

ECE 480 - Design Team 3

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**How to use MSP 430 Peripheral Sensors and use of
LEDs as sensors**

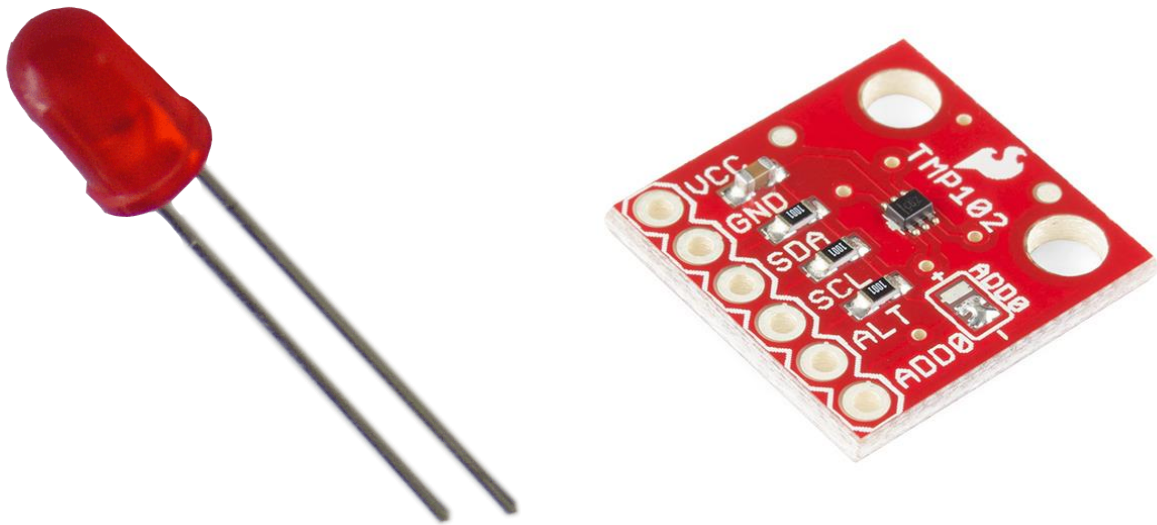


Table of Contents

LED definition and structure.....	3
LED setup as a receiver.....	4
MSP 430 Peripheral sensor set up.....	5
Sensor Programming using TI's demo in Code Composer Studio.....	5
Conclusion.....	8
References.....	8

Keywords: LED, sensors, receiver, MSP 430 peripheral sensor, line laser

Abstract: How to use light-emitting diodes as a light sensor (i.e. receiver) to use for detection.

How to output MSP 430 peripheral sensors' data for user's reading.

What is an LED?

Light-Emitting Diode is a semiconductor device which emits light when current flows through it. LED works due to p-n junction i.e. when diode is on electrons move from negative side i.e. cathode to the positive side of diode i.e. anode.

