TI-RSLK MAX

Texas Instruments Robotics System Learning Kit

TEXAS INSTRUMENTS

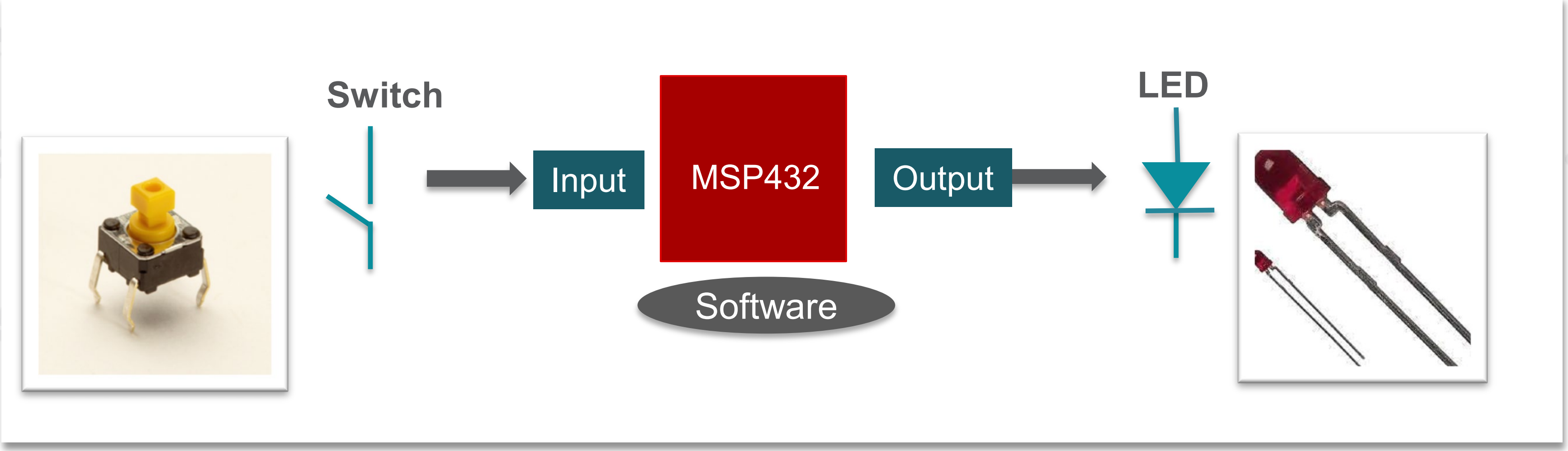
Module 8

Lecture : Interfacing input and output - Switches

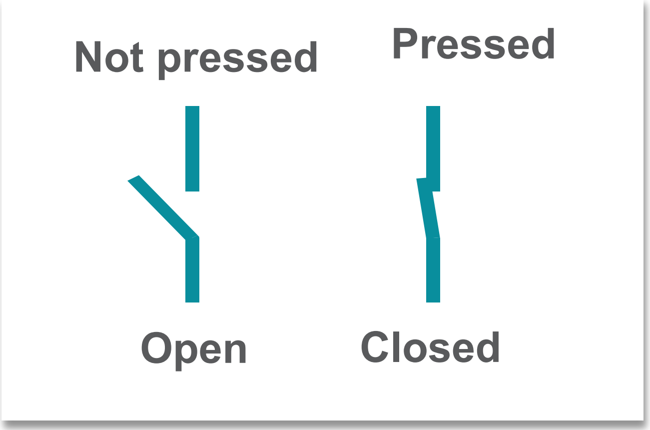
Interfacing input devices using Switches

You will learn in this module

- Fundamentals of switches
- How to interface switches TI's Launchpad Development board
- Software driver (set of functions to create an abstract module)
- Motivation for lab

