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CPE 403 ADV EMB SYS DES F 2018

TITLE: TIVAC the Light

GOAL:

- Configure I2c interface between TM4C123GXL board and TSL2951 sensor
- Configure UART communication between TM4C123GXL and ESP8266 module
- Upload TSL2951 data readings to cloud server hosted on thingspeak.com

DELIVERABLES:

The final project was supposed to record luminosity from the TSL2951 sensor and send that data via I2C to the TM4C123G; that light data was then processed and transmitted to the ESP8266 Wi-Fi module which would connect to the cloud and graph the data. All of this was accomplished with the most difficult part being configuring the TSL2951 sensor. I was not properly initializing the ALS portion of the sensor, and not leaving a delay for the values to be gathered so I would only get 0. After fixing this I was able to get values as low as 0 (pitch black) or as high as 1138.83.

COMPONENTS:

- **Tiva TM4C123GH6PM –** MCU to control project. Device is initialized by setting the system clock, enabling GPIO module, enabling the I2C module, enabling and setting the clock for I2C0 master module, enabling UART1, and configuring port pins.
- **TSL2591 –** A high dynamic digital light sensor which can measure the Lux up to ranges of 188u – 88,000 Lux. Its interfaced with the TivaC using I2C.
- **ESP8266 -** A Wi-Fi module interfaced with the TivaC using UART. It is initialized and will send information to server.
- **TSL2591 –** A high dynamic digital light sensor which can measure the Lux up to ranges of 188u – 88,000 Lux. Its interfaced with the TivaC using I2C.

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IIMPLEMENTATION:

- **UART Initialization**

  The GPIOB module is enabled for port pins, PB0 and PB1, which are configured to be used for U1RX and U1TX. The clock for UART1 is set to use the internal oscillator and the baud rate is set to 9600.

- **I2C Initialization**

  The I2C0 module is enable and the clock is set for the I2C0 master module, with data rate to 400kbps, this will enable the port pins PB2 and PB3 to be used as SCL and SDA which communicates with the same pins on the TSL2951 sensor.

- **Luminosity**

  The TSL2591 is initialized by reading the Device ID register setting the gain, the timing, and the Power On Register to 1. It will read the channel data from Channel0 and Channel1; moreover, these two values are calculated to find the Lux value of the sensor and the value is returned to the caller.

