Description

The ZMOD4450 Evaluation Kit (EVK) is designed for evaluating IDT's ZMOD4450 Gas Sensor Module for Refrigeration Air Quality (RAQ). In addition, a light sensor indicates if the refrigerator door is open and a control signal may trigger an external device (e.g., active filter ventilation, ozone generation etc.) based on the air quality change.

IDT's *ZMOD4450 Evaluation Software* allows Windows®-based operating systems to communicate with the ZMOD4450 EVK via a USB connection on the user's computer, which functions as a master. The software and additional related documentation is available on the IDT website.

The EVK's Communication Board (HiCom) handles the interface between the user's computer and the ZMOD4450 module mounted on the ZMOD4450 Sensor Board (Daughter Board). Note: Only one Communication Board with one Sensor Board can be connected to the computer at a time.

The ZMOD4450 Evaluation Kit uses an FTDI controller on the Communication Board to handle the USB protocol, translate communications, and synchronize communications with the I2C interface. The Sensor Board includes a decoupling capacitor.

The Communication Board has devices mounted on both sides. The components on the top side generate a stable supply voltage. A potentiometer can be used to adjust the internal supply voltage in the typical range from 1.7V to 3.6V. Alternatively, the user's external supply voltage can be used. The intensity of the adjacent LED is proportional to the supply voltage.

Features

- User-friendly EVK expedites configuration and evaluation of the ZMOD4450 Refrigeration Air Quality Sensor
- Operates with IDT provided software; either with executable ZMOD4450 GUI or alternatively with firmware programming examples for Windows® and Linux
- The modular design of the EVK allows simple connection of Sensor Boards for different gas sensor derivatives and easy integration with other sensor products via the I2C interface
- The required *ZMOD4450 Evaluation Software* is available for download on the IDT website, which also provides background information on refrigeration gas sensing and sensor programming.
- Additional pins provided to measure power consumption, supply voltage, and the GPIO trigger for an external device
- Integrated light sensor to indicate the position of the refrigerator door for infiltrated air quality changes
- The bill of materials (BOM) and schematics for the ZMOD4450 Communication Board and Sensor Board are included in this document

ZMOD4450-EVK Contents

- HiCom Communication Board
- Sensor Board with ZMOD4450 Gas Sensor Module
- 3.0m Type-B USB to Micro-USB Cable (flat type)

ZMOD4450 Evaluation Kit
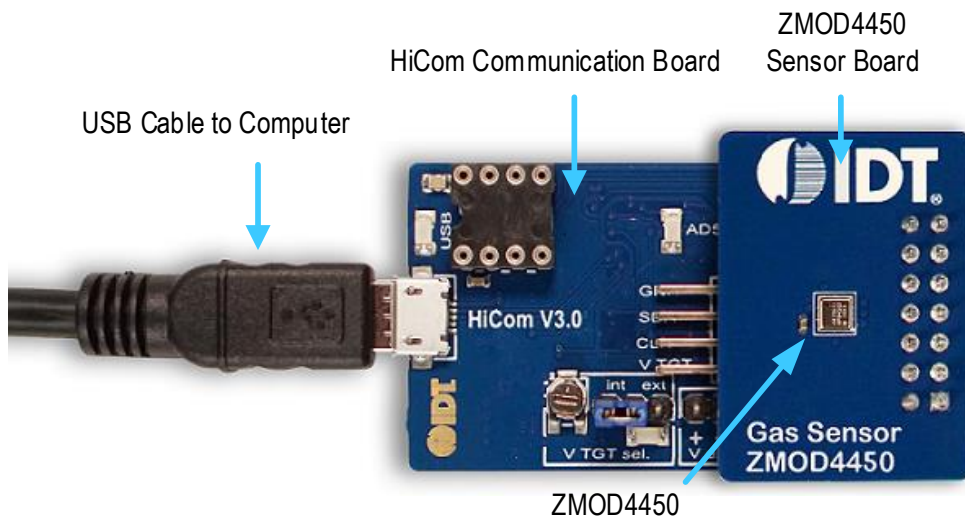
Important Notes

<u>Disclaimer</u>

Integrated Device Technology, Inc. and its affiliated companies (herein referred to as "IDT") shall not be liable for any damages arising out of defects resulting from

    (i)   delivered hardware or software

    (ii)   non-observance of instructions contained in this manual and in any other documentation provided to the user, or

    (iii)   misuse, abuse, use under abnormal conditions, or alteration by anyone other than IDT.

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<u>Restrictions in Use</u>

IDT's ZMOD4450 Evaluation Kit, consisting of the HiCom Communication Board, ZMOD4450 Sensor Board, and the *ZMOD4450 Evaluation Software*, is designed for evaluation purpose only. IDT's ZMOD4450 Evaluation Kit must not be used for calibration, test, qualification, or production.

!

Important Equipment Warning: Ensure the correct connection of all cables. Supplying the board using the wrong polarity could result in damage to the board and/or the equipment. Check that all jumpers have been placed as specified in this document.

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1. Setup

1.1 Required or Recommended User Equipment

By default, the internal supply voltage for powering the Sensor Board is generated from the USB voltage supplied by the user's computer via the USB cable. If there is a need for currents higher than the defined USB standard (usually 500mA at 5V), an external voltage supply source can be used instead of the internally generated voltage supply provided on the Communication Board.

