Clanert field calibration, step by step

- 1 **Choose a reference.** One of:
 - **Reference instrument** (for example a regulatory BAM or TEOM monitor, a gravimetric sampler, or a calibrated portable photometer): its data is uploaded as a CSV file.
 - **A trusted Clanert station** already calibrated: chosen by the administrator ("pinned") or automatically by distance, trust and data freshness.
 - **Two files:** the station's own exported data and the reference file for the same period, for historic or offline calibrations.
- 2 **Co-locate.** Place the station next to the reference, ideally with inlets within a few metres, for **at least two weeks, ideally 30 days**, covering day and night, dry and humid weather and the site's normal activities. More distant references are matched statistically rather than hour by hour, and are used only when closer options are not available.
- 3 **Clean the data (automatic QA/QC).** Readings are averaged to hourly values and paired in time. The system removes negative values, readings at very high humidity where droplets dominate, physically impossible combinations (such as PM2.5 above PM10), and gaps. The number of rows kept and dropped is recorded.
- 4 **Build the correction.** Using the paired data, the system builds a correction for the station that accounts for humidity, temperature and the local mix of particles. The correction is applied securely in the cloud; users see quality metrics only.
- 5 **Validate on unseen data.** The correction is fitted on the earlier part of the co-location period and tested on a later block it has never seen (never a random split, which would flatter the result). The test results are compared with the US EPA targets below.
- 6 **Classify and activate.** The result is given a tier (below). Only a **Calibrated** result is applied to live data, and only after an administrator or the station owner switches it on. Optionally, earlier readings can be recalculated (backfilled) with the same correction.
- 7 **Keep it calibrated.** The correction is updated automatically on recent data so it follows slow changes, and an automatic check watches for drift; if a station starts to drift, the administrator is e-mailed. Each station also has a **trust score** showing its stability and its agreement with the rest of the network. Corrected PM2.5 is never allowed to exceed PM10.

VALIDATION

Performance targets

Field calibrations are judged on the held-out test period against the United States Environmental Protection Agency (EPA) performance targets for fine particulate matter air sensors.

Metric	PM2.5 target (US EPA)	What it means
Coefficient of determination (R^2)	≥ 0.70	The station follows the rises and falls of the reference.
Slope	1.0 ± 0.35	A change at the reference gives the same-sized change at the station.
Intercept	-5 to $+5 \mu\text{g}/\text{m}^3$	No large constant offset.
Root mean square error (RMSE)	$\leq 7 \mu\text{g}/\text{m}^3$	Typical size of the remaining difference.
PM10	$R^2 \geq 0.50$ (Clanert acceptance level)	Coarse dust is harder for optical sensors; a looser bar applies.

Reference: US EPA (2021), Performance Testing Protocols, Metrics, and Target Values for Fine Particulate Matter Air Sensors, EPA/600/R-20/280.

Calibration tiers

Calibrated

Meets the targets on unseen data.
Can be applied to live readings and reports.

Indicative

Follows the reference but misses one or more targets. Kept for review; not applied automatically. Extend co-location or improve siting.

Not calibrated

Not enough paired data or no relationship with the reference. Factory calibration only; data labelled accordingly.

Records and transparency

- **Raw values are always kept** alongside calibrated values, so any correction can be reviewed or reversed.
- Every calibration run is logged: date, reason (initial, scheduled refit, reference switch, drift alert, CSV upload), reference used, number of samples, QA/QC summary, R^2 , RMSE and tier.
- The website shows each station's tier, fit quality and trust score to administrators; station owners see the same for their own stations.