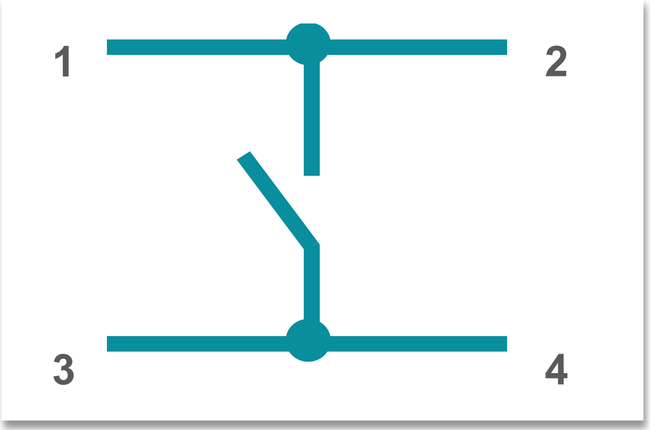


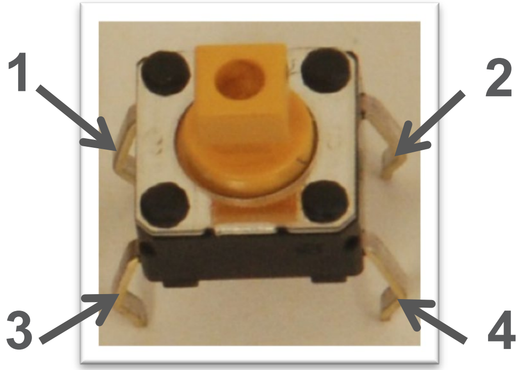
Switch Configuration



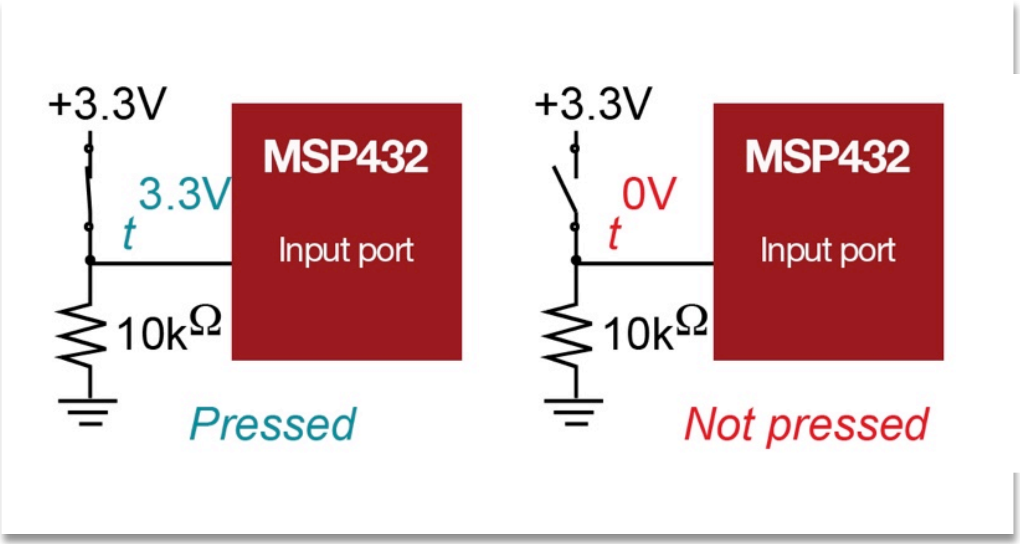
Not pressed R = 100MΩ

Pressed R = 0.1Ω