The external supply powers only the sensor modules, and not the communication board itself. The supply must meet the following requirements:

- Voltage. 1.7V to 3.6V
- Current must meet the user's specifications. The minimum is 30mA for electronics with additional current needed for each gas sensor module of approximately 13mA (with a 1.8V voltage supply).

1.2 User Computer Requirements

1.2.1 Computer Requirements

A Windows®-based computer is required for interfacing with the EVK and configuring the ZMOD4450. The user must have administrative rights on the computer to download and install the *ZMOD4450 Evaluation Software*.

The computer must meet the following requirements:

- 1GB RAM
- Hard drive with at least 500MB free space
- 1 USB port
- Windows Vista®/Windows 7®/Windows 8®/Windows 10®
- Internet access for initial download of the drivers and software

Important: Before installing and activating the software, assemble and connect the hardware for the kit to the user's computer according to steps 1 through 3 in section 1.4.

1.3 Software Installation and Setup

Before using the *ZMOD4450 Evaluation Software*, the USB drivers for the FTDI device must be installed. Download the drivers and corresponding installation guides from the FTDI website (www.ftdichip.com). The drivers will not affect the operation of any other USB peripherals. The kit does not need to be connected during installation of the drivers.

Follow these procedures to download and install the *ZMOD4450 Evaluation Software* with the kit connected:

1. Download the *ZMOD4450 Evaluation Software* zip file at www.IDT.com/ZMOD4450-EVK.
2. Create a folder on the user's computer for the software (e.g., C:\Program Files (x86)\IDT Software). Extract the contents of the downloaded zip file into this folder.
3. Double-click on the extracted batch file *ZMOD4450_Evaluation_Software.bat* to start the software each time the program is used. Figure 3 shows the initial display after execution.

1.4 EVK Hardware Connections and Initial Power-up

To set up the EVK hardware before using the software, complete the following procedure:

1. Refer to Figure 1, Figure 2, and Table 1 to determine the correct jumper settings for the ZMOD4450 Communication Board depending on whether an external supply or the internal voltage supply on the board is used.

   ▪ If the internal voltage supply is used, ensure that the jumper is across the pins labeled "int" on the K2 connector.

   ▪ If using an external supply, ensure that the jumper is across the pins labeled "ext" on the K2 connector. In this case, without connecting the external supply to the Communication Board, verify that the external voltage supply setting does not exceed the voltage supply specifications (a minimum of 1.7V and a maximum of 3.6V) as per the *ZMOD4450 Datasheet.* With the external supply off, connect the external voltage to the 2-pin "+ - V ext" header adjacent to the K2 jumper with the orientation indicated in Figure 2. Note: If this option is used, adjustments of the external voltage are not possible on either the Communication Board or the Sensor Board for adjusting an external voltage supply.

2. Install the ZMOD4450 Sensor Board on the 14-pin connector on the ZMOD4450 Communication Board taking care to ensure the proper orientation of the Sensor Board as shown on page 1.

3. Insert the flat micro-USB cable into the X1 connector on the Communication Board and connect it to a free USB port on the user's computer.

   ▪ If the external voltage supply has been selected, turn on the external supply and verify that the D3 LED adjacent to the potentiometer is on. See Figure 1. Note: The intensity of the green D3 LED is proportional to the supply voltage.

4. Activate the software as described in section 1.3.

5. If the internal voltage is used, the *ZMOD4450 Evaluation Software* activates the internal voltage after the sensor has been started. Use the metal potentiometer to the left of the K2 connector to adjust the VDD supply voltage in the typical range from 1.7V to 3.6V as measured across the V_TGT and GND pins available on the K3 connector as shown in Figure 2. Its initial adjustment on delivery provides a voltage of VDD ≈ 2.0V. Once a measurement has been started by the software, the green D3 LED adjacent to K2 will light with an intensity proportional to the voltage supply that was set using the potentiometer.

6. Verify that the red D1 LED is on, which indicates that the kit is properly connected and powered. (See Figure 1.)

The Communication Board provides the additional K3 and Modul1 connectors for the following optional uses as described in Table 1. To make use of any of these options, contact IDT for further instructions (see contact information on last page).

▪ Extra measurement options (e.g., current consumption to determine the power requirements of the ZMOD4450)

▪ Connections for additional sensors (e.g., IDT humidity sensor HS3001)

