Multiple Lux Sensors via RF

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Goal:

- Implement TSL2591 sensor interfaced by I2C communication
- Implement TCA9548A to select between multiple TSL2591 sensors
- Communicate between two nRF24L01's via serial peripheral interface
- Use Data Visualizer to receive data from the sensor via USART
- Monitor and graph multiple lux levels

Deliverables:

This project is intended to measure multiple lux levels and select which sensor to read from, and then display calculated lux values in Data Visualizer (through text and graph) via USART for usability. The use of RF allows users to remotely measure lux values of multiple areas.

I. Literature survey

One of the uses for measuring multiple lux sensors is for application in home automation technology. The home automation benefits could include: blinds that automatically open when a set lux value is reached (i.e. sunrise or sunset), smart LEDs that adjust to the measured lux value inside of the home, or limiting power consumption from electronics based on remotely measured lux values.

For home automation, raw lux data outside of home will be sent to Microcontroller A via I2C, will be converted into a lux value and transmitted to Microcontroller B via RF. Microcontroller B will receive calculated lux value from RF transmission. Microcontroller B will then compare value to set threshold and open/close blinds accordingly. The lux values can be monitored with either Microcontroller via USART.

For power consumption, raw lux data inside of home will be sent to Microcontroller A via I2C, will be converted into a lux value and transmitted to Microcontroller B via RF. Microcontroller B will received calculated lux value from RF transmission. Microcontroller B will then compare value to set threshold and remotely control electronics to prevent excessive power consumption. The lux values can be monitored with either Microcontroller via USART.

II. COMPONENTS

A. ATmega328p Xplained Mini

The ATmega328p Xplained Mini is an 8-bit microcontroller from Atmel that can be programmed with either Atmel Studio or Arduino IDE using C/C++, AVR assembly, or Arduino. The code will allow users to manipulate the board's 32 GPIOs, 6 PWMs, 3 timer/counters, 1kB EEPROM, 2kB SDRAM, I2C interface, SPI interface, 10-bit ADCs, and up to an internal 16 MHz clock.

B. TSL2591 (Light-to-Digital Converter)

This I2C sensor uses 6 pins: SCL, INT, GND, NC, V_{CC}, and SDA. The chip has a voltage regulator with a range of 2.7V – 3.6V that regulates input voltage to 3.3V. The SDA pin is the serial data IO terminal that is used for passing/receiving data between microcontroller and chip. The SCL pin is the I2C serial clock input terminal that is used to regulate operating frequency.

C. TCA9548A (Low-Voltage 8-Channel Switch)

This I2C switch (with reset) uses 24 pins to select between 8 different bidirectional channels. This is accomplished by using 3 address pins (A_0, A_1, A_2). It can operate between 0 to 400 kHz clock frequencies, and has an active-low reset pin. This switch allows voltage-level translation between 1.8V, 2.5V, 3.3V, and 5V buses. The operating power supply voltage range is between 1.6V – 5.5V.

D. nRF24L01 (Single Chip 2.4GHz Transceiver)

This transceiver can communicate at 250kbps, 1Mbps, and 2Mbps on air data rates. It contains a voltage regulator that allows a voltage supply range between 1.9V and 3.6V. The average current used during TX settling is 8.0mA, while the average current used during RX settling is 8.9mA.

III. SCHEMATICS

Figure 1: Schematic of Receive Circuit

Figure 2: Schematic of Transmit Circuit

IV. Implementation

- TCA9548A interfaced via I2C to receive commands and send data back to microcontroller, as well as send commands to and receive data from TSL2591's.
    - The I2C library is referenced via header file from g4lvanix's Github
    - USART functions are referenced from Lecture 11 class notes
    - USART functions are used for checking sent and received data
- nRF24L01 transceiver is used to send and receive data between microcontrollers
    - The nRF24L01 library is referenced via header file from antoineleclaire's Github
- TSL2591 Light-to-Digital Converter is used to measure brightness and sends data to TCA9548A via I2C
    - The TSL2591 library is referenced via Lecture 17 class notes

V. Snapshots and Screenshots

VI. CODE

Transmit:

Receive:

VII. Links

- Dayton Flores: https://github.com/daytonflores/homework
- Joseph Sharp-Halpin: https://github.com/jsharpin/My-Repos
- Presentation Links:
  - https://www.youtube.com/watch?v=l7GHWaOyC2g&feature=youtu.be
  - https://www.youtube.com/watch?v=zt9b3CEuNu8&list=PLOWewY7_3-gN1EzhvFH4MSnkMhOsOXWeV&index=11&t=0s
- Demo Links:
  - https://www.youtube.com/watch?v=l2gM2lUtcB0&list=UUc3Y_f20-g3ll-FvewTRxaw
  - https://www.youtube.com/watch?v=kE_EY3_Hkgs&feature=youtu.be

VIII. Conclusion

Remotely measuring multiple lux values from different can be applied in home automation technology and to control power consumption. Automated blinds could adjust according to measured lux values (i.e. sunrise or sunset), and smart electronics could have their usages adjusted via indoor measured lux values.

IX. References

[1] ATmega328p Xplained Mini Datasheet: http://ww1.microchip.com/downloads/en/DeviceDoc/50002659A.pdf
[2] nRF24L01 Datasheet: https://www.sparkfun.com/datasheets/Components/SMD/nRF24L01Pluss_Preliminary_Product_Specification_v1_0.pdf
[3] TSL2591 Datasheet: https://cdn-shop.adafruit.com/datasheets/TSL25911_Datasheet_EN_v1.pdf
[4] TSL2591 Lux Project: https://cdn-learn.adafruit.com/downloads/pdf/adafruit-tsl2591.pdf
[5] TCA9548A Datasheet: http://www.ti.com/lit/ds/symlink/tca9548a.pdf
[6] Lecture 11 Class Notes
[7] Lecture 17 Class Notes
[8] g4lvanix's Github: https://github.com/g4lvanix/I2C-master-lib
[9] antoineleclaire's Github: https://github.com/antoineleclair/avr-nrf24l01