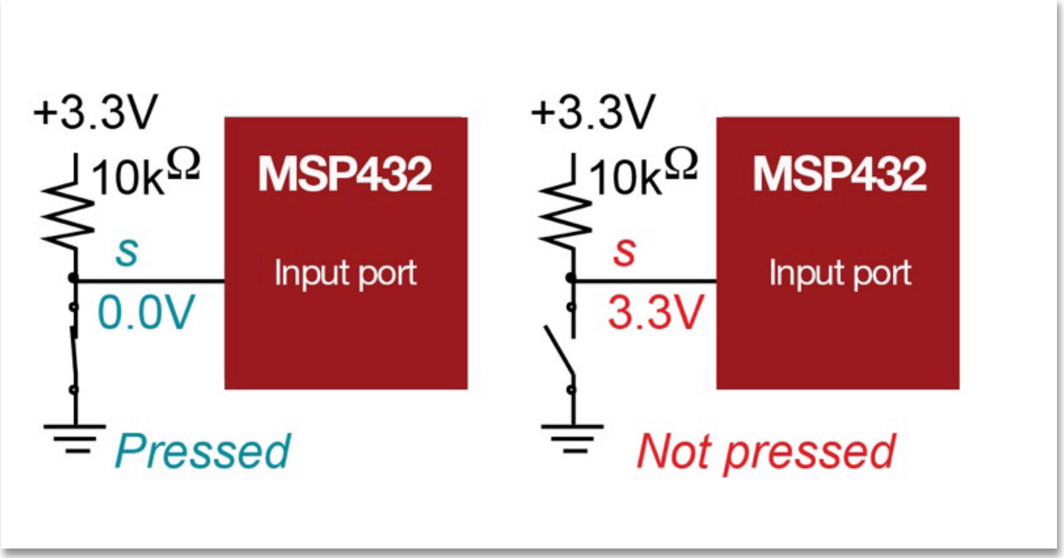
Positive Logic Switch Interface



Positive Logic *t*

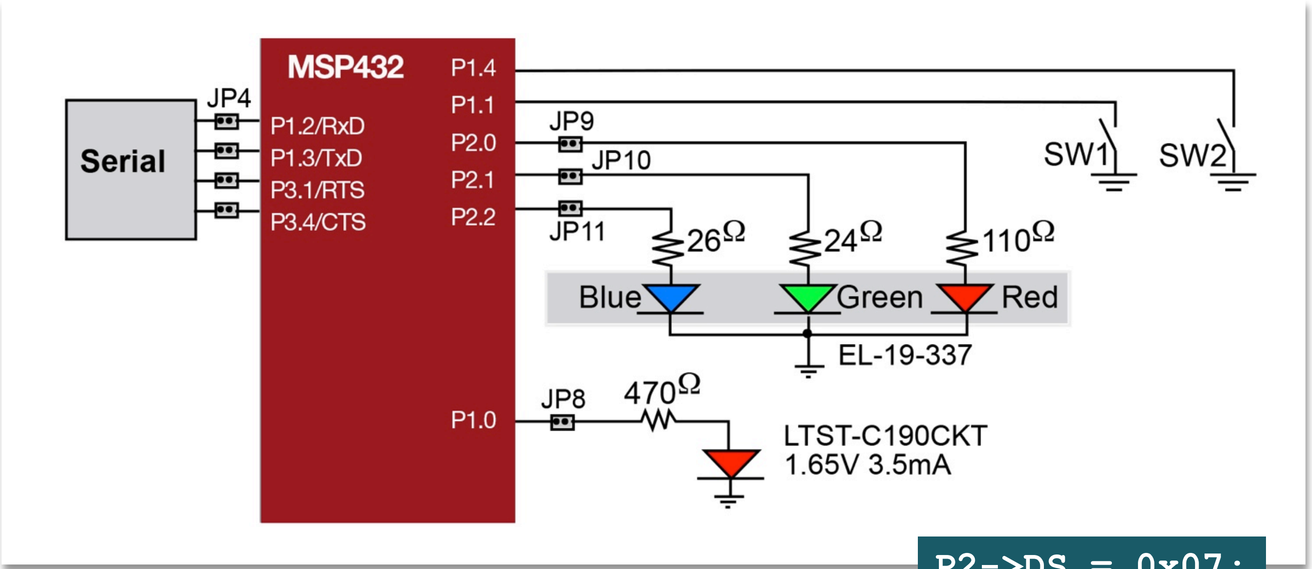
- pressed, 3.3V, true
- not pressed, 0V, false