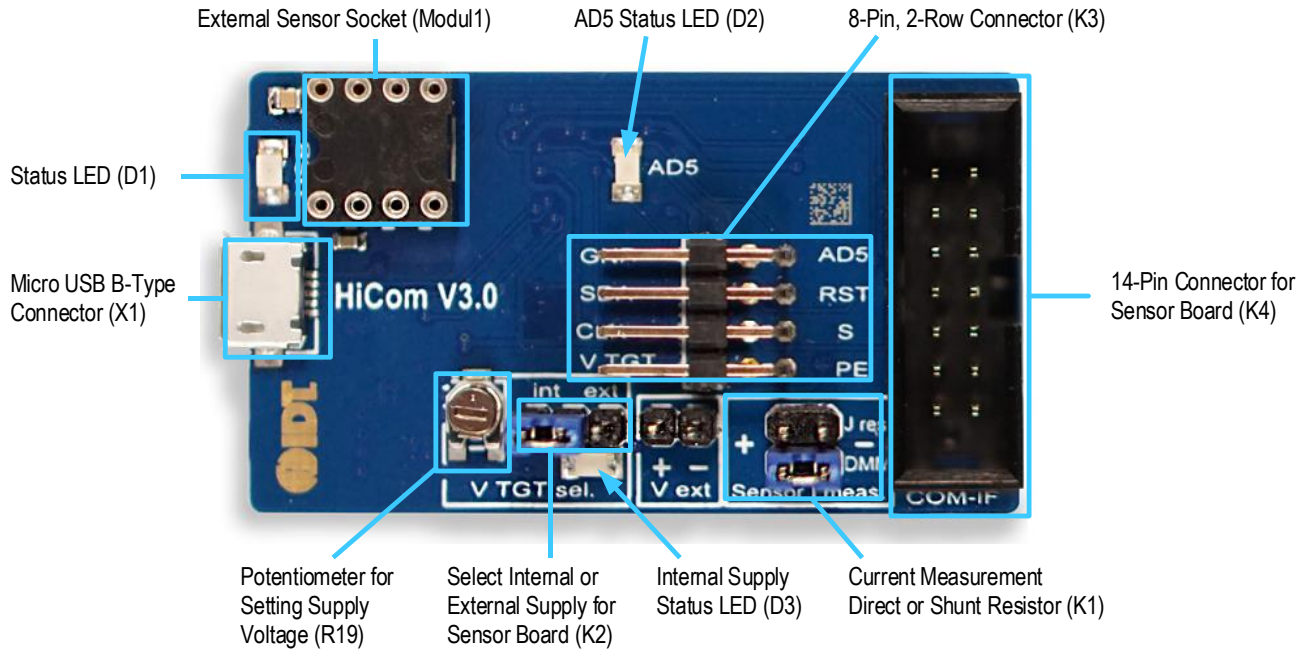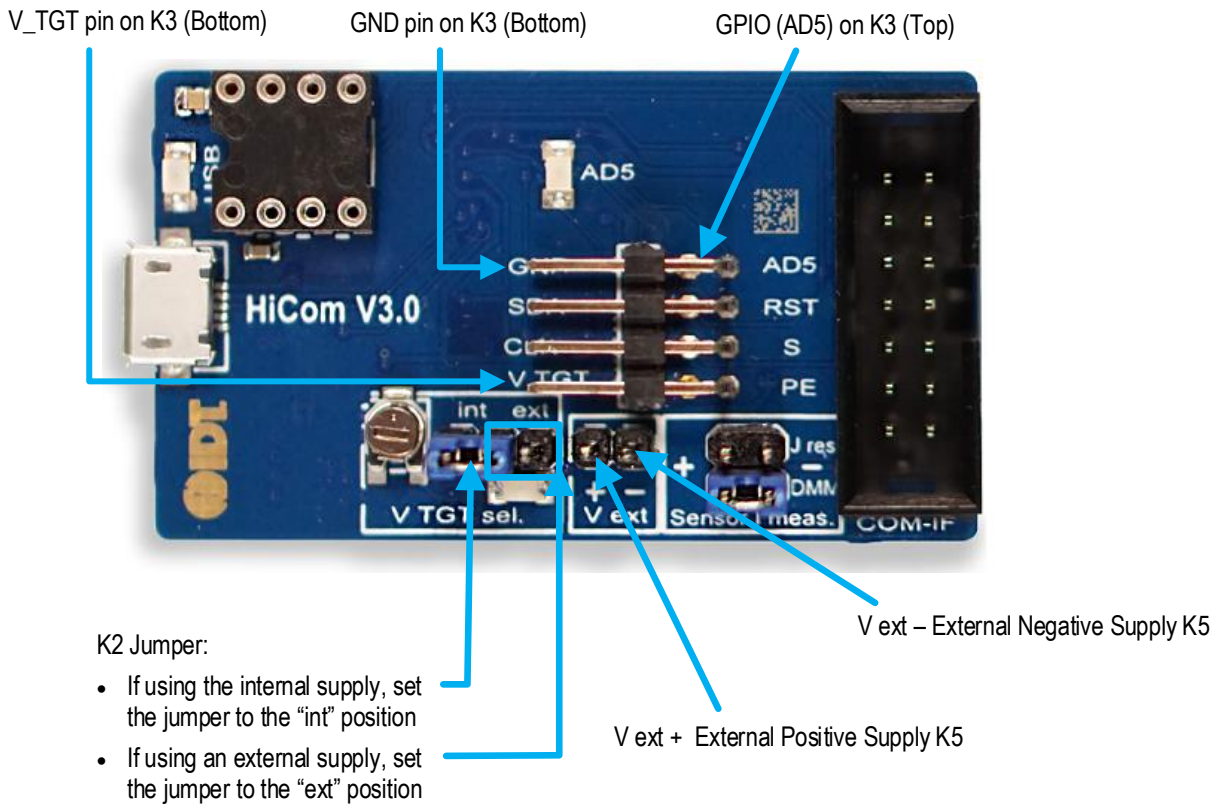**Figure 1.   Jumper Settings, LEDs, and Connectors on the Top Side of the ZMOD4450 Communication Board**

