

Application Brief

Temperature, Humidity, and Optical I2C Sensors Made Simple With MSP430 MCU



Introduction

This design shows how to use MSP430FR2433 to communicate with three kinds of inter-integrated circuit (I2C) sensors on BP-BASSENSORSMKII: including the optical sensor, the temperature sensor and the humidity sensor. The I2C communication speed is set to 100 kHz. This type of functionality is useful for systems that need to detect different kinds of environment information, especially in building automation.

Implementation

The key point to realize with this function is to understand the usage of sensors on BP-BASSENSORSMKII. Here, the operation of the three sensors is introduced one by one.

The OPT3001 is a digital ambient light sensor (ALS) that measures the intensity of light as visible by the human eye. For more information on the OPT3001 light sensor, see the OPT3001 product folder.

The TMP117 is a 16-bit digital local temperature sensor that measures the ambient temperature or the temperature of an object in direct contact. In order to use the TMP117, the ribbon cable must be connected. For more information on the TMP117 temperature sensor, see the TMP117 product folder.

The HDC2080 is an integrated temperature and humidity sensor that measures ambient temperature and relative humidity in RH%. Note that V Supply Pin must drive a Logic Low or zero to power the HDC2080. For more information on the HDC2080 humidity sensor, see the HDC2080 product folder. All of these sensors' output is an I2C- and SMBus-compatible, 2-wire serial interface. Table 1 lists the I2C address of these three sensors.

Table 1. I2C Address

Device	7-Bit Address	Hex (7 bit)
OPT3001	1000100	44
TMP117	1001000	48
HDC2080	1000000	40

Table 2 lists the pin connections of these three sensors.

Table 2. Sensors Pinout

Pin Function	OPT3001	TMP117	HDC2080
I2C SCL	J1.9	J1.9	J1.9
I2C SDA	J1.10	J1.10	J1.10
V Supply Pin	J1.27	J1.28	J1.6
INT Pin	J1.25	J1.26	J1.23

The hardware connection can refer to Figure 1. To run this application, the MSP430FR2433 Launchpad should first be connected to BP-BASSENSORSMKII. Make sure BP-BASSENSORSMKII is in the right direction by checking the pinout on two boards: like 3V3 and GND. Second, connect the related headers on BP-BASSENSORSMKII. J1 should be connected to J27 and J28, to power on the OPT3001 and TMP117. J22 should be connected to J6, to give a zero logic to Q2 to power on the HDC2080. Third, connect ribbon cable to link the TMP117 to the main board. Remember to remove J10 on the launchpad.

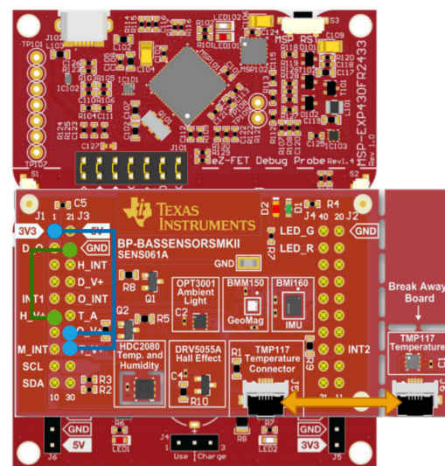


Figure 1. Hardware Connection

The I2C communication flow between these three sensors will be different, because they work under different conversion modes. The OPT3001 will be set in continuous conversion mode. Figure 2 shows the communication flowchart. The result data is 16 bits. The first read 1 byte is high 8 bits. The second read 1 byte is low 8 bits. The high 4 bits of result data is exponent. The low 12 bits is fractional result. To get the final result, the equation $(lux = 0.01 \times (2E[3:0]) \times R[11:0])$ needs to be used to decode the data. The unit is Lux.