Negative Logic Switch Interface



Negative Logic *s*
- pressed, 0V, true
- not pressed, 3.3V, false

LaunchPad Switches and LEDs




```
P2->DS = 0x07;
```

The Switches on the LaunchPad

- Negative logic
- Require internal pull-up

The LEDs are positive logic

Software Driver (inputs)

Initialization (executed once at beginning)

1. Set *DIR* to 0 for input
2. Enable pullup on inputs

Input from switches

1. Read from data input port
2. Mask (select) desired bits

```
all = P1->IN;
in = all&0x01;
```

Mask

Software Driver (simple, not friendly)

```
#include "msp.h"
void Port1_Init(void){
  P1->DIR = 0x00;    // 1) make P1.4 and P1.1 in
  P1->REN = 0x12;    // 2) enable pull resistors on P1.4 P1.1
  P1->OUT = 0x12;    //    P1.4 and P1.1 are pull-up
}
uint8_t Port1_Input(void){
  return (P1->IN&0x12); // read P1.4,P1.1 inputs
}
```

See **InputOutput_MSP432** example project

Software Driver (friendly)

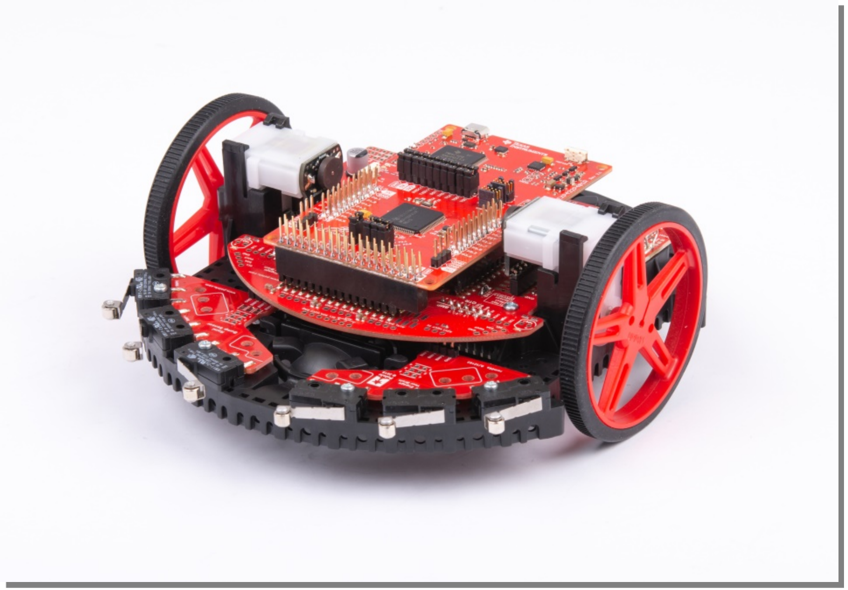
```
#include "msp.h"
void Port1_Init(void){
  P1->DIR &= ~0x12;  // 1) make P1.4 and P1.1 in
  P1->REN |= 0x12;   // 2) enable pull resistors on P1.4 P1.1
  P1->OUT |= 0x12;   //    P1.4 and P1.1 are pull-up
}
uint8_t Port1_Input(void){
  return (P1->IN&0x12); // read P1.4,P1.1 inputs
}
```

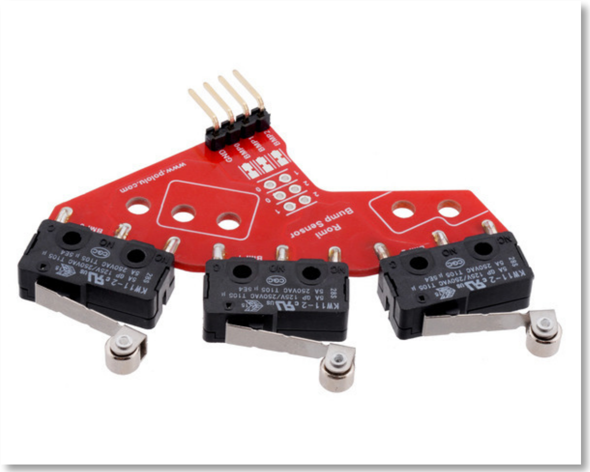
See **InputOutput_MSP432** example project