Table 1.   Evaluation Kit Connection Descriptions

Connector	Type	Description
K1	4-pin, 2-row header	This jumper can be used to break the supply voltage line to measure the current consumption of a connected Sensor Board. Important: During normal operation, ensure that a jumper is on the "DMM" position as shown in Figure 1.
K2	3-pin header	This jumper selects either the internal or external voltage supply. See Figure 2 for the proper position for the jumper.
K3	8-pin, 2-row right-angle header	This connector can be used to connect the ZMOD4450 in different configurations or to measure the communication lines and voltages on the ZMOD4450 Sensor Board. AD5 is a GPIO pin that can be controlled via the software.
K4	14-pin connector	This is the connector for installing the ZMOD4450 Sensor Board on the Communication Board.
K5	2-pin header	This is the connector for an optional external voltage supply (see Figure 2).
D1	Status LED	This LED lights if the Communication Board is powered correctly (see Figure 1).
D2/AD5	Status LED	This LED lights if the trigger pin is set by the software (see Figure 1).
D3	Status LED	This LED will light with an intensity proportional to the internal voltage supply that was set using the potentiometer (see Figure 1).
X1	Micro-USB B-type	This is the micro-USB cable connector for connecting the Communication Board to the user's computer.
R19	Potentiometer	This potentiometer adjusts the internal supply voltage. The internal supply voltage can be adjusted by rotating the potentiometer with a small screwdriver.
Modul1	DIL socket	This socket can be used to add external components (e.g., a humidity sensor) to the Communication Board. Contact IDT for further instructions.

Figure 2.   Jumper Settings, Connections, and Test Points on the Communication Board for the Internal or External Supply Voltage


V_TGT pin on K3 (Bottom)

GND pin on K3 (Bottom)

GPIO (AD5) on K3 (Top)

V ext – External Negative Supply K5

V ext + External Positive Supply K5

K2 Jumper:

- If using the internal supply, set the jumper to the "int" position
- If using an external supply, set the jumper to the "ext" position

2. Usage Guide

When the *ZMOD4450 Evaluation Software* is started, the initial window is displayed as shown in Figure 3.

The initial display consists of 3 blocks:

- Measurement control
- Signal analysis
- Plot visualization

Figure 3. Initial Display for the ZMOD4450 Start-up

Measurement Control   Signal Analysis

Plot Visualization
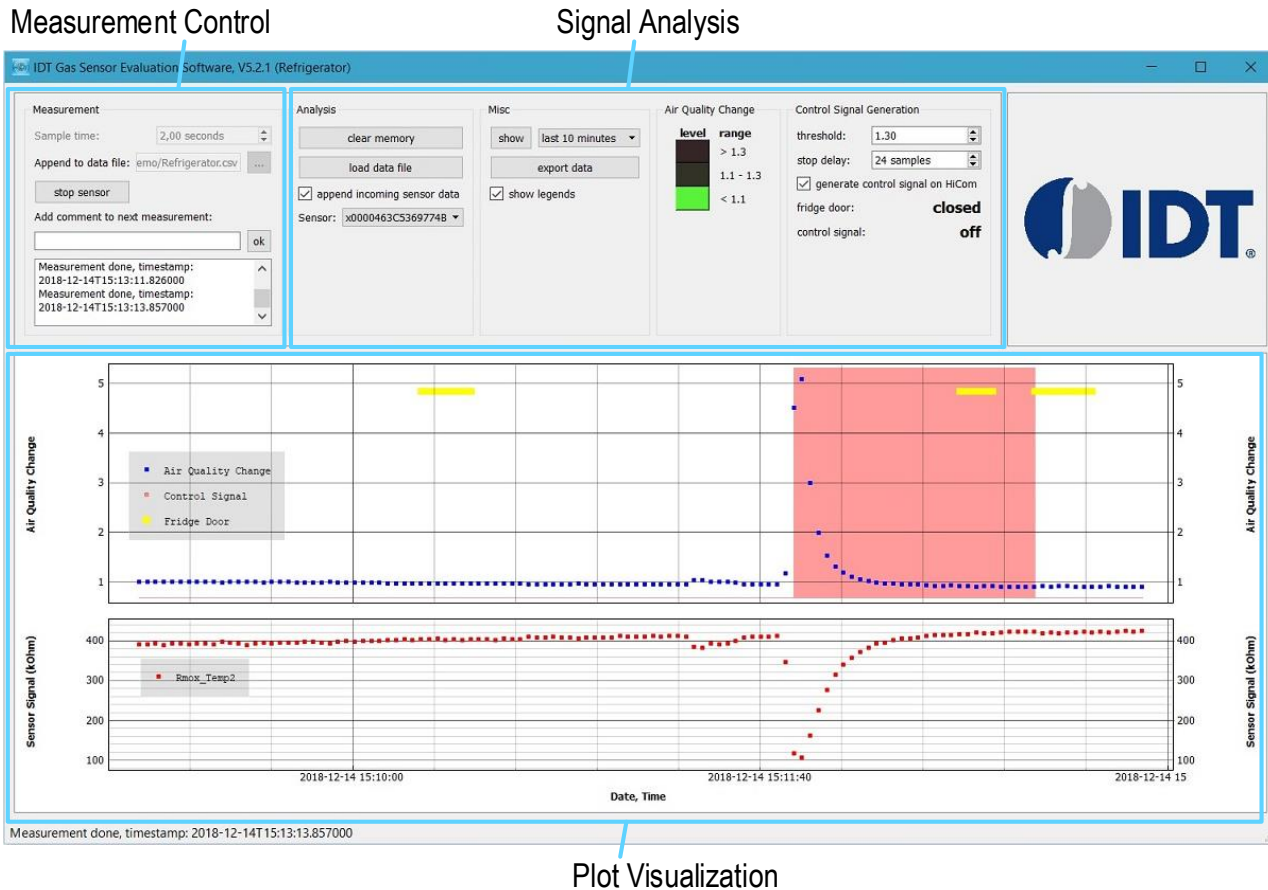
2.1 Measurement Control Block