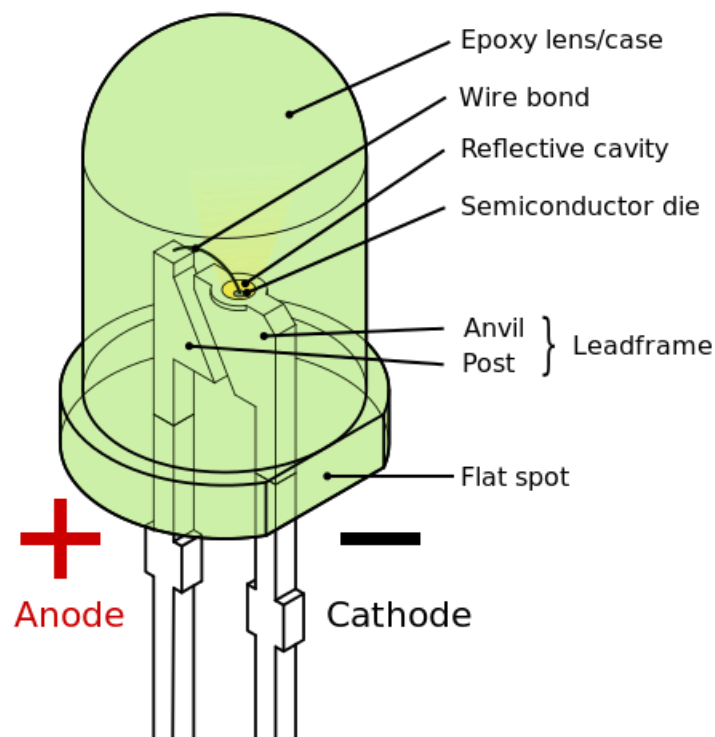


Figure 1: LED structure

Use of LEDs for light detection

LEDs are mainly designed to make light not to detect it. In this cases, LEDs are in forward bias i.e. electrons flow from cathode to anode. To make LEDs useful for light detection, LEDs should be set in reverse bias i.e. electrons flow from anode to cathode. Moreover, it will be simpler that power source for example, line laser and LED will have the same wavelength. Red LEDs are fully compatible and are able to detect line laser. While laser emits at LED, LEDs will provide voltage to stay powered on. To provide stable voltage it will be useful to provide resistor load. In such applications LED is working as a light receiver. For projectile detection, LEDs can be used as detectors when projectile blocks laser's light and therefore voltage drop decreases, it triggers interrupt to the attached microcontroller e.g. TI MSP 430 microcontroller.

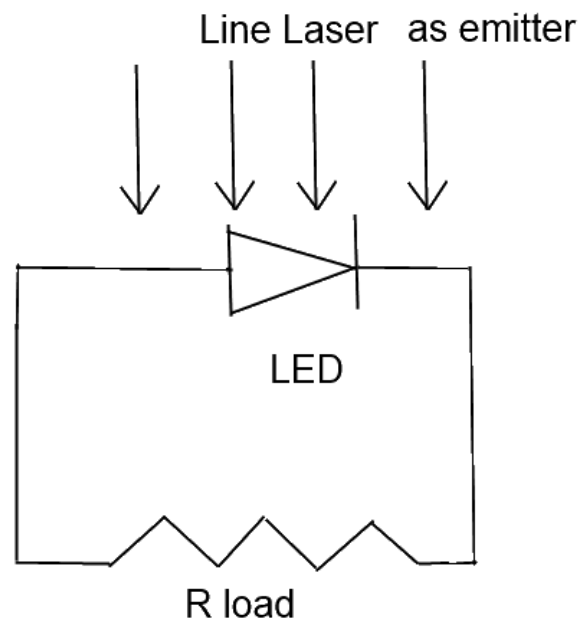


Figure 2: Reverse biased LED circuit that working as a receiver

MSP 430 Peripheral Sensors

TI MSP 430 microcontroller allows usage of different peripheral sensors that can output data measurements depending on type of sensor into the MSP 430 microcontroller. To make these sensors work with MSP 430, it is needed to solder sensor's breakout connectors into MSP 430 pin-out connections. As attachment is done, it is needed to program MSP 430 microcontroller to make it to interface with sensor to get required data. This objective can be achieved using Code Composer Studio which is TI's certified development software for MSP 430 microcontroller.



Figure 3: Sample sensor attached to MSP 430 microcontroller

Sensor Programming using Code Composer Studio

To make sensor work, it is crucial to create a C program that tells MSP 430 to interface with a sensor. First of all, it is needed to declare variables that should work as outputs for data. Moreover, it is needed to set up pins where a sensor is attached to MSP 430. Depending on a type of sensor, it is also needed to tell microcontroller, when to output data measurements from a

sensor. There is no need for advanced programming i.e. creating own library files for different sensors as Texas Instruments provide most library files on their support website. For example, to make use of altitude sensor on MSP 430 microcontroller, following code can be used with little changes depending on your pin-out connections to make altimeter output data about altitude into MSP 430. The following demo is based on TI's sample code and provided by Texas Instruments. This demo helps end-user to be able to use MSP 430 without advanced programming skills.

