# ENS145


## Analog gas sensor for home appliance applications



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# Analog Metal-Oxide Multi-Gas Sensor

The ENS145 is as MOS (metal oxide semiconductor) based gas sensor. It is specifically designed for a broad detection of reducing and oxidizing gases associated with bad air quality such as VOCs (volatile organic compounds), CO (carbon monoxide) and nitrogen oxides (NOx). The ENS145 sensor component is a micro-machined sensor with long-lifetime and long-term stability. It combines high sensitivity with a very low power consumption. The sensor is encapsulated in a small outlined LGA package and can be reflow soldered.

## Key Features & Benefits

**Independent Sensor Heater Control** for highest selectivity (e.g. to ethanol, toluene and acetone) and outstanding background discrimination

**High sensitivity** for volatile organic compounds (VOC), CO, NOx.

**Low power consumption** with 13mW (1.3mW) for indoor air quality with heater constantly on (pulsed mode)

**Wide operating ranges**: temperature: -40 to +85°C; humidity: 5 to 95%[1]

**Ease of integration** with reflow soldering capable SMD package.

## Applications

The ENS145 is designed as analog gas sensor for home appliance applications.

## Properties

- Small-2.5 x 2.5 x 0.9mm LGA package
- T&R packaged, reflow-solderable[2]



[1] Non-condensing

[2] See section “Soldering Information” for further details

# Content Guide

# 1 Block Diagram

The block diagram for the ENS145 is shown in Figure 1. The sensor has two independent blocks: a platinum heater and a transducer. The heater controls the temperature of the sensitive layer. The sensitive layer is responsible for the output signal of the ENS145. Both functional blocks can be seen as resistors.

The ENS145 is a passive component, a micro hotplate with two different hotplates. External circuits are required to drive the heater and to read out the sensitive layer. The signal interpretation is typically done by an algorithm on a microcontroller. Both hotplates can be controlled independently.

The functional blocks of this device and its required context are shown in Figure 1.

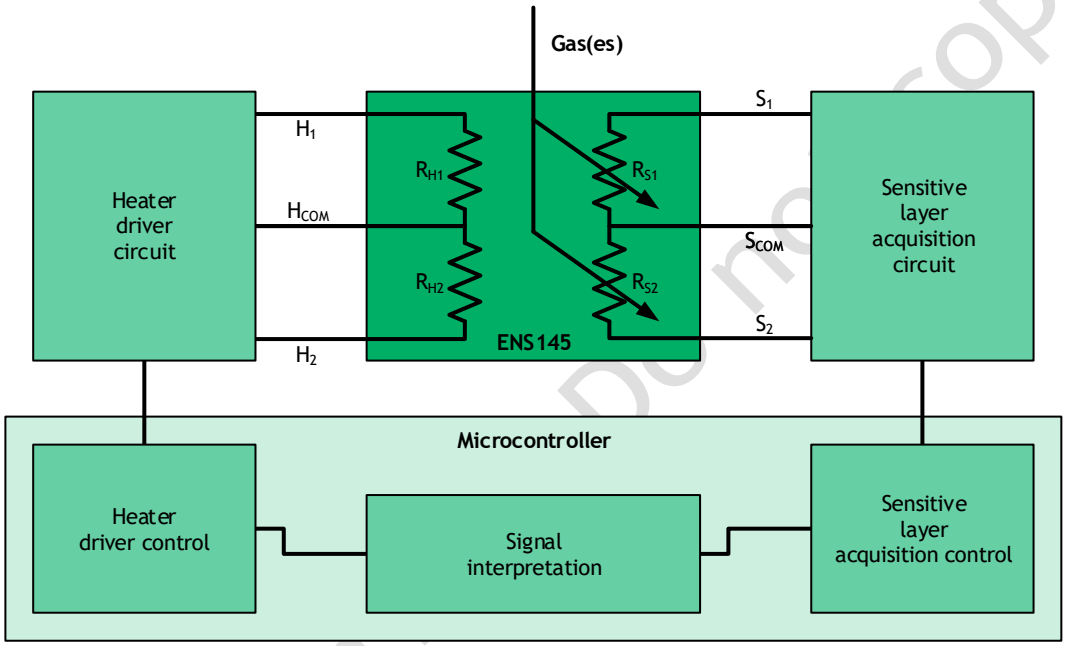


Figure 1 Functional blocks of the ENS145 in its context

For details regarding heater driver and sensitive layer acquisition, please refer to specific application note.