The "Measurement" area of the display allows users to control the properties of the ZMOD4450's gas measurements; for example, the sample interval can be selected with the "sample time" entry field. When the "start sensor" button is clicked, the button name changes to "stop sensor" and the measurement starts running continuously with the given sample time (the default is 2.00 seconds). For longer measurement series, IDT strongly recommends increasing the sample rate to avoid reaching the limit of the computer's power.

The results will be automatically added to the plots and continuously saved in a comma separated file (CSV), which is user-selected via the file selection dialog accessed by clicking the "…" button adjacent to the "Append to data file" field, which displays the selected path and file name.

A comment (for example, "Start test") can be added to the data entry by adding a text string to the "Add comment to next measurement" field and then clicking the "ok" button. If a measurement is already in progress, the comment will be added to the next measurement. The comments will be displayed in the plot and will be saved in the CSV result file. This facilitates tracking the user's experimental investigations. Below this entry field, a small window with a log field shows all events logged.
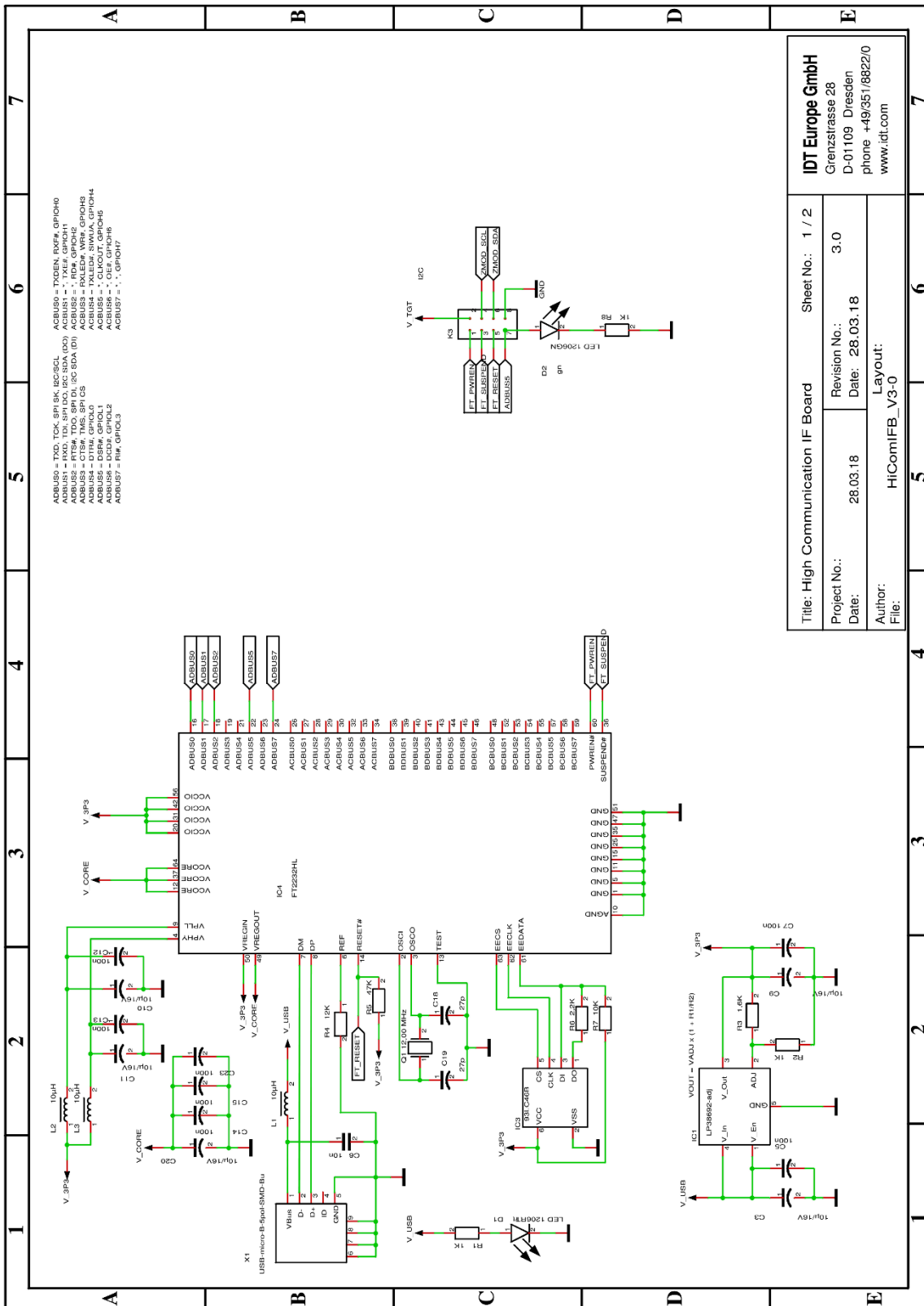
2.2 Signal Analysis Block

