SPRING 2025/ECE4144 EXAM 2 (Open book, notes and Laptop) Due: 4/30/2025 (Midnight)

Name: _____

ID: _____

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During the COVID pandemic, one of the most monitored biometric parameters measured was blood oxygen saturation, or Sp02. One of the most available sensors to make this measurement, as well as heart rate is the MAX30100 chip. Attached is the datasheet for your review.

Review the I2C section of the datasheet.

Question 1.

The objective of this question is to connect to the MAX30100 chip and retrieve SP02 information (Red LED and IR LED) from the FIFO buffer. We also wish to capture the interrupt and toggle the onboard LED every time a measurement is received.

1. Read the relevant parts of attached datasheet to familiarize yourself to the device. Specifically focus on the serial communications part (pages 23-26), the register map shown on page 10.
2. Using the pin diagram on Page 8, sketch a schematic that connects your development board's I2C bus (review the datasheet for SCL/SDA pin information) to the correct pins on the MAX30100. Don't forget pull up resistors. Also connect the INT pin from the sensor to a an appropriate external INT pin (you can choose which one, INT0, INT1, etc..). Pick wisely though since you will need to write an interrupt handler for this pin to capture when an SP02 measurement is ready.
3. Start a new project in PlatformIO, chose your board, and select Arduino framework.
4. In your void setup() , Write the code to:
    a. Setup the onboard LED.
    b. Configure the sensor:
        i. Using the Wire library in Arduino, configure register address 0x01 to enable only the SP02 interrupt.
        ii. Set sensor mode to SP02 (See register address 0x06, MODE BITS)
        iii. Leave default settings in SP02 Config register (0x07)
    c. Set up the pin on your microcontroller to receive the INT from the sensor when an SP02 measurement is ready. Also write the ISR function that handles the interrupt.

5. Write a function called GetData() that communicates I2C to the chip and retrieves (and returns) the values of the sensor's Red LED and the IR LED. This involves:
    a. Reading the FIFO Data register (0x05). Be sure to fully read the DATASHEET pages 12-15 to understand fully how the FIFO works and how the data for the 2 sensor LEDs is provided. Pseudo code is provided in the datasheet as well. You can use any of the I2C functions provided in the Wire library.
6. Write the ISR for the function that you configured to receive the SP02 measurement RDY interrupt. You can call GetData() from 5. Also write the code to display the SHORT value of both the Red LED and the IR LED to the terminal. You should also blink the on board LED each time the interrupt is received.
7. Submit 2 files, your schematic and your code file with full comments.

Question 2.

Suppose you were tasked with designing your own device that measures respiratory rate, to be used along side the MAX30100 described above that used SPI for communication. Please read the whole question before beginning your design.

1. Propose a pinout diagram for your device that provides the necessary power pins, GPIO pins, and communications pins.
2. What interrupts would your design provide, if any, that the remote microcontroller may interface to?
3. Propose a register mapping, similar to that of the MAX30100 that provides an external microcontroller the capabilities to configure your device, interrupts, etc. and retrieve the relevant information you choose to provide. Be sure to specify default values and bit specifications of each memory location.
4. Show a sample SPI communications timing diagram that indicates how to communicate (read/write single/multiple registers) to your device.
5. Write a sample code segment that you would include in your datasheet that would help the end user interact with your device in a typical use case.