## 1.1 Pin assignment

The pin assignment of the ENS145 is shown in Figure 2 and described in Table 1.The ENS145 is available in a standard LGA package with six connections to contact the heaters and the sensitive layers. The visible venting hole on top side corresponds to Pin#1 corner.

### *1.1.1 Pin diagram*

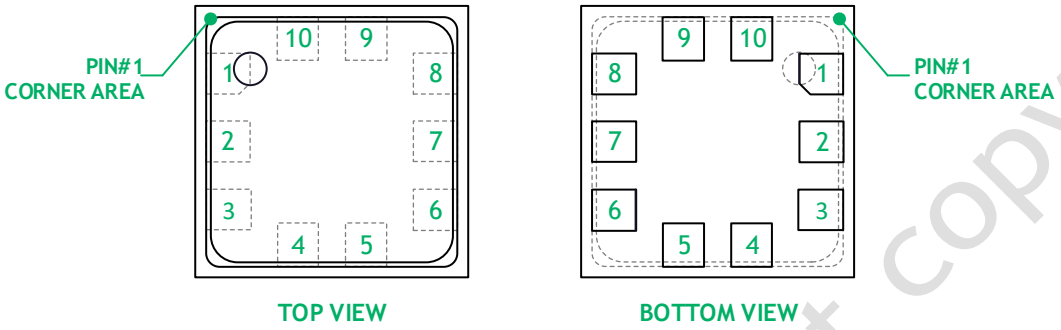


Figure 2 Top and bottom view of the pin diagram

### *1.1.2 Pin description*

The following table includes the description for the pin out of the ENS145.It is recommended to connect NC pads to ground.

| Pin Number | Pin Name | Value | Description |
|---|---|---|---|
| 1 | NC | NC | Not connected or GND |
| 2 | S1 | SE1 Sensor | Sensitive layer #1 acquisition circuit (Sensitive to oxidizing gases) |
| 3 | H1 | SE1 Heater | Heater #1 driver circuit |
| 4 | HCOM | Heater Common [GND] | Common heater connection (GND) Connected with Metal lid |
| 5 | SCOM | Sensor Common | Common sensor connection |
| 6 | NC | NC | Not connected or GND |
| 7 | NC | NC | Not connected or GND |
| 8 | S2 | SE2 Sensor | Sensitive layer #2 acquisition circuit (Sensitive to reducing gases) |
| 9 | H2 | SE2 Heater | Heater #2 driver circuit |
| 10 | NC | NC | Not connected or GND |

Table 1 Detailed pin and connection description

## 1.2 Absolute maximum ratings

Stresses beyond those listed under “Absolute Maximum Ratings” may cause permanent damage to the device. These are stress ratings only. Functional operation of the device at these or any other conditions beyond those indicated under “Operating Conditions” is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

| Symbol | Parameter | Min | Max | Units | Comments |
|---|---|---|---|---|---|
| **Electrical Parameters** | | | | | |
| $P_H$ | Heater power | | 20 | mW | |
| $I_H$ | Heater current | | 13 | mA | |
| $V_S$ | Sensitive layer voltage | | 3.3 | V | |
| $I_S$ | Sensitive layer current | 0 | 1 | mA | |
| **Electrostatic discharge** | | | | | |
| $ESD_{HBM}$ | Electrostatic Discharge HBM | +/- 400 | | V | Norm: JS-001-2014 |
| **Temperature ranges and storage conditions** | | | | | |
| $T_{Amb}$ | Ambient Temperature for operation | 0 | 85 | ˚C | |
| $T_{Store}$ | Storage Temperature | -40 | 125 | ˚C | |
| $T_{Body}$ | Package Body Temperature | | 260 | ˚C | Norm: IPC/JEDEC J-STD-020 |
| $RH_{NC}$ | Relative Humidity (non-condensing) | 5 | 95 | % | |
| MSL | Moisture Sensitivity Level | 1 | | | |