Table 2.   Signal Analysis Block User Options

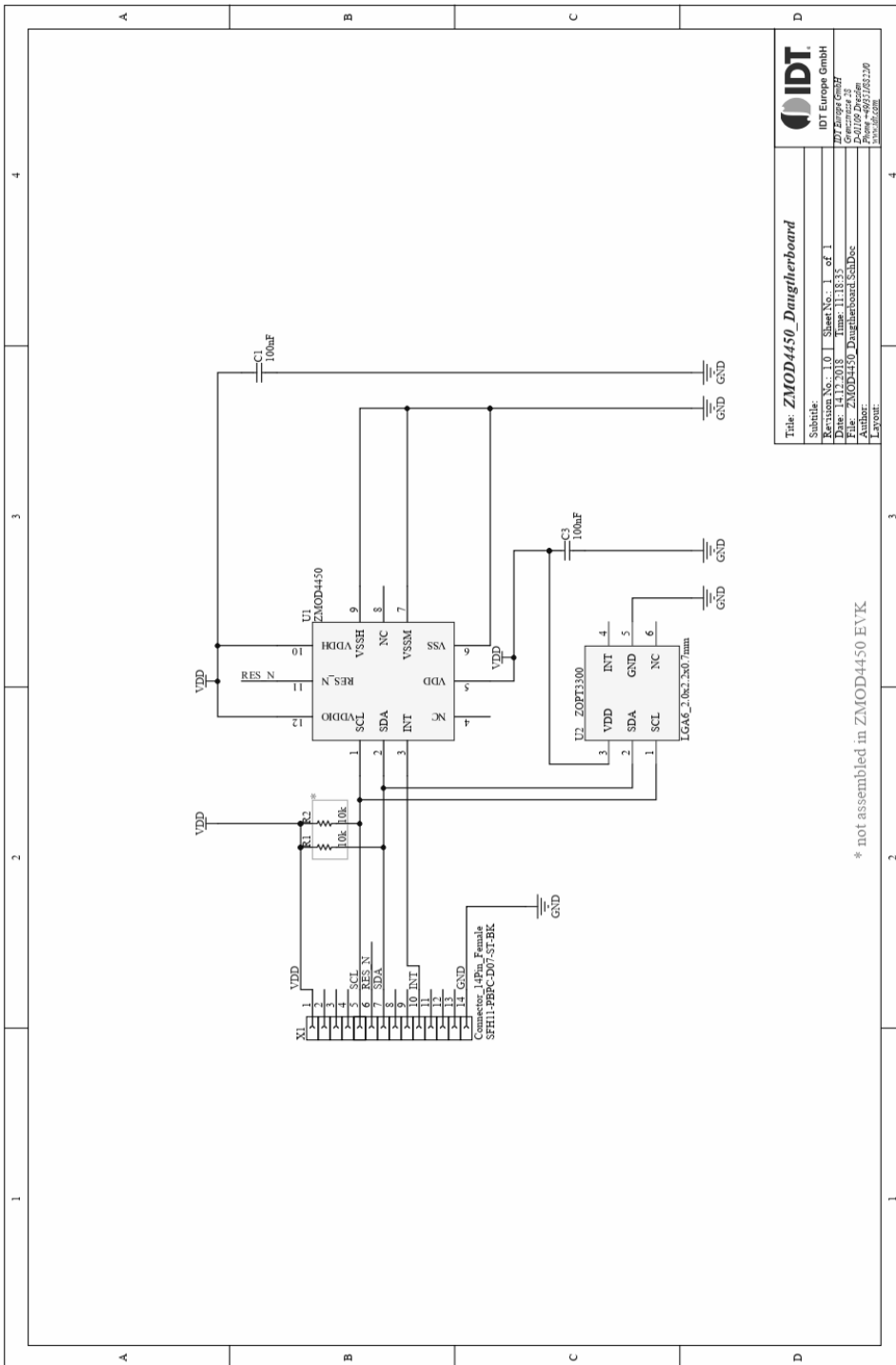| Display Section	Button/Action	Description
Analysis	clear memory / load data file	The "clear memory" button will delete all current data from the plots (memory). The data in the measurement file will remain. The "load data file" button will open a file selection dialog. This function can be used to display and analyze data from a measurement file acquired earlier. The data file must have the same structure as the measurement file created by the *ZMOD4450 Evaluation Software.*
	☑ append incoming sensor data Sensor: x0000463C5369774B ▼	The "append incoming sensor data" checkbox activates the functionality to append the current measurement data to the graphs in the plot visualization area. If measurements are acquired simultaneously for multiple ZMOD4450 gas sensors, the measurement results file can contain data from different sensors. In the "Sensor" drop-down menu, the user can choose a sensor to display by selecting the unique sensor identification number.
Air Quality Change	Air Quality Change **Sensor Stabilization 2 of 15**	The first 15 measurements of the algorithm will be taken for sensor stabilization. During this time, the "Air Quality Change" section will indicate how many measurements have been completed. Note that this does not cover the full stabilization of the sensor module. Recommendation: IDT recommends a sample time of 2 seconds for these 15 measurements resulting in 30 seconds for the initialization measurements.
	Air Quality Change level range > 1.3 1.1 - 1.3 < 1.1	After the stabilization measurements, the "Air Quality Change" section changes to show a colored bar representing the results from the algorithm. The air quality change is shown in three categories: < 10% Minor changes or improvement in Air Quality: Control Signal Off 10% to 30% Slight change in Air Quality: Control Signal Off > 30% Major change in Air Quality: Control Signal On
Control Signal Generation	Control Signal Generation threshold: 1.30 stop delay: 24 samples ☑ generate control signal on HiCom fridge door: **closed** control signal: **off**	The "threshold" field shows the current threshold setting that determines when the ZMOD4450 sends the control signal indicating a sensor signal change. This control signal triggers the AD5 GPIO pin on the HiCom board. In the example shown in Figure 3, the threshold is set to 1.30 (default value). This default setting means a signal change of 30% or more will set the control signal to the "on" status. The user can select a different threshold using the up/down arrows adjacent to the "threshold" field if needed. If the air quality improves, the control signal will remain "on" for a designated number of samples to provide a hysteresis for the threshold. This delay is indicated in the "stop delay" field. In the example shown in Figure 3, the delay has been set to 24 samples (2 minutes for default operation). The user can select a different delay using the up/down arrows adjacent to the "stop delay" field if needed A light threshold indicator shows whether the refrigerator door is open by checking for light on the sensor board. An open refrigerator door could lead to fast changes in air quality and invalidate the user's interpretation of data regarding processes inside the refrigeration unit.
"Misc"	Misc show last 10 minutes ▼ export data ☑ show legends	The drop-down menu adjacent to the "show" button provides options for selecting the time period for showing the recent history or the complete data. Click the "show" button to apply new settings to the plots. The "export data" button opens a file selection dialog for selecting a path to immediately save the measurement results and the processed algorithm results of the "Analysis" section. The file will be saved in comma-separated format (CSV).