SCREENSHOTS & PHOTO

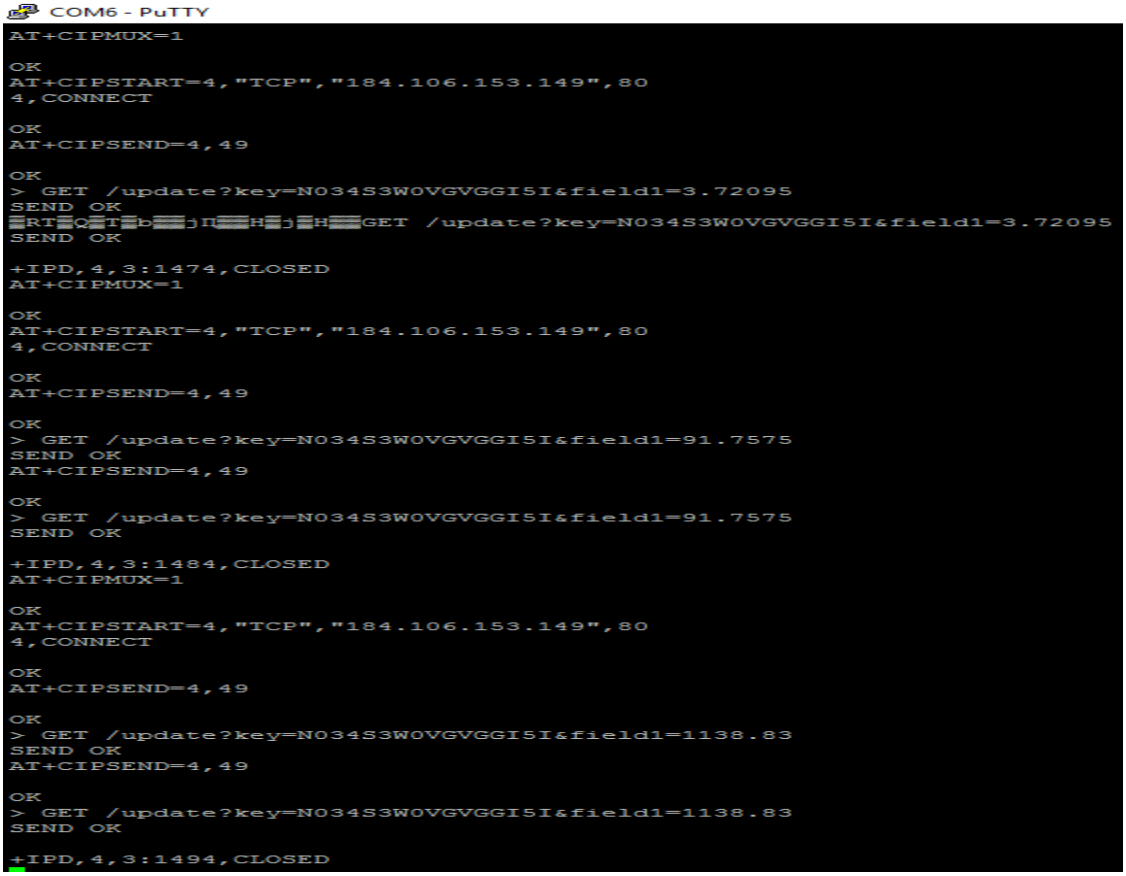

Figure 1- Putty terminal showing strings being transmitted from TM4C to ESP8266 shows 3 posts being made with low, medium, and high lighting on sensor

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Channel Stats

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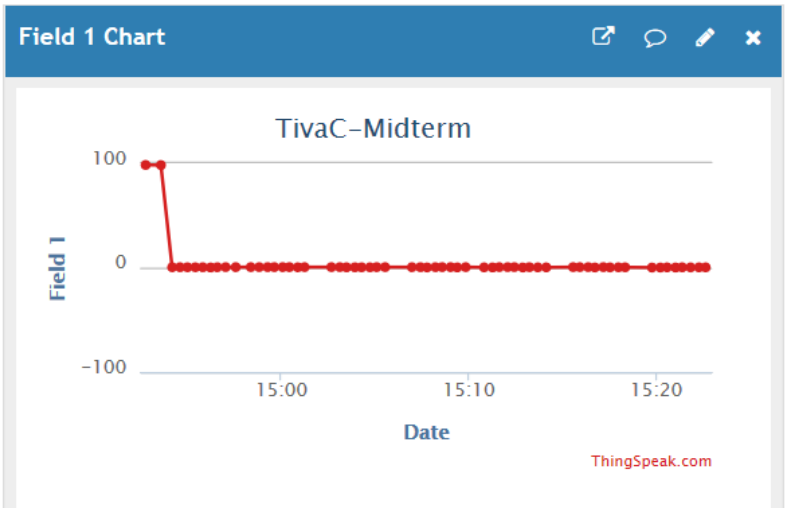

Figure 2- Thingspeak plot of data from TSL2591 (Lights on and off)

Updated: less than a minute ago
Last entry: less than a minute ago
Entries: 161

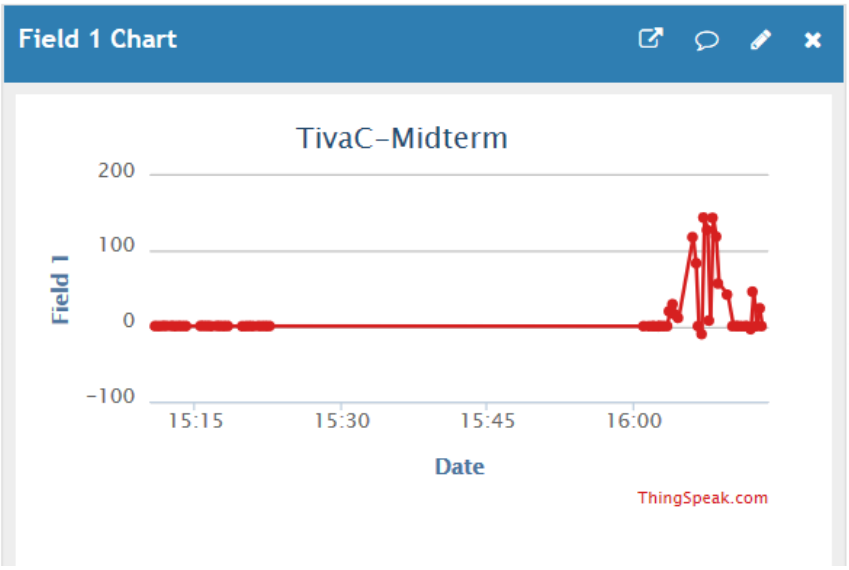

Figure 3- Thingspeak plot of data from TSL2591 (Peaks represent bright light contact with sensor)