Application

Switches provide

1. Feedback to robot as bump sensors to determine if there is an obstruction
2. Control/command inputs to robot (e.g., start/stop)

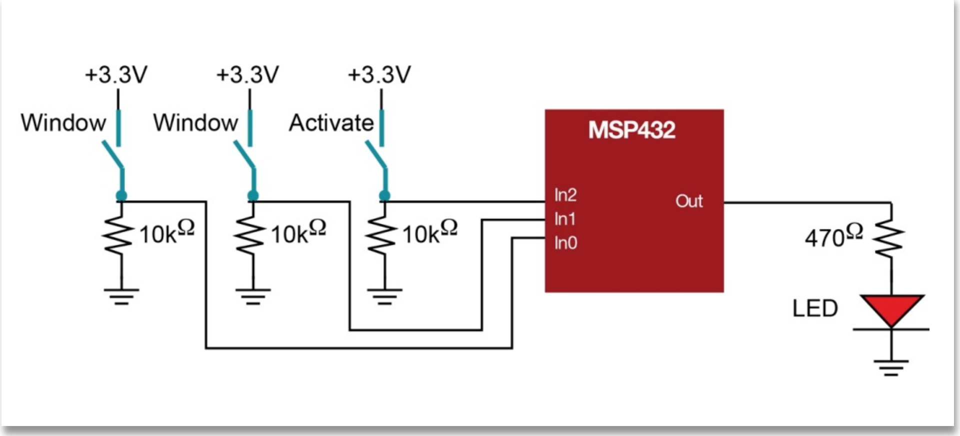




Summary

- Positive and negative logic
- Ohm's Law for resistors
- Switch interface with pullup or pulldown
- LaunchPad switches and LEDs
- Software driver
  - Initialization
  - Input/Output functions

$V = I * R$



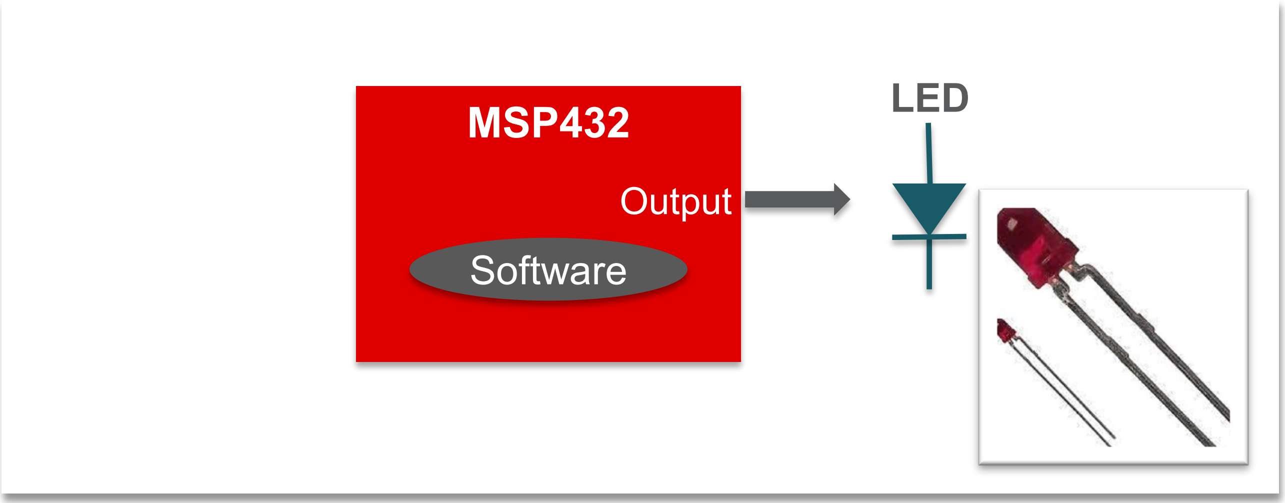
Module 8

Lecture : Interfacing input and output - LEDs

Lecture
Interfacing output devices using LEDs

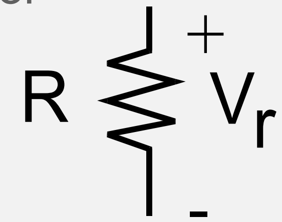
You will learn in this module

- Fundamentals of LEDs
- How to LEDs to TI’s Launchpad Development board
- Software driver (set of functions to create an abstract module)
- Motivation for lab