Table 2 Absolute maximum ratings

## 1.3 Electrical characteristics

The values in this section are the parameters for indoor air quality, when operating at room temperature.

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| $P_H$ | Heater power | | 0 | | 16 | mW |
| $R_H$ | Heater resistance (idle) | $P_H$ = 0 mW | 40 | 49 | 58 | Ohm |
| $R_S$ | Sensitive layer resistance | $P_H$ = 10 mW | 1k | 1M | 10M | Ohm |

Table 3 Electrical characteristics

Note(s):

(I) $T_{amb}$ = 25 ˚C, $T_{heater}$ = 300 ˚C (sweet spot for indoor air quality)

# 2 Package drawings & markings

## 2.1 Package outline dimension

The following section describes the package outline dimensions and the pin positions.

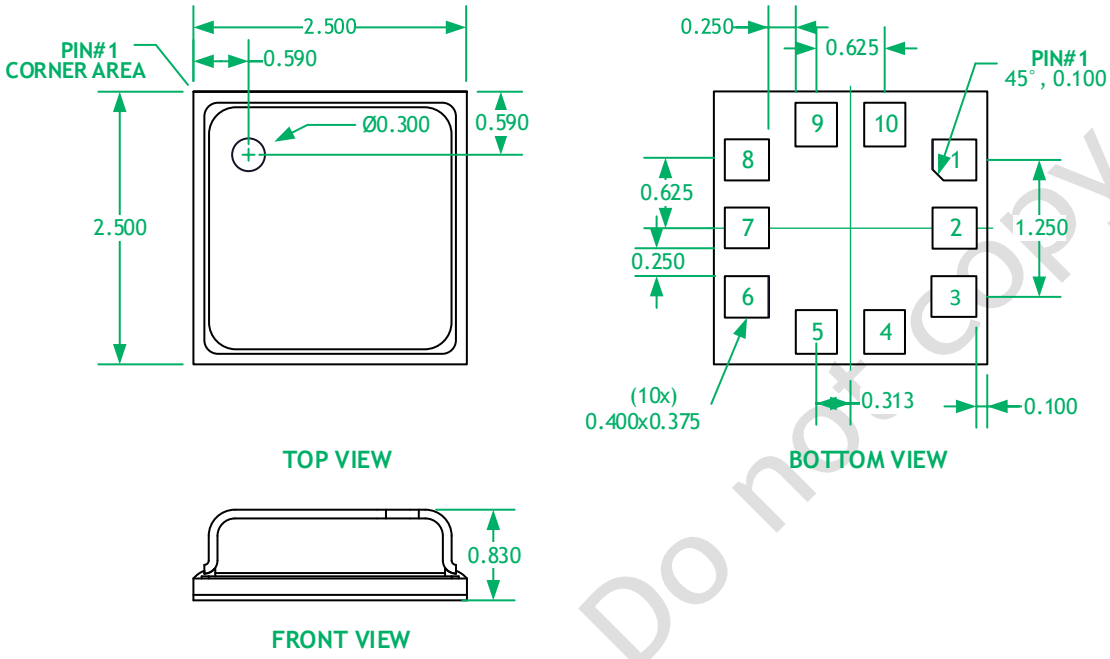


Figure 3 LGA package drawings

| Parameter | Symbol | Dimensions | | |
|---|---|---|---|---|
| | | Min | Nominal | Max |
| Total thickness | A | - | 0.83 | 0.9 |
| Body Size | D | - | 2.5 | BSC |
| | E | - | 2.5 | BSC |
| Lead Width | W | 0.35 | 0.4 | 0.45 |
| Lead Length | L | 0.325 | 0.375 | 0.425 |
| Lead Count | n | | 10 | |

Table 4 LGA package dimensions

**Note(s):**

(1) All dimensions are in millimeters

## 2.2 Package marking

The package marking shown in Figure 4 is design to enable traceability according to the explanation provided in Table 5.