MSP430F4270 Altimeter Demo - C Language Version - TI LCD

Description:

PRESSURE SENSOR IS SAMPLED/AVG'D 64X WITH OSR=1024, fSD16=32kHz, 16-bit
TEMP SENSOR IS SAMPLED/AVG'D 1X WITH OSR=1024, fSD16=32kHz, 16-bit

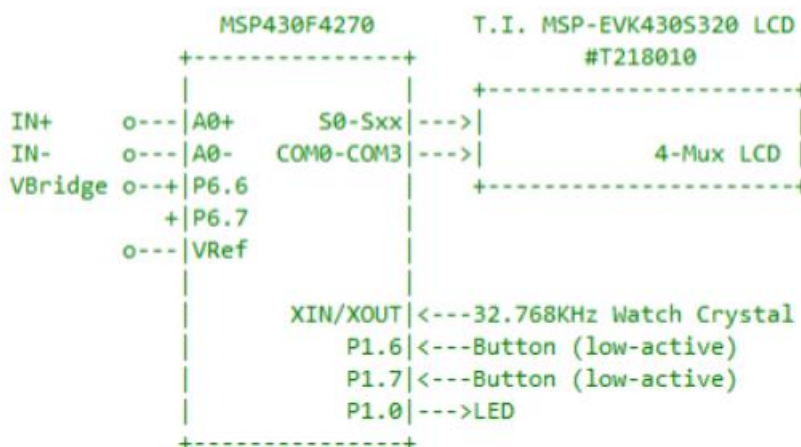


Figure 4: MSP 430 TI's altimeter demo

```
// Circuit related definitions
#define BRIDGE_SUPPLY (0xc0) // IO pins P6.6/P6.7 for
// pos. bridge rail
#define LED1 (0x01) // LED on P1.0
#define PUSH_BUTTON1 (0x40) // Button on pin P1.6
#define PUSH_BUTTON2 (0x80) // Button on pin P1.7
```

Figure 5: Definitions for altimeter sensor usage

```

// Constants for math calculations (for altitude/pressure measurement)
#define VREF_VOLT_EXT (1.26923077f) // External ref voltage
#define GAIN_32 (28.35f) // Typ. gain for 32x
#define NR_BITS (32767) // 15 bits of resolution
#define UV_PER_LSB (1000000.0f * VREF_VOLT_EXT / 2 / GAIN_32 / NR_BITS)
#define MB_PER_UV (10.0f / 120.0f) // 10mbar / 120uV @ V_Bridge = 3V
#define NORMAL_P (1013.25f) // Normal air pressure in mbar

// Constants for math calculations (for temperature measurement)
#define VREF_VOLT_INT (1.20f) // Internal ref voltage
#define MV_PER_LSB (1000.0f * VREF_VOLT_INT / 2 / 32767)
#define K_PER_MV (1.0f / 1.32f)

```

Figure 6: Mathematical equations for altimeter sensor

```

// Misc definitions
#define MODE_TIMEOUT (240) // Max time for A/P measurement
                             // (in s)

enum
{
    PM_MEASURE_A, // Mode - Measure Altitude
    PM_MEASURE_P, // Mode - Measure Pressure
    PM_DISPLAY_TIME, // Mode - Display Time
    PM_MEASURE_TEMP, // Mode - Measure Temperature
    PM_DISPLAY_CONTR, // Mode - Display Contrast
    PM_CAL_A, // Mode - Cal Altitude
    PM_CAL_P, // Mode - Cal Pressure
    PM_SET_TIME, // Mode - Set Time
    PM_CAL_TEMP, // Mode - Cal Temperature
    PM_SET_CONTR // Mode - Set Contrast
};

```

Figure 7: Sample functions useful for altimeter sensor

Above TI's sample code can be used by user to make altimeter sensor interface with MSP430. It will require little changes from user to configure everything right but it won't require writing everything from scratch as most vital software elements are provided by Texas Instruments.

Conclusion:

This application note summarizes information on how to use LEDs as a receiver which is uncommon in most diode applications. Moreover, it shows how it will interface with microcontroller in case of interrupt i.e. power source that emits light into LED is blocked by an object. In addition, it covers how to program MSP 430 using Code Composer Studio to make it interface with peripheral sensors based on TI's altimeter demo.

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