2.3 Plot Visualization Block

The lower half of the display provides a visualization of the data. The bottom plot shows the sensor raw signal, the MOx resistance in ohms. The upper plot shows the air quality change rate and indicates whether the threshold of the control signal has been exceeded (control signal "on/off") and whether the refrigerator door is open or closed.

3. Schematics

Figure 4. Communication Board Schematic – Page 1

Figure 5.   Communication Board Schematic – Page 2

Figure 6.   Sensor Board Schematic

4. Bill of Materials (BOM)

Table 3.   Communication Board BOM

Pos	Name	Value	Package
1	C3	10µF/16V	0805
2	C5	100nF	0603
3	C6	10nF	0805
4	C7	100nF	0603
5	C8	100nF	0603
6	C9	10µF/16V	0805
7	C10	10µF/16V	0805
8	C11	10µF/16V	0805
9	C12	100nF	0603
10	C13	100nF	0603
11	C14	100nF	0603
12	C15	100nF	0603
13	C16	100nF	0603
14	C17	10µF/16V	0805
15	C18	27pF	0603
16	C19	27pF	0603
17	C20	10µF/16V	0805
18	C21	10µF/16V	0805
19	C22	100nF	0603
20	C23	100nF	0603
21	C24	10µF/16V	0805
22	C25	100nF	0603
23	C26	100nF	0603
24	C27	10µF/16V	0805
25	C28	100nF	0603
26	C29	10µF/16V	0805
27	C30	100nF	0603
28	C31	220nF	0805
29	D1	LED 1206RT	1206-DIODE
30	D2	LED 1206GN	1206-DIODE
31	D3	LED 1206GN	1206-DIODE
32	D4	SD0805S040S0R1-SCHOTTKY	0805-DIODE
33	IC1	LP38692-adj	SOT-223-5

Pos	Name	Value	Package
34	IC2	LP38692-adj	SOT-223-5
35	IC3	93LC46B	SOT23-6
36	IC4	FT2232HL	LQFP64
37	IC6	SN74LVC1T45	SOT23-6
38	IC8	SN74LVC2T45DCT	SSOP8_0,65
39	K1	I_meas	2X02
40	K2	Select	1X03
41	K3	K2X4	2X04-90
42	K4	K2X7	LH-14
43	K5	V_EXT	1X02
44	L1	10µH	1210
45	L2	10µH	1210
46	L3	10µH	1210
47	Modul1	Honeywell480-3652-1-ND	DIL8 SMD Socket
48	Q1	12.00MHz	QUARZ-ABM3
49	R1	1kΩ	0805
50	R2	1kΩ	0805
51	R3	1.6kΩ	0805
52	R4	12kΩ	0805
53	R5	47kΩ	0805
54	R6	2.2kΩ	0805
55	R7	10kΩ	0805
56	R8	1kΩ	0805
57	R13	51Ω	0805
58	R15	51Ω	0805
59	R16	10Ω	0805
60	R17	1kΩ	0805
61	R18	470Ω	0805
62	R19	2.0kΩ	TRIMMER-3142 SERIES
63	R20	1kΩ	0805
64	R21	10kΩ	0805
65	R22	2.0kΩ	0805
66	R23	2.0kΩ	0805
67	X1	USB-micro-B-5pol-SMD-Bu	USB-MICRO_TYPB_AMTEK