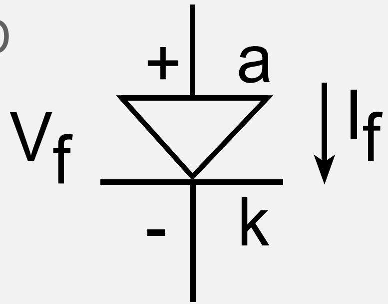


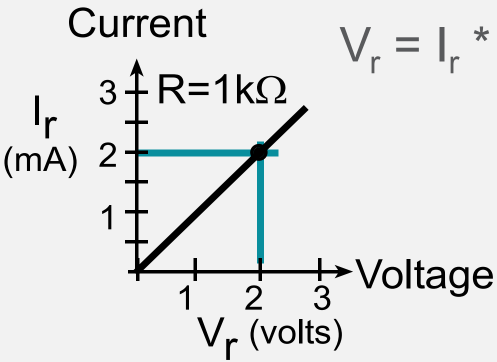
LED Interfacing

Resistor

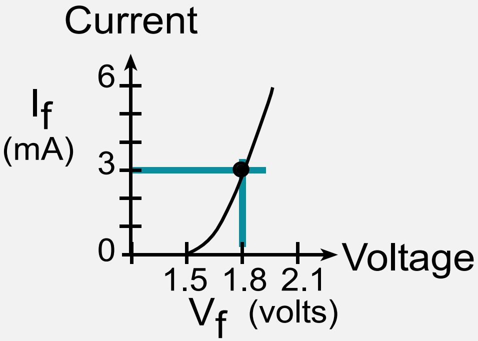


LED



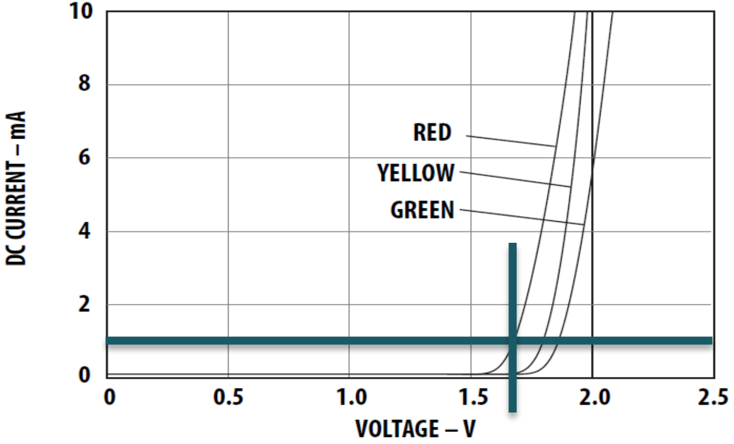


$V_r = I_r * R$



LED Interfacing

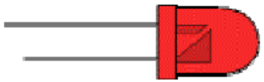
LED current vs voltage



1 mA, 1.6V

Brightness = power = V*I

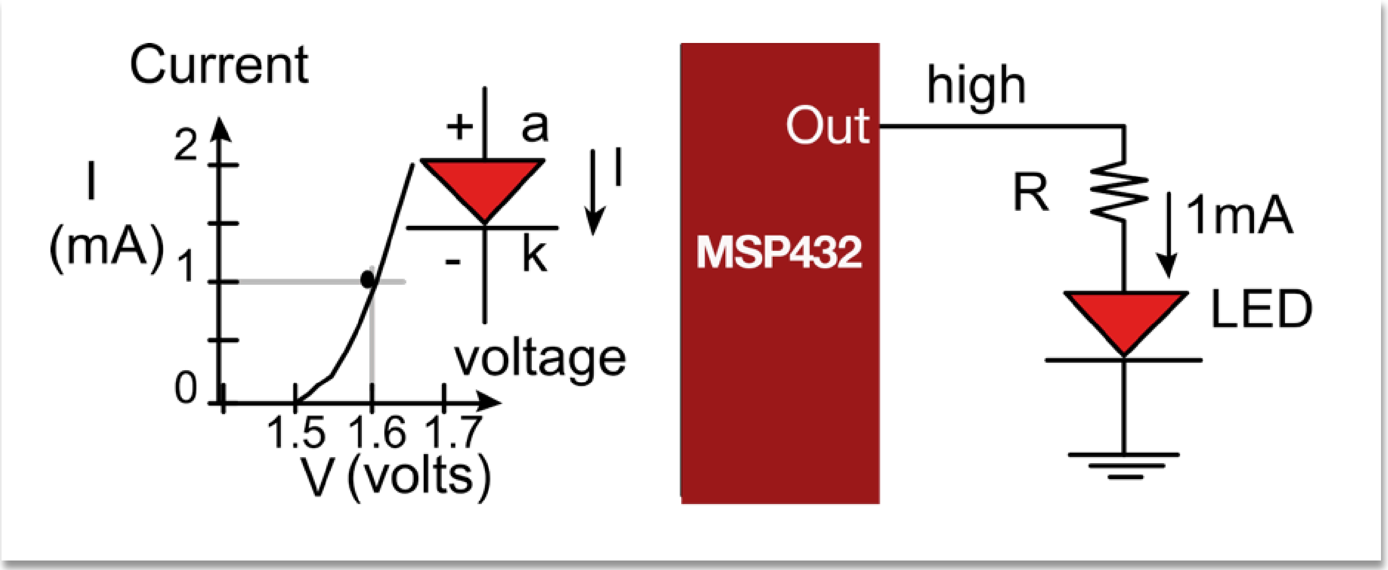
anode (+)



cathode (-)

“big voltage connects to big pin”

