

## Description

IDT's SMOD707 is a complete smart sensing solution for general volatile organic compounds (VOCs). The module, consisting of the SMOD smart sensing platform combined with IDT's SGAS707 VOC sensor, provides an indication of total VOCs measured both as resistance and as a linear response proportional to the concentration of a representative VOC calibration gas (ethanol). The SMOD707 communicates with an external controller or a data logger through a USB interface, and it can be supplied with an I<sup>2</sup>C or UART interface via special order.

The SGAS707 sensor can be supplied separately from the SMOD707 Smart Sensing Module. See the *SGAS707 Datasheet* for more information.

## Features

- High-sensitivity, non-specific detection of a wide range of VOCs
- Sensor operating parameters can be tailored to specific VOC measurement applications
- Targeted toward OEM system integration and peripheral device applications

## Typical Applications

- General indoor air quality
- Solvent levels in manufacturing environments

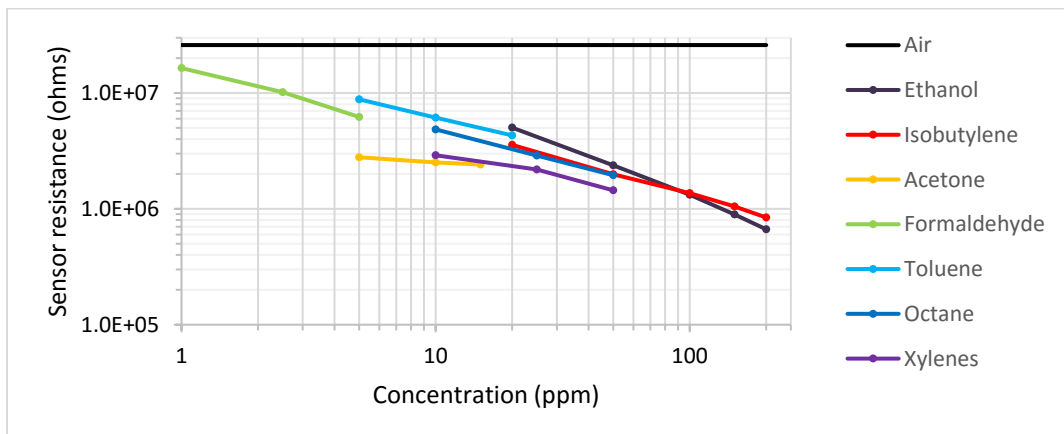
Figure 1. SMOD707 Smart Sensing Module



## Typical Module Response

Figure 2 shows the typical response and selectivity of the SMOD707 module for detecting several applied VOC and non-VOC gases operated in clean, dry air.

Figure 2. Typical Response and Selectivity of the SMOD707 vs. Common VOC Gases



## Absolute Maximum Ratings

Stresses above the ratings listed below can cause permanent damage to the SMOD707. These ratings, which are standard values for IDT commercially rated parts, are stress ratings only. Functional operation of the device at these or any other conditions above those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods can affect product reliability. Electrical parameters are guaranteed only over the recommended operating temperature range.

**Table 1. SMOD707 Absolute Maximum Ratings**

| Symbol     | Parameter                               | Conditions | Minimum | Maximum | Units |
|------------|---|------------|---------|---------|-------|
| $V_{IN}$   | Supply Voltage (referenced to ground)   |            |         | 12      | V     |
|            | Digital Inputs and Output Voltage Level |            | -0.5    | 3.8     | V     |
|            | Electrostatic Discharge (MIL-STD-883)   |            | 2000    |         | V     |
| $T_{AMB}$  | Ambient Operating Temperature           |            | 0       | 50      | °C    |
| $T_{STOR}$ | Storage Temperature                     |            | -65     | 150     | °C    |

## Recommended Operating Conditions

**Table 2. Recommended Operating Conditions**

| Symbol    | Parameter                                  | Minimum | Typical | Maximum | Units |
|-----------|--|---------|---------|---------|-------|
| $V_{IN}$  | Supply Voltage (referenced to ground)      |         | 5       |         | V     |
| $T_{AMB}$ | Ambient Operating Temperature              | 0       |         | 50      | °C    |
| RH        | Ambient Relative Humidity – Non-condensing | 0       |         | 95      | %     |

## DC Electrical Characteristics

**Table 3. DC Electrical Characteristics**

| Symbol          | Parameter            | Conditions               | Minimum | Typical | Maximum | Units            |
|-----------------|----------------------|--------------------------|---------|---------|---------|------------------|
| $V_{IN}$        | Input Voltage        |                          | 4.5     | 5       | 12      | V                |
| $V_{IN,RIPPLE}$ | Input Voltage Ripple | $I_{HTR} = 114\text{mA}$ |         |         | 100     | mV <sub>PP</sub> |
| $I_{IN}$        | Input Supply Current | $I_{HTR} = 114\text{mA}$ |         | 125     | 140     | mA               |
| $V_{HTR}$       | Heater Drive Voltage |                          |         | 3.5     | 3.85    | V                |
| $I_{HTR}$       | Heater Drive Current |                          |         | 114     | 125     | mA               |
| $V_{SEN}$       | Sensor Drive Voltage |                          |         |         | 3.0     | V                |