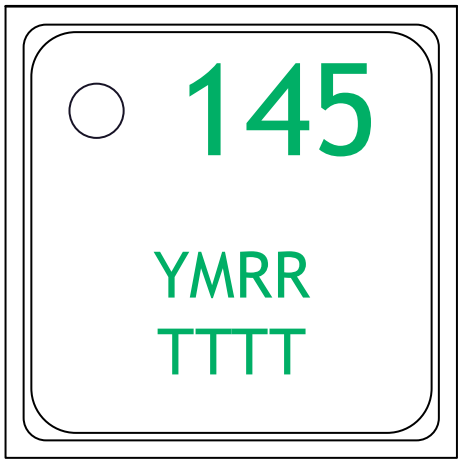


Figure 4 Package code (Top view, to be finalized)

| Code | Description |
|---|---|
| **Y** | Year Code [0 – 9] |
| **M** | Month Code [1 - 9, A - C] |
| **TTTT** | Assembly Lot Trace Code<br>According to ScioSense standard |
| **RR** | Revision number |

Table 5 Package marking explanation (to be finalized)

## 2.3 Storage & handling

The target for the ENS145 is a moisture level 1 (MSL1), which corresponds to an unlimited out-of-bag lifetime at T=30°C, H=90% maximum.

The pick and place machine must not apply vacuum to the cavity package. The pick-up nozzle needs to be positioned accordingly.

The ENS145 should not be exposed to high concentrations of corrosive gases like chlorine, hydrogen sulfide or Sulphur-dioxide. The device must not be used in conditions where silicone can accumulate in the package cavity. Silicone vapors may result in a permanent poisoning of the sensor surface and loss of sensitivity.

# 3 Soldering Information

## 3.1 Landing pattern

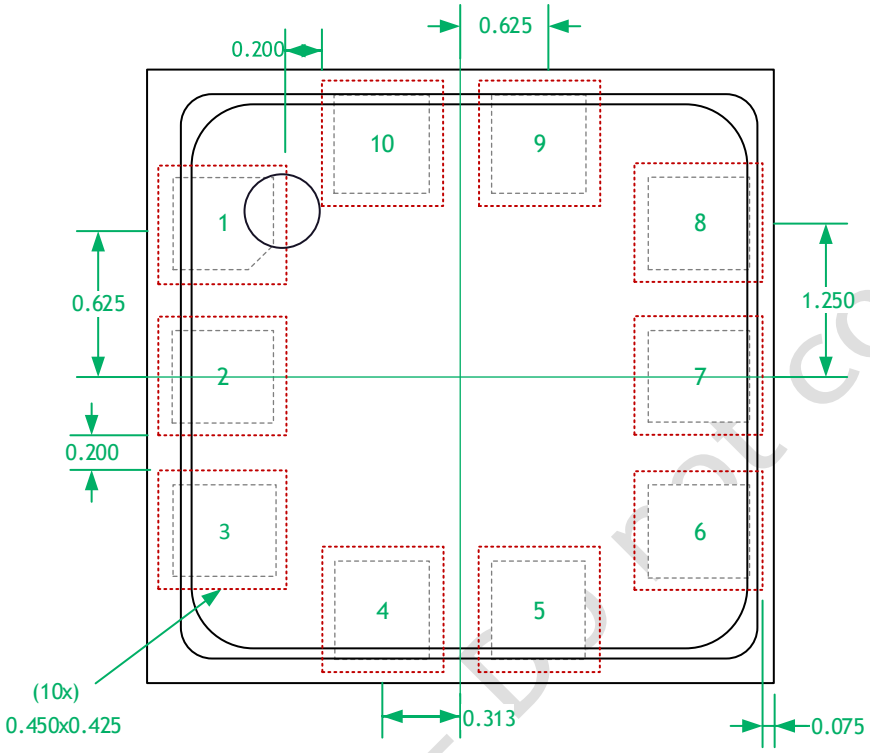


Figure 5 Recommend LGA landing pattern (Top view)