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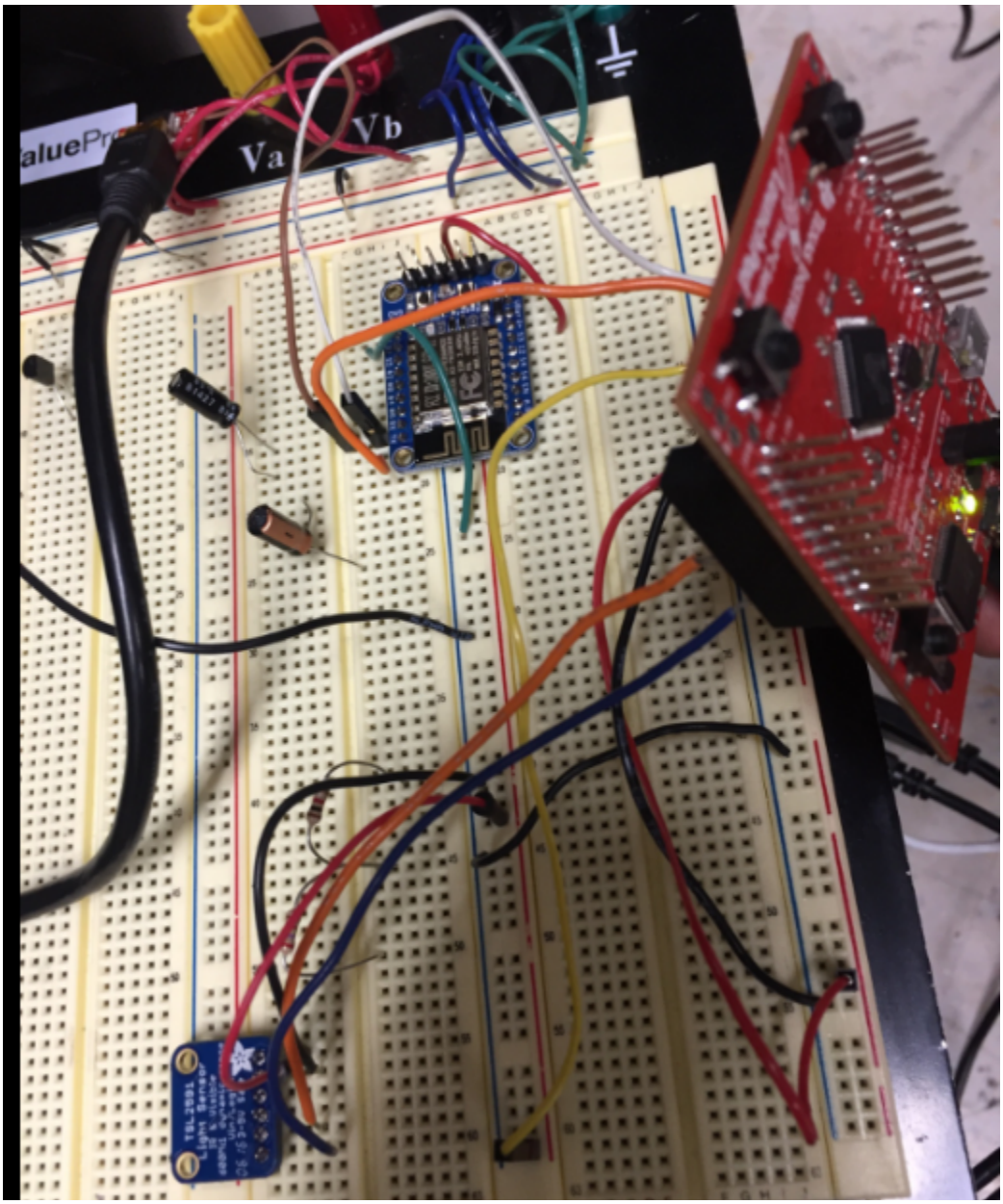