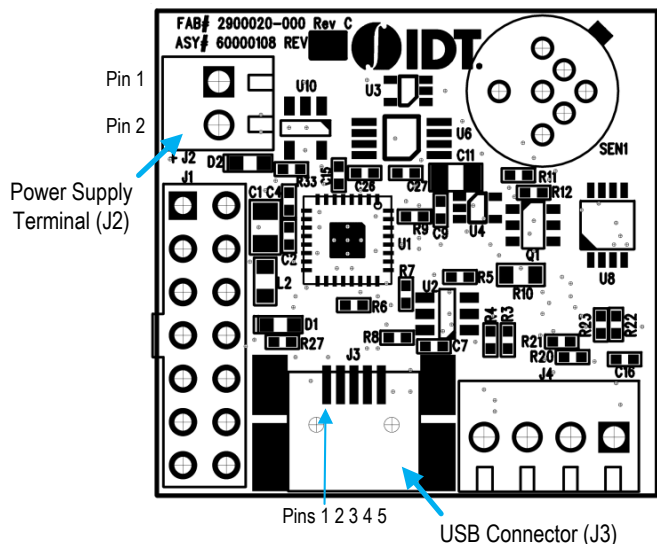
## Interface Characteristics

The SMOD707 utilizes a USB communication interface that conforms to the USB 2.0 standard.

## Connector Assignments

Refer to Figure 3 for the location of the connectors described in the following tables.

**Figure 3. Connector Locations on the SMOD707**



**Table 3. Pin Assignments: 2-Post Screw Terminal for Input Power (J2)**

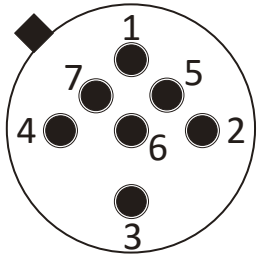
| Pin Number | Description  |
|------------|--------------|
| 1          | Power ground |
| 2          | $V_{IN}$     |

**Table 4. Pin Assignments: Mini-B Connector for USB Communications (J3)**

| Pin Number | Description   |
|------------|---------------|
| 1          | VBUS          |
| 2          | D+            |
| 3          | D-            |
| 4          | No connection |
| 5          | USB ground    |

The SGAS707 VOC sensor is housed in a TO-39 package. Figure 4 shows the combined TO-39/46 sensor socket (SEN1) on the module. The SGAS707 sensor utilizes pins 1, 2, 3, and 4 (pins 5-7 are unused). Figure 4 provides the definitions of the pins.

**Figure 4. Top View SEN1 Sensor Socket**



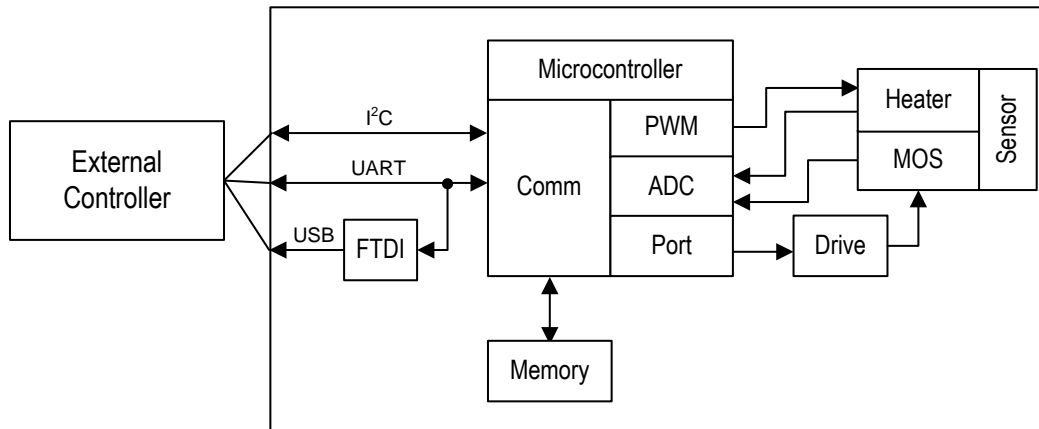
**Table 5. Pin Assignments: TO-39 Sensor Socket for SGAS707 (SEN1)**

| Pin Number             | Description |
|------------------------|-------------|
| 1 (clockwise from tab) | Heater +    |
| 2, 5                   | Sensor +    |
| 3, 6                   | Heater -    |
| 4, 7                   | Sensor -    |

## Principles of Operation

The SMOD707 module consists of a combination of the SMOD smart sensing platform and a SGAS707 VOC sensor. The SMOD smart sensing platform is a general purpose microcontrolled device with a broad array of capabilities that can be applied in gas sensing applications. As in other SMOD7xx devices, the SMOD707 selects a subset of measurement and control capabilities from a larger set and adds application-specific settings/capability, such as default sensor operation parameters, and calibration and analysis algorithms appropriate for the gas sensor utilized in the module.