**Note(s):**

(I) All dimensions are in millimeters

(II) PCB land pattern in **dotted lines**

(III) Add 0.05mm all around the nominal lead width and length for the PCB land pattern

The ENS145 uses an open LGA package. This package can be soldered using a standard reflow process in accordance with IPC/JEDEC J-STD-020D.

## 3.2 Reflow profile

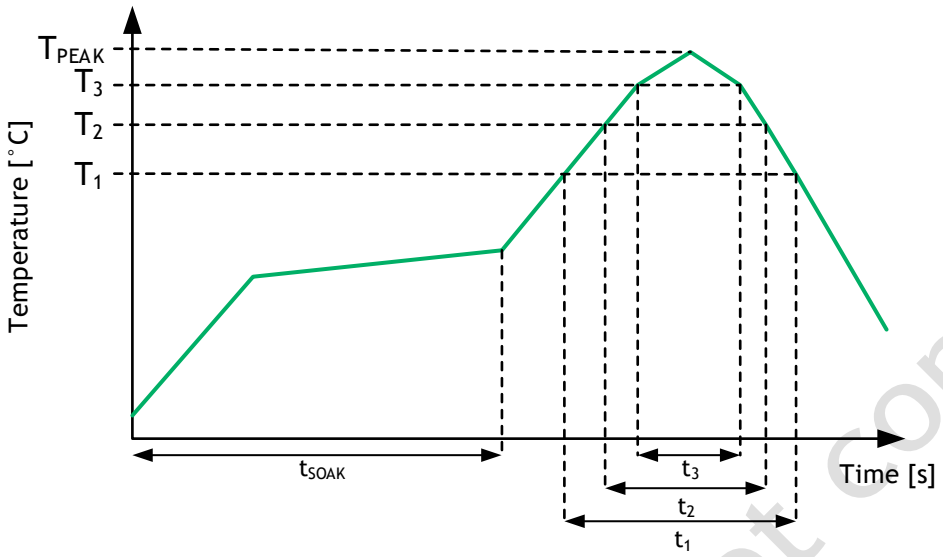


Figure 6 Solder reflow profile graph

The detailed settings for the reflow profile are shown in the table below.

| Parameter | Reference | Rate / Unit |
|---|---|---|
| Average temperature gradient in preheating | | 2.5K/s |
| Soak time | $t_{SOAK}$ | 2..3 min |
| Soak temp range | Ts max | 200°C |
| | Ts min | 150°C |
| Time above 217°C ($T_1$) | $t_1$ | Max. 60s |
| Time above 230°C ($T_2$) | $t_2$ | Max. 50s |
| Time above $T_{PEAK}$ -10°C ($T_3$) | $t_3$ | Max. 10s |
| Peak temperature in reflow | $T_{PEAK}$ | 260°C |
| Temperature gradient in cooling | | Max. -5K/s |

Table 6: Solder reflow profile

It is recommended to use a no-clean solder paste. There should not be any board wash processes, to prevent cleaning agents or other liquid materials contacting the sensor area.

Wave soldering cannot be applied because of open cavity package of the ENS145. It is recommended to use a solder paste with non-clean flux for soldering the sensor component on a PCB. There should not be any board wash processes. The sensor area must not get in contact with cleaning agents or other liquid materials.

# 4 Packaging & Ordering

## 4.1 Packaging

Carrier tape for ENS145 is made of polystyrene with normal seal according to the drawing shown in Figure 7 with the dimension listed in Table 7.