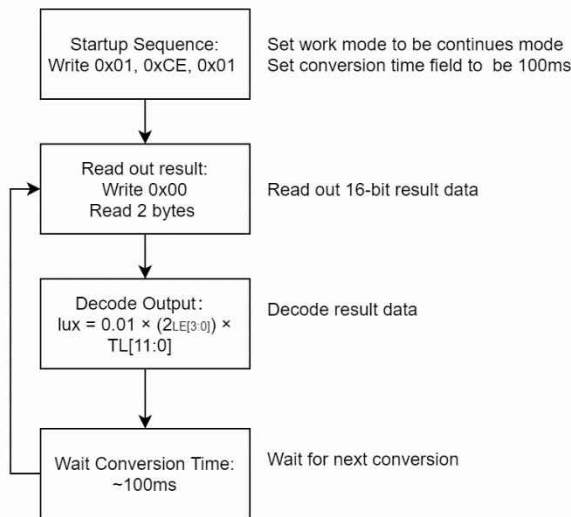


Figure 2. OPT3001 I2C Communication Flowchart

For the TMP117, the default mode is continuous conversion mode. The communication flow chart and the decode equation is shown in Figure 3. The result data is 16 bits. The first read 1 byte is high 8 bits. The second read 1 byte is low 8 bits. To be careful, the decoding way will be different when the data above or below 0°C.

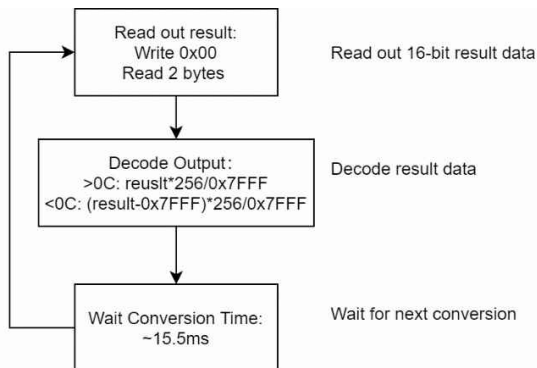


Figure 3. TMP117 I2C Communication Flowchart

For the HDC2080, will work under single trigger conversion mode. So, you need to trigger HDC2080 to start the conversion and wait for about 2 ms, until the result is prepared. The result data is 16 bits. The first read 1 byte is high 8 bits. The second read 1 byte is low 8 bit. The communication flow chart and the decode equation is shown in Figure 4.

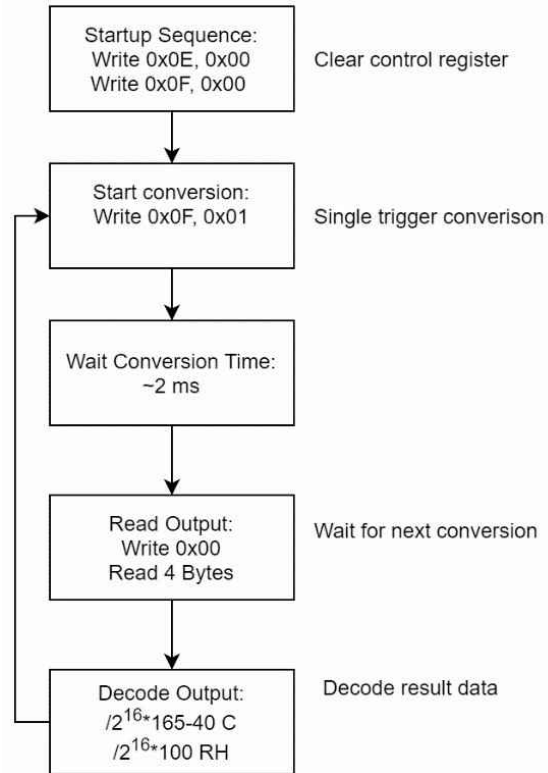


Figure 4. HDC2080 I2C Communication Flowchart

After a device reset on this application, the MSP430™ MCU sources the subsystem master clock (SMCLK) from the DCO configured to run at 1 MHz. The device then does the peripheral and sensor initialization. Later, the MSP430 keeps accessing data from the OPT3001, TMP117 and HDC2080, one by one. Because the TMP117 and HDC2080 can both sense temperature, you should use TMP117 to sense temperature and use HDC2080 to sense humidity.

To help the customer catch up with the demo, make a GUI show the sensor results. Figure 5 shows the block diagram for this implementation. MSP430FR2433 will keep updating data to GUI through back channel universal asynchronous receiver/transmitter (UART).

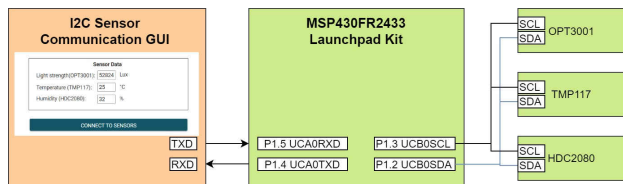


Figure 5. System Diagram

The MSP430FR2433 LaunchPad™ Development Kit should be used with this example project. Back channel UART interface on eZ-FET is used for UART communication with the GUI. A baud rate of 9600 must be selected with one stop bit and no parity. The COM channel number information can be found in the PC device management under the control panel.