Figure 4- Photo showing interconnection of TM4C, TSL2951, and ESP8266

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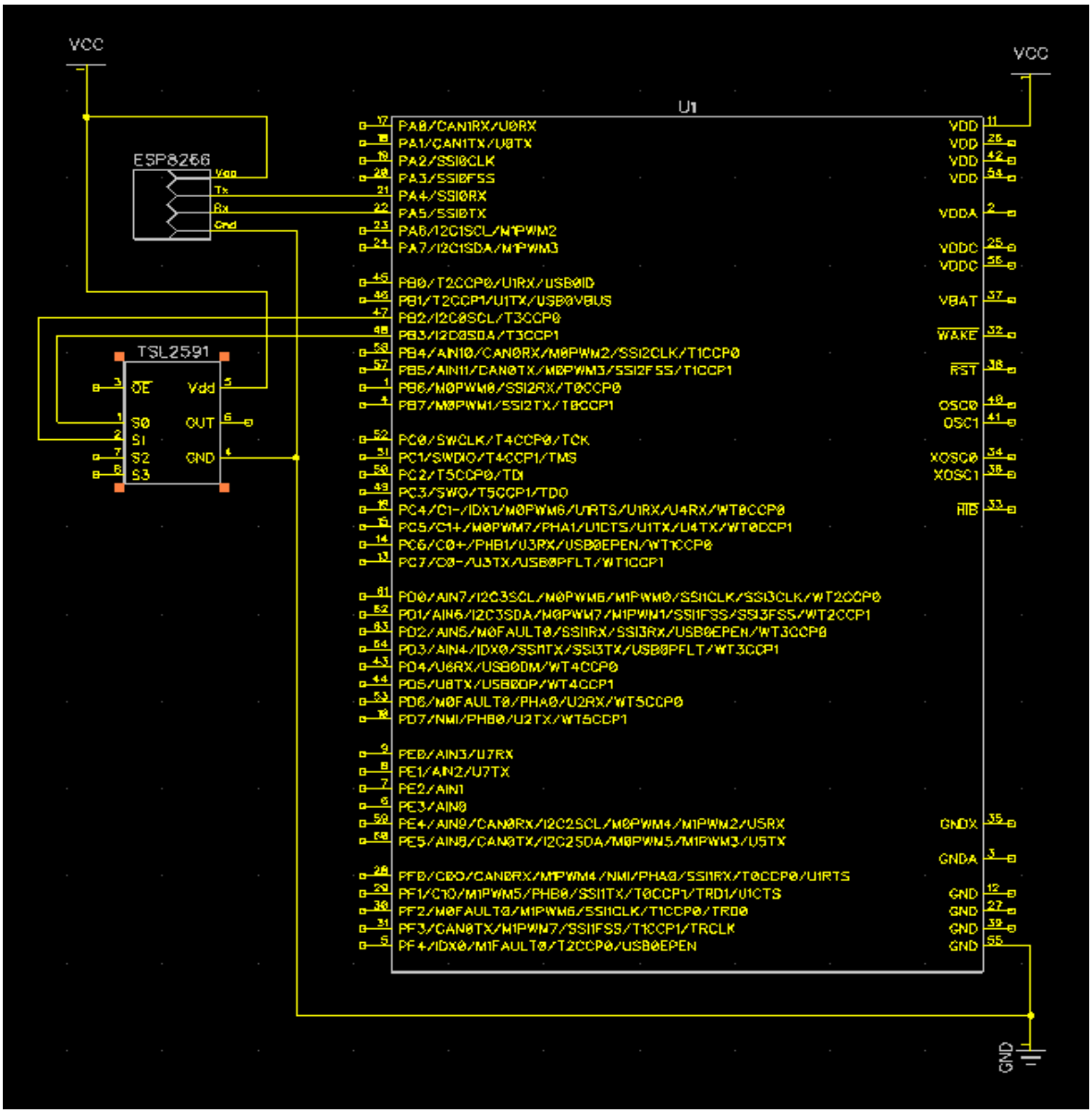
SCHEMATICS:



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CODE:

```
#include <stdbool.h>
#include <stdint.h>
#include "inc/hw_i2c.h"
#include "inc/hw_ints.h"
#include "inc/hw_memmap.h"
#include "inc/hw_types.h"
#include "driverlib/gpio.h"
#include "driverlib/i2c.h"
#include "driverlib/interrupt.h"
#include "driverlib/pin_map.h"
#include "driverlib/sysctl.h"
#include "driverlib/uart.h"
#include "utils/uartstdio.h"
#include "driverlib/rom_map.h"
#include "inc/hw_types.h"
#include "inc/hw_gpio.h"

uint32_t ui32SysClock;


const uint8_t TSL2591address = 0x29;


//UART1
void InitConsole(void)
{
    SysCtlPeripheralEnable(SYSCTL_PERIPH_GPIOB);
    GPIOPinConfigure(GPIO_PB0_U1RX);
    GPIOPinConfigure(GPIO_PB1_U1TX);
    SysCtlPeripheralEnable(SYSCTL_PERIPH_UART1);
    UARTClockSourceSet(UART1_BASE, UART_CLOCK_PIOSC);
    GPIOPinTypeUART(GPIO_PORTB_BASE, GPIO_PIN_0 | GPIO_PIN_1);
    UARTStdioConfig(1, 115200, 16000000);
}

void ftoa(float f,char *buf)
{
       /*Function acquired from forum:
        *
http://e2e.ti.com/support/microcontrollers/stellaris_arm/f/471/p/44193/156824.aspx
        */

      /*Parses through float # and stores the value as a character array*/
    int pos=0,ix,dp,num;
    if (f<0)
    {
        buf[pos++]='-';
        f = -f;
    }
    dp=0;
    while (f>=10.0)
    {
        f=f/10.0;
```

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```
        dp++;
    }
    for (ix=1;ix<8;ix++)
    {
            num = (int)f;
            f=f-num;
            if (num>9)
                buf[pos++]='#';
            else
                buf[pos++]='0'+num;
            if (dp==0) buf[pos++]='.';
            f=f*10.0;
            dp--;
    }
}


// USING I2C0 - CHECK FOR TIVAC LAUNCHPAD PINS
void i2c0_init()
{
             //enable i2c0
       MAP_SysCtlPeripheralEnable(SYSCTL_PERIPH_I2C0);
       //reset i2c0
       MAP_SysCtlPeripheralEnable(SYSCTL_PERIPH_GPIOB);
       //Set pin type for PB3, configure as data pin
       MAP_GPIOPinTypeI2C(GPIO_PORTB_BASE, GPIO_PIN_3);
       MAP_GPIOPinConfigure(GPIO_PB3_I2C0SDA);

       //Set pin type for PB2, configure as SCL
       MAP_GPIOPinTypeI2CSCL(GPIO_PORTB_BASE, GPIO_PIN_2);
       MAP_GPIOPinConfigure(GPIO_PB2_I2C0SCL);

       //Enable and initialize i2c0 master module. Use System Clock.  Set i2C data
rate at 100kbps (try true for 400)
       I2CMasterInitExpClk(I2C0_BASE, SysCtlClockGet(), false);
              while (I2CMasterBusy(I2C0_BASE));

}

void i2c0_write(uint8_t dev_addr, uint8_t dev_reg, uint16_t dev_data)
{

      //Tell device we want to write to bus
    I2CMasterSlaveAddrSet(I2C0_BASE, dev_addr, false);
    //Bitwise or command bit to tell device we want to write to dev_reg
    I2CMasterDataPut(I2C0_BASE, TSL2591_COMMAND_BIT |dev_reg);
      //Send and wait
    I2CMasterControl(I2C0_BASE, I2C_MASTER_CMD_BURST_SEND_START);
       while (I2CMasterBusy(I2C0_BASE));
       //Now write the data to the register
    I2CMasterSlaveAddrSet(I2C0_BASE, dev_addr, true);
      //place the data in Master and send
    I2CMasterDataPut(I2C0_BASE, dev_data);
    I2CMasterControl(I2C0_BASE, I2C_MASTER_CMD_BURST_RECEIVE_FINISH);
```

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```
        while (I2CMasterBusy(I2C0_BASE));

}


uint8_t i2c0_read(uint32_t slave_addr, uint8_t reg)
{
    //specify that we are writing (a register address) to the
    //slave device
    I2CMasterSlaveAddrSet(I2C0_BASE, slave_addr, false);
    while(I2CMasterBusy(I2C0_BASE));
    //specify register to be read
    I2CMasterDataPut(I2C0_BASE, TSL2591_COMMAND_BIT | reg);
    while(I2CMasterBusy(I2C0_BASE));
    //send control byte and register address byte to slave device
    I2CMasterControl(I2C0_BASE, I2C_MASTER_CMD_SINGLE_SEND);

    //wait for MCU to finish transaction
    while(I2CMasterBusy(I2C0_BASE));
    //specify that we are going to read from slave device
    I2CMasterSlaveAddrSet(I2C0_BASE, slave_addr, true);
    while(I2CMasterBusy(I2C0_BASE));
    //send control byte and read from the register we
    //specified
    I2CMasterControl(I2C0_BASE, I2C_MASTER_CMD_SINGLE_RECEIVE);
    //wait for MCU to finish transaction
    while(I2CMasterBusy(I2C0_BASE));
    //return data pulled from the specified register
    return I2CMasterDataGet(I2C0_BASE);
}

void TSL2591_init()
{
        uint8_t DevID;
        i2c0_write(TSL2591address,TSL2591address,1); //literally no idea what this
does


        DevID = i2c0_read(TSL2591address,TSL2591_REGISTER_DEVICE_ID); //read device ID
        //Alert user if errors reading ID

       // Set Gain and Timing
        i2c0_write(TSL2591address,0x01, 0xB0 );//CONFIG medium gain and reset the
device (self-clearing)
        i2c0_write(TSL2591address, 0x00, 0x03);//ENABLE Power, Oscillator,

}

void TSL2591_disable()
{
       i2c0_write(TSL2591address,0xA0, 0x00); //turn off TSL2591
}

float getLuminosity ()
```