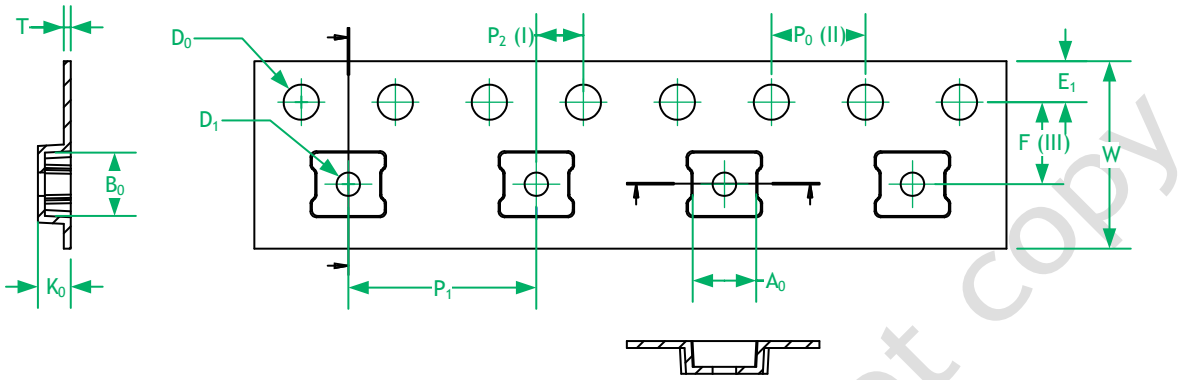


Figure 7 Drawing of the tape & reel

**Note(s):**

(I) Measured from centerline of sprocket hole to centerline of pocket
(II) Cumulative tolerance of 10 sprocket holes is ±0.20
(III) Measured from centerline of sprocket hole to centerline of pocket

| Variable | Parameter | Variable | Parameter |
|---|---|---|---|
| $A_0$ | 2.70 ± 0.05 | $B_0$ | 2.70 ± 0.05 |
| $D_0$ | 1.50 + 0.10 / - 0.00 | $D_1$ | 1.00 + 0.10 / - 0.00 |
| $E_1$ | 1.75 ± 0.10 | F | 3.50 ± 0.05 |
| $K_0$ | 1.10 ± 0.10 | T | 0.30 ± 0.03 |
| $P_0$ | 4.00 ± 0.10 | $P_1$ | 8.00 ± 0.10 |
| $P_2$ | 2.00 ± 0.05 | W | 8.00 + 0.30 / - 0.10 |

Table 7 Parameter definition for tape & reel

**Note(s):**

(I) All dimensions are in millimeters

## 4.2 Ordering

| Ordering Code | Package | Marking | Delivery Form | Delivery Quantity |
|---|---|---|---|---|
| ENS145 | LGA | 145 | Tape & Reel | 1k (TBD) |

Table 8 Ordering information

# 5 RoHS Compliance & ScioSense Green Statement

**RoHS:** The term RoHS compliant means that ScioSense B.V. products fully comply with current RoHS directives. Our semiconductor products do not contain any chemicals for all 6 substance categories, including the requirement that lead does not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, RoHS compliant products are suitable for use in specified lead-free processes.

**ScioSense Green (RoHS compliant and no Sb/Br):** ScioSense Green defines that in addition to RoHS compliance, our products are free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material).

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| Document Status | Product Status | Definition |
|---|---|---|
| Preview | Pre-Development | Information in this document is based on product ideas in the planning phase of development. All specifications are design goals without any warranty and are subject to change without notice. |
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Table 9 Document Status

# 8 Revision Information

| Revision | Date | Comment | Page |
|---|---|---|---|
| 0.1 | 2020-02-25 | Initial Version | |

Table 10 Revision History

**Note(s) and/or Footnote(s):**

(I) Page and figure numbers for the previous version may differ from page and figure numbers in the current revision.

(II) Correction of typographical errors is not explicitly mentioned.