Table 4.   Sensor Board BOM

Designator	Quantity	Manufacturer	Manufacturer Part Number
C1, C3	2	Taiyo Yuden	LMK105BJ104KV-F
U1	1	IDT	ZMOD4450
U2	1	IDT Europe GmbH	ZOPT3300
X1	1	Sullins	SFH11-PBPC-D07-ST-BK

5. Board Layout

Figure 7.   HiCom Communication Board Layout – Top Layer
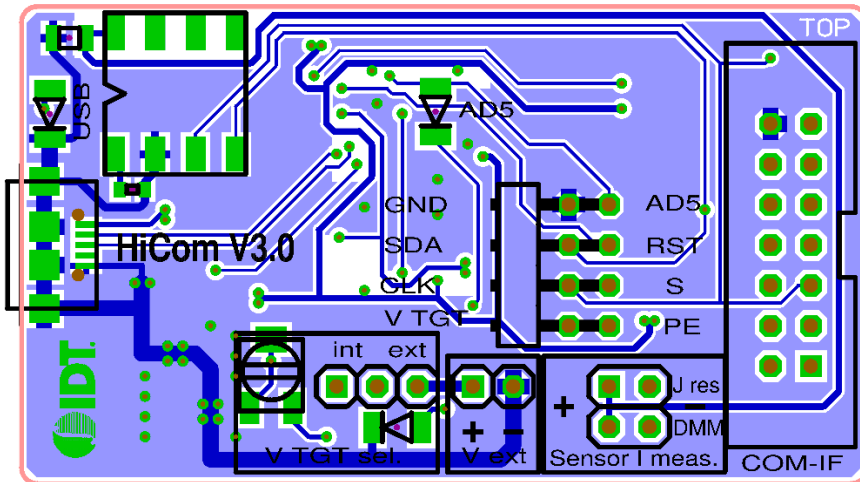
Figure 8.   HiCom Communication Board Layout – Bottom Layer
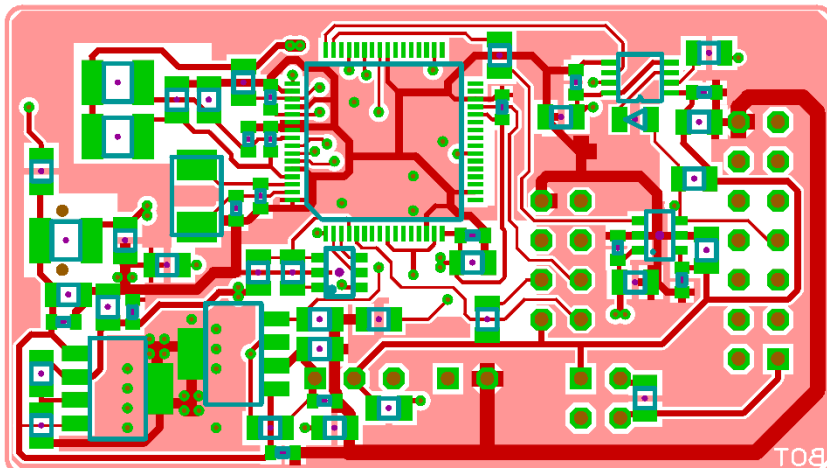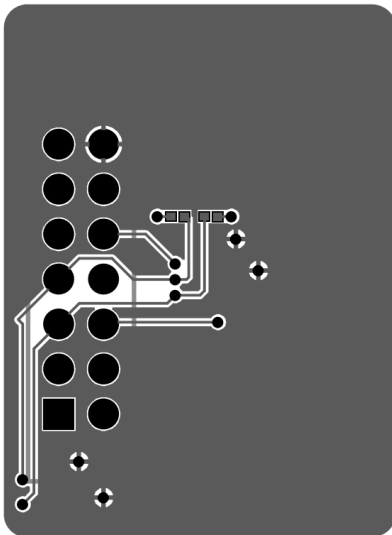
Figure 9. Sensor Board Layout – Top Layer
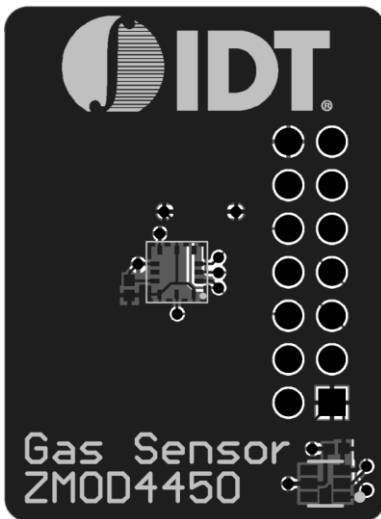
Figure 10. Sensor Board Layout – Bottom Layer

6. Ordering Information

Orderable Part Number	Description
ZMOD4450-EVK-HC	ZMOD4450 Evaluation Kit, including the ZMOD4450 Sensor Board, HiCom Communication Board (USB Interface), and Micro-USB Cable. The *ZMOD4450 Evaluation Software* is available for download free of charge on www.IDT.com/ZMOD4450-EVK.

7. Revision History

Revision Date	Description of Change
December 20, 2018	Initial release.

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