The GUI is used to displays the feedback information from MSP430. Figure 6 shows the overview of GUI. On the top of the GUI, there are three text boxes to display the related sensors' data. On the bottom, there is a button for connection. When the button is clicked, the GUI will send a command to ask for connection and MSP430 will reply sensor data on the related text box.

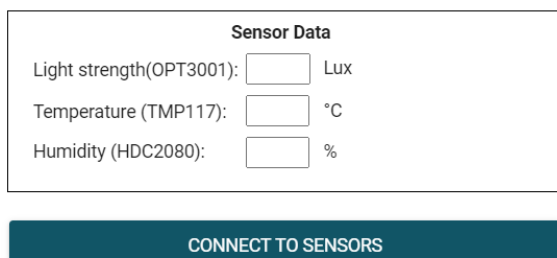


Figure 6. I2C Sensor Communication GUI

To Get Started

1. Watch the training video “I2C Sensor Communication with a Housekeeping MCU”, to walk through how to use a GUI to show I2C data.
2. Order a MSP430FR2433 LaunchPad kit and BP-BASSENSORSMKII for evaluation.
3. Download and test this example with I2C Sensor Communication GUI.
4. Evaluate the I2C Sensor Communication code for the MSP430FR2433 LaunchPad kit.

Device Recommendations

The device used in this example is part of the MSP430 housekeeping portfolio. This example can be used with the devices shown in Table 3 with minimal code changes.

Table 3. MSP430FR243x series

Part Number	Key Features
MSP430FR2433	16KB FRAM, 4KB SRAM, 10-bit ADC, UART/SPI/I2C, Timer
MSP430FR2422	8KB FRAM, 2KB SRAM, 10-bit ADC, UART/SPI/I2C, Timer

Related Information

- [MSP430FR2433 LaunchPad™ Development Kit](#)
- [Building automation sensors BoosterPack module](#)
- Texas Instruments: [HDC2080 Low-Power Humidity and Temperature Digital Sensor](#)
- Texas Instruments: [TMP117 High-Accuracy, Low-Power, Digital Temperature Sensor With SMBus™- and I2C-Compatible Interface](#)
- Texas Instruments: [OPT3001 Ambient Light Sensor \(ALS\)](#)

Trademarks

MSP430™ and LaunchPad™ are trademarks of Texas Instruments. All trademarks are the property of their respective owners.

IMPORTANT NOTICE AND DISCLAIMER

TI PROVIDES TECHNICAL AND RELIABILITY DATA (INCLUDING DATASHEETS), DESIGN RESOURCES (INCLUDING REFERENCE DESIGNS), APPLICATION OR OTHER DESIGN ADVICE, WEB TOOLS, SAFETY INFORMATION, AND OTHER RESOURCES "AS IS" AND WITH ALL FAULTS, AND DISCLAIMS ALL WARRANTIES, EXPRESS AND IMPLIED, INCLUDING WITHOUT LIMITATION ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF THIRD PARTY INTELLECTUAL PROPERTY RIGHTS.

These resources are intended for skilled developers designing with TI products. You are solely responsible for (1) selecting the appropriate TI products for your application, (2) designing, validating and testing your application, and (3) ensuring your application meets applicable standards, and any other safety, security, or other requirements. These resources are subject to change without notice. TI grants you permission to use these resources only for development of an application that uses the TI products described in the resource. Other reproduction and display of these resources is prohibited. No license is granted to any other TI intellectual property right or to any third party intellectual property right. TI disclaims responsibility for, and you will fully indemnify TI and its representatives against, any claims, damages, costs, losses, and liabilities arising out of your use of these resources.

TI's products are provided subject to TI's Terms of Sale (<https://www.ti.com/legal/termsofsale.html>) or other applicable terms available either on [ti.com](https://www.ti.com) or provided in conjunction with such TI products. TI's provision of these resources does not expand or otherwise alter TI's applicable warranties or warranty disclaimers for TI products.

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265
Copyright © 2021, Texas Instruments Incorporated