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```
{
  float    atime = 100.0F, again=25.0F; //For 100ms integration time and med gain
  float    cpl, lux1, lux2, lux;
  uint16_t ch0 ;
  uint16_t ch1 ;

// Get full luminosity
  //read channel 0 into x0
  uint16_t x0;
  uint16_t y0;


  y0 = i2c0_read(TSL2591address,0x14);
  while(I2CMasterBusy(I2C0_BASE));
 // UARTprintf("\n\nChannel 0L: %d", y0);
  x0 = i2c0_read(TSL2591address,0x15); //C0DataHigh
  while(I2CMasterBusy(I2C0_BASE));
 // UARTprintf("\nChannel 0H: %d", x0);
  x0 <<= 8;


  uint16_t x1;
  uint16_t y1;
  //read channel 1 into x1
  y1 = i2c0_read(TSL2591address, 0x16);
  while(I2CMasterBusy(I2C0_BASE));
 // UARTprintf("\nChannel 1L: %d", y1);
  x1 = i2c0_read(TSL2591address, 0x17);
  while(I2CMasterBusy(I2C0_BASE));
 // UARTprintf("\nChannel 1H: %d", x1);
  x1 <<= 8;

// Disable Sensor


  ch0 = x0+y0;
  ch1 = x1+y1;
//Calculate Lux value from sensor
      cpl = (atime * again) / TSL2591_LUX_DF;
  lux1 = ( (float)ch0 - (TSL2591_LUX_COEFB * (float)ch1) ) / cpl;
  lux2 = ( ( TSL2591_LUX_COEFC * (float)ch0 ) - ( TSL2591_LUX_COEFD * (float)ch1 ) )
/ cpl;
  lux = lux1 > lux2 ? lux1 : lux2;

  return lux;
}

void ESPSENDPREP()
{
      SysCtlDelay(2000000);
      UARTprintf("AT+CIPMUX=1\n\r");
      SysCtlDelay(2000000);
      UARTprintf("AT+CIPSTART=4,\"TCP\",\"184.106.153.149\",80\n\r");
      SysCtlDelay(2000000);
```

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```
//     SysCtlDelay(20000000);
//     UARTprintf("GET /update?key=N034S3W0VGVGGI5I&field1=50\n\r");
//     SysCtlDelay(20000000);
//     UARTprintf("GET /update?key=N034S3W0VGVGGI5I&field1=\n\r");

}

int main(void)
{
       char myLux[48] = "GET /update?key=N034S3W0VGVGGI5I&field1=";//52 bit string,
42 instr, 6 are lux. (append \n\r at end)
    float lux_read;
  ui32SysClock = MAP_SysCtlClockFreqSet((SYSCTL_XTAL_25MHZ |
                 SYSCTL_OSC_MAIN | SYSCTL_USE_PLL |
                 SYSCTL_CFG_VCO_480), 120000000);
  InitConsole();
  i2c0_init();

  while(1)
  {

       // UARTprintf("AT\n");

        TSL2591_init();
        SysCtlDelay(2000000);
        lux_read = getLuminosity();
        ftoa(lux_read, &myLux[40]);
        myLux[47]='\0';
TSL2591_disable();
        ESPSENDPREP();

              UARTprintf("AT+CIPSEND=4,49\n\r");
              SysCtlDelay(20000000);
        UARTprintf("%s\n\r",&myLux);
        SysCtlDelay(20000000);
              UARTprintf("AT+CIPSEND=4,49\n\r");
              SysCtlDelay(20000000);
        UARTprintf("%s\n\r",&myLux);



        SysCtlDelay(5000000*20); //slightly more than 15 seconds per so
  }
}
```

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