PROCEDURE

Calibration schedule and responsibilities

When	What	Who
Before delivery	Factory calibration and end-of-line test of the sensor	Sensirion
After installation	2–4 weeks of co-location; first field calibration; activation if Calibrated	Clanert / administrator
Every day (automatic)	Refit on recent data; drift detection and e-mail alert	Clanert cloud
Quarterly	Review tier, trust score, data completeness and comparison with nearby stations	Environmental officer
Yearly	Co-location check against a reference instrument; renewed field calibration certificate	Clanert
After relocation, repair or sensor replacement	New co-location and calibration before data is used for compliance	Clanert / administrator
On a drift alert	Inspect pod and vents; check for new local sources; recalibrate if confirmed	Environmental officer

Doing a calibration on the website

1. **Administrators:** Admin portal → **Calibration**. Pick the station, choose the reference (station, CSV upload, or two files), set the period and run. Read the tier, R^2 , RMSE and QA/QC summary; switch on when Calibrated; optionally backfill history.
2. **Station owners:** Analysis → Plugins → **Station Calibration**. Upload the reference CSV, check the automatic column mapping, run, and switch the result on or off for your own stations.
3. **Reference CSV format:** a time column (date and time) and PM2.5 and/or PM10 columns; temperature and humidity are optional. Use the same time zone as stated in the file.

— TEMPLATE

Field calibration certificate

Clanert Air · Field Calibration Certificate

Certificate No. _____ · Issued under CA-CAL-01



Station ID / name

Model / sensor

Standard (SPS30) ☐ Expanded (SEN55) ☐

Site and coordinates

Sensor serial number

Reference type and ID

Distance to reference / pairing

_____ m · Hourly ☐ Distribution ☐

Co-location period

Paired hours used / QA-QC dropped

Result (held-out test period)	PM2.5	PM10	Target	Pass
R ²			≥ 0.70 / ≥ 0.50	☐
Slope			1.0 ± 0.35	☐
Intercept (µg/m ³)			-5 to +5	☐
RMSE (µg/m ³)			≤ 7	☐

Tier

Calibrated ☐ Indicative ☐

Activated on live data

Date:

Next calibration due

The sensor is factory calibrated by Sensirion AG (Appendix A). This certificate covers the field calibration of the complete station at its installed location, validated against the US EPA performance targets for PM2.5 air sensors. VOC and NOx indices are relative indices and are not field-calibrated.

Performed by (name, signature, date)

Approved by (name, signature, date)

APPENDICES

Appendix A: Sensirion Calibration Certification

The following page reproduces, unmodified, Sensirion AG's public "Calibration Certification – Particulate Matter Sensors" (Staefa, May 2026), covering the SEN50, SEN54 and SEN55 sensors used in Clanert Air pods. Source: sensirion.com.

Appendix B: Sensirion SEN5x Datasheet

The complete Sensirion "Datasheet SEN5x", Version 2 (March 2022), is supplied with this document as a separate file: **Sensirion_SEN5x_Datasheet_v2.pdf**.

References

- Sensirion AG, Calibration Certification – Particulate Matter Sensors, May 2026.
- Sensirion AG, Datasheet SEN5x – Environmental Sensor Node for HVAC and Air Quality Applications, Version 2, March 2022.
- Sensirion AG, SPS30 Particulate Matter Sensor datasheet and specification change notice (PM2.5 precision from 31 January 2021).
- US EPA (2021), Performance Testing Protocols, Metrics, and Target Values for Fine Particulate Matter Air Sensors, EPA/600/R-20/280.
- Clanert Air Data Sheet CA-DS-01 and Training Manual CA-TM-01.

Calibration Certification

Name and address of the manufacturer: Sensirion AG
Laubisruestrasse 50
CH-8712 Switzerland

Description: Particulate Matter Sensors

- SEN50, SEN54, SEN55
- SEN62, SEN63C, SEN65, SEN66, SEN68, SEN69C

The above mentioned products are calibrated to meet the specifications according to the corresponding Sensirion data sheet. Each device is individually tested after its calibration.

Sensirion uses transfer standards for the calibration. These transfer standards are themselves subject to a scheduled calibration procedure. The calibration of the reference itself used for the calibration of the transfer standards is performed by an ISO-9001:2015 registered calibration system.

The accreditation body is full member of the International Laboratory Accreditation Cooperation (www.ilac.org). Calibration certificates issued by facilities accredited by a signatory to the ILAC Mutual Recognition Arrangement (MRA) are accepted by all signatories to the ILAC MRA.

This provides traceability of measurement to recognized national standards and to units of measurement realized at the "National Physical Laboratory" (NPL) or other recognized national standards laboratories like "Physikalisch-Technische Bundesanstalt" (PTB) or "National Institute of Standards and Technology" (NIST).

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