**Figure 5. SMOD707 Block Diagram**



## Power Requirements

The SMOD707 utilizes an SGAS707 ceramic sensor that requires a nominal heater drive of 3.5V at 114mA. The input power to the module can be sourced from one of the following:

- 4.5V to 12V DC power supply connected directly to J2
- USB +5V supply

External commands (described below) support operation of the sensor heater at voltages other than 3.5V. Power supplied to the module does not require regulation, but the supply should have a ripple of less than 0.1V under load.

## External Communication

The SMOD707 communicates with external devices via a USB connection at J3 (Mini-B connector). The SMOD707 conforms to the USB 2.0 specification (full speed). The communication protocol used for sending commands to and receiving responses from the SMOD707 is described in the “Communication Protocol” section.

## Sensor Operating Conditions

The SMOD707 operates the SGAS707 sensor in isothermal mode at a constant voltage defaulting to 3.5V. This corresponds to a nominal heater current of 114mA and a heater power of 400mW. The heater voltage is regulated via a feedback measurement so that the voltage set-point is maintained under changing environmental conditions. The heater voltage set-point can be altered via the **HVw** command described in the “Command Summary” section.

Sensor measurements are performed by default once every second; this rate may be changed to any value between 1 and 60 seconds using the **PDw** command.

## Communication Protocol

The external communication protocol is a mixed ASCII-binary protocol designed to work within paradigms associated with I<sup>2</sup>C, with the intent that both SMOD7xx firmware and external communication software be as similar as possible across I<sup>2</sup>C, UART, and USB based modules. All communication initiates from the external device, with the exception of the *data ready* signal that is preemptively sent from the module to the external device when module-generated data is available for fetching by the external device. All commands to the module are responded to with a sequence consisting of a 1-byte *count* followed by 2 or more bytes as specified by *count*. The first two bytes after *count* are an unsigned 16-bit status word containing values as specified in Table 6. Command responses may contain additional information depending upon the specific command received by the module.

For USB-based modules, the data ready signal consists of the transmission of the three-character ASCII sequence INT. The external device is responsible for monitoring USB transmissions for this sequence and responding appropriately with the **GD** (get data) command.

Commands to the module are delimited by a colon (:) at the start of the request and a semicolon (;) at the end. Commands consist of a two or three letter command identifier, followed by zero or more space-separated numeric parameters. Numbers may contain a decimal point, but individual commands may interpret floating point inputs as integers and vice versa. Exponential formats are not allowed. Most commands are constructed using a two-letter acronym for the command plus an appended *w* (for write) or *r* (for read). For example, the command to write the heater voltage is **:HCw**; while the command to read the heater voltage is **:HCr**.

A LabVIEW-based application and associated interface drivers are available as an example to aid in implementation of communication between the SMOD707 and external devices.

**Table 6. Status Return Values**

| Status | Meaning                  |
|--------|--------------------------|
| 0      | SUCCESS                  |
| 1      | ERROR_INIT               |
| 2      | ERROR_WR_EEPROM          |
| 3      | ERROR_FTDI_NOT_READY     |
| 4      | ERROR_WR_BUF_OVL         |
| 5      | ERROR_INVALID_SIGN       |
| 6      | ERROR_INVALID_CMD        |
| 7      | ERROR_PARAM_OUT_OF_RANGE |
| 8      | ERROR_PARAM_ORDER        |
| 9      | ERROR_NO_PERIOD_SET      |
| 10     | ERROR_NO_ADC_POINTS_SET  |
| 11     | ERROR_NUMBER_OF_PARAMS   |
| 12     | ERROR_STEP_MISMATCH      |
| 13     | RETURN_VALUE             |
| 14     | ERROR_CONFIG             |
| 15     | NOT_INDEPENDENT          |
| 16     | ERROR_WRONG_PASSWORD     |
| 17     | ERROR_CMD_NOT_ALLOWED    |
| 18     | INDEPENDENT              |
| 19     | ERROR_FLASH_CLK          |
| 255    | RESTART_REQUIRED         |

## Command Summary

Seven commands are available to control the SMOD707:

- :CPw {p1}{p2};** Writes the calibration parameters used in converting resistance to linear sensor response. **p1** and **p2** are supplied by the factory on a sensor-by-sensor basis. Response is **{byteCount}{status}**.
- :HVr;** Reads the heater voltage set point in the SMOD707. The response is **{byteCount}{status}{voltage}**, where the voltage is specified in deci-seconds.
- :HVw {voltage};** Writes the voltage at which the heater is to be driven. The voltage is specified in millivolts, i.e. a voltage value of 3000 would set the heater voltage to 3.000V. The response is **{byteCount}{status}**.
- :HVr;** Reads the heater voltage set point in the SMOD707. The response is **{byteCount}{status}{voltage}**, where the voltage is specified in deci-seconds.
- :PDw {period};** Writes the periodic rate at which data is reported from the SMOD707. The period is specified in deci-seconds; i.e., a period value of 20 would set a 2-second period. The response is **{byteCount}{status}**.
- :PDr;** Reads the periodic rate setting in the SMOD707. The response is **{byteCount}{status}{period}**, where the period is specified in deci-seconds.
- :GD;** Instructs the module to return the last data set, consisting of values as shown in Table 7.

**Table 7. Data Message Format**

| Offset in response | Data type               | Contents  |
|--------------------|-------------------------|---|
| 0                  | Unsigned 8-bit integer  | byteCount   |
| 1                  | Unsigned 16-bit integer | Status  |
| 3                  | Unsigned 8-bit integer  | Data set identifier ('d')   |
| 4                  | Unsigned 8-bit integer  | Data set identifier ('2')   |
| 5                  | Unsigned 16-bit integer | Sequence count (starts from zero at power-up and increments with each data point collected)   |
| 7                  | Unsigned 8-bit integer  | Heater control method (0 = voltage, 1 = resistance, 2 = power, 255 = current)                 |
| 8                  | Unsigned 16-bit integer | Heater value (voltage in mV)  |
| 10                 | Unsigned 32-bit integer | Sensor resistance (ohms)  |
| 14                 | Unsigned 8-bit integer  | Sequence (high nibble = total steps in sequence; low nibble = active step)                    |
| 15                 | Unsigned 16-bit integer | Analysis result (linear response proportional to ppm of a representative VOC calibration gas) |

## Sensor Replacement

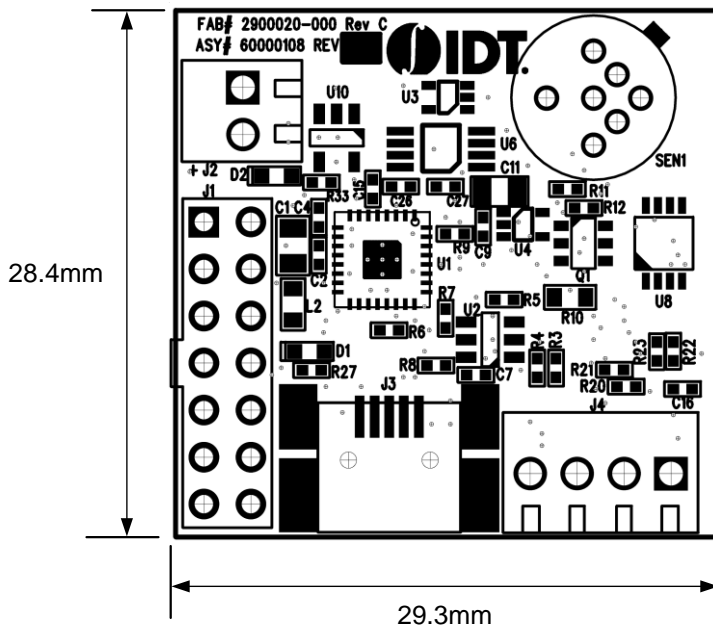


**Important Safety Warning:** Power should be removed from the board during any sensor replacement operation. Sensor heaters are subject to damage if inserted while being driven by heater current, and sensor packages at operating temperatures might be hot to the touch. Always use caution when handling sensors.

Removing the sensor on the SMOD707 is accomplished by gripping the sensor on each side and then pulling gently straight up from the module. To insert a sensor, align the sensor tab with the silkscreen indicator and then gently push the sensor pins into the socket.

## Package Drawing

**Figure 6. Package Outline Drawing and Dimensions**



## Ordering Information

| Orderable Part Number | Description                                  | Package | Shipping Packaging | Temperature |
|-----------------------|--|---------|--------------------|-------------|
| SMOD707               | SMOD707 VOC Sensor Module with USB Interface | Module  | Box                | 0°C to 50°C |



## Revision History

| Revision Date | Description of Change |
|---------------|-----------------------|
| July 21, 2017 | Initial release.      |

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