LED Interfacing (I < 6 mA), Positive Logic

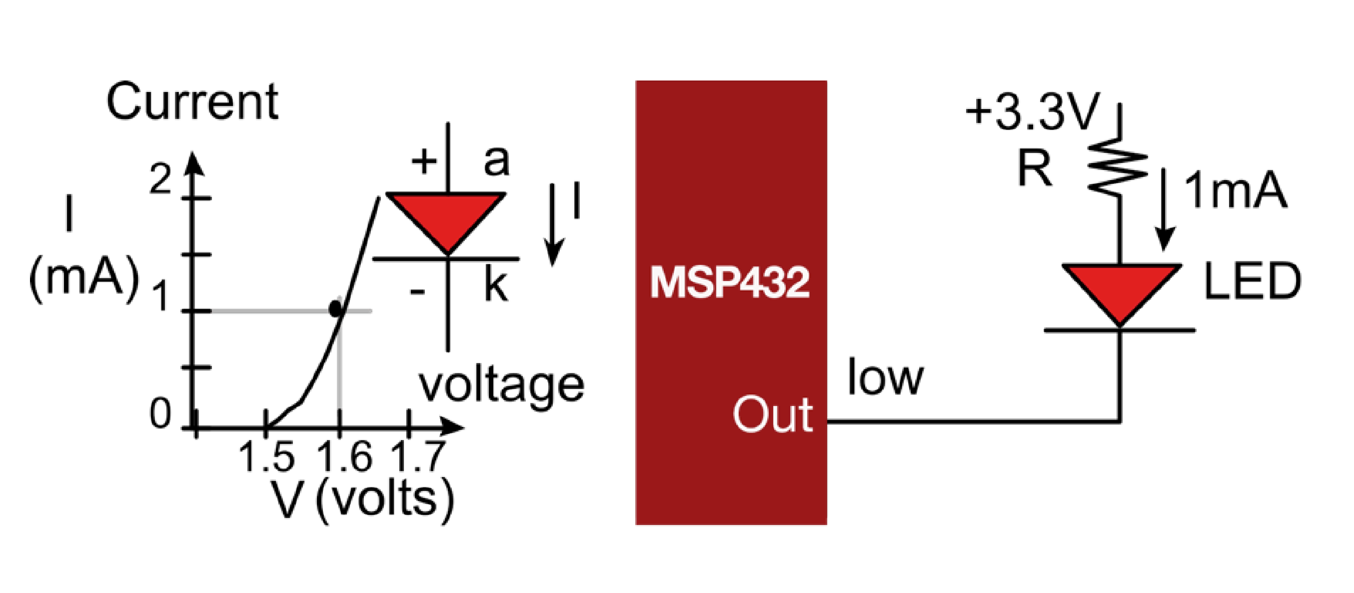


R = (3.3V – 1.6)/0.001A = 1.7 kΩ

Standard R = 1.6 kΩ

Brightness = power = V*I

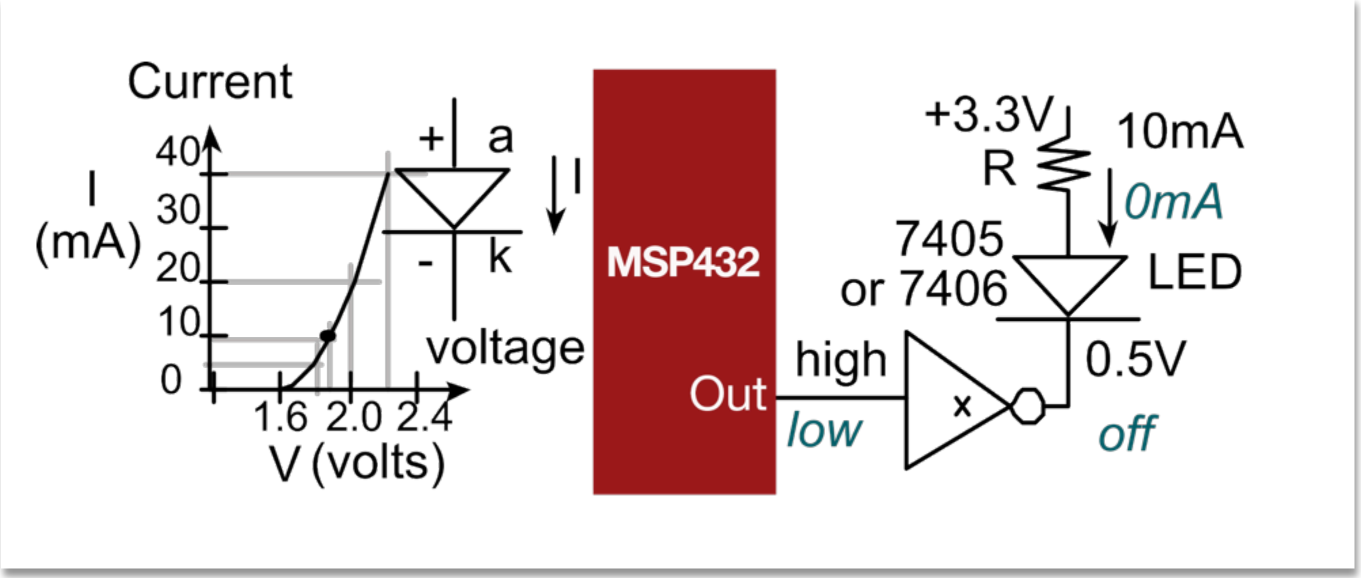
LED Interfacing (I < 6 mA), Negative Logic



R = (3.3V – 1.6)/0.001A = 1.7 kΩ
Standard R = 1.6 kΩ

Brightness = power = V*I

LED Interfacing (I > 6 mA)



LED may contain several diodes in series

R