# VOC air pollutants and their sources

Examples of air pollutants and their source

<table>
<thead>
<tr>
<th>Category</th>
<th>Pollutants</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Harmful gases</strong></td>
<td>- Acetone (paints, glues)</td>
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<tr>
<td></td>
<td>- Toluene (furniture, mattresses, building products)</td>
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<tr>
<td><strong>Other gases</strong></td>
<td>- Ethanol (alcohol, cleaner, perfume)</td>
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<tr>
<td><strong>Odors</strong></td>
<td>- Hydrogen sulfide, volatile sulfuric compounds (rotten food, farts)</td>
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<td></td>
<td>- Ammonia, amines (pet pee)</td>
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<tr>
<td><strong>Smoke</strong></td>
<td>- Benzene, nitrosamines (cigarette smoke)</td>
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</tbody>
</table>

- **People**: breath, cosmetics, …
- **Carpets, furniture and floorings**: paints and solvents
- **Cleaning and cooking**: plastic products
Monitoring indoor air with the VOC Index

- Monitors VOC (gas) intensity relative to environment
- Excellent D2D
- 10 years lifetime + siloxane stable
- Incl. RH compensation
- Incl. robust VOC Index software

Customer benefits for air purifiers

- VOC Index behaves similar to human nose
- Extends auto mode to gas events
- Fits well to APs with high VOC CADRs
- Proves that an air device works
- Adapts to filter saturation
- Adapts to room backgrounds
Three main components of the VOC Index signal

- **How strong?** Detects *relative intensity* of VOC events
  - SGP40 detects odorless gases as well, but it cannot discriminate between different VOCs.

- **How long?** Detects VOC event *duration*
  - Human nose adapts in a few minutes. SGP40 adapts in a few hours.

- **How often?** Informs about VOC event *frequency*

Example: smelling an orange
The VOC Index covers all information needed

How intense?

VOC Index…

- shows changes of intensity relative to the history in the room
- is referenced to the average of VOCs present over the last 24 h in the room
- behaves similar to a human nose, a MOX sensor is not able to detect the absolute VOC concentration
- starts going back to average VOC Index after 3 h for very long events – adapts to background

500 = relative intensity
Visualizing VOC events by means of VOC Index

VOC Index visualizes VOC events on a logarithmic scale\(^1,2\) and relative to typical indoor gas composition during the recent 24 h. This means that level “typical” refers to the typical conditions of the environment. The scale does not represent absolute concentrations.

Next-level air treatment

VOC Index notifies end users or air treatment devices when air pollution changes. Notifications are actionable in environments with low and high VOC backgrounds independent of the absolute VOC concentrations.

**Interpretation**
- Worse air quality
- Typical air quality
- Better air quality

**Example**

**Recommendation**
- Ventilate, purify intensely
- Ventilate, purify
- No need to ventilate, purify
VOC Index accuracy

- Laboratory
- Field
Proxy gas ethanol

Laboratory tests typically use a proxy gas for real life VOCs. Sensirion recommends ethanol as proxy gas:

- The SGP40 sensor sensitivity to ethanol is representative of the ISO-standard VOC mix ($n$-octane + $m$-xylene)\(^1\) and other VOCs occurring in everyday life\(^2\)
- Ethanol is safe and easy to acquire
- Ethanol enables a simple test setup, only one gas to mix with zero air and humidity

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[2] For more details, please ask for the “SGP40 Performance Report”
Laboratory accuracy

After stabilization at 1 ppm of EtOH in a test chamber (equivalent to a small controlled room in a “perfect world”)

Note: The shown relationship holds only for the standard VOC test sequence¹ as provided by Sensirion.

¹ For details please refer to Sensirion’s application note «SGP40 Testing Guide»
VOC Algorithm

- Signal flow
- Startup
- Long-term behavior
Signal flow in the VOC Index driver

VOC Algorithm calculates VOC Index from measurements with SGP40 and SHT sensors:

- voc_engine_init
- Measure T, RH
- Measure SGP compensated
- voc_engine_process
- VOC Index

every 1 second
Startup

The VOC Algorithm initializes in two phases:

- **0…1.5 h**: fast adaptation to the environment. Signal always initializes in level “typical”. From the beginning, sensor-to-sensor-variation is excellent and fast VOC events are shown.
- **>1.5 h**: final, slow adaptation. Even very slow changes in chemical air pollution are now visualized for best user experience.
Long-term behavior

The VOC Algorithm constantly estimates sensor baseline and sensitivity from statistical data of the past 24 h. For this reason, multiple VOC Index signals are most similar if history is equal since startup. When placed into a common room but with different histories, all VOC Index signals usually converge within 1 to 12 h.

Figure: Three sensor modules with different histories converge after few hours:

![Graph showing convergence of VOC Index signals over time for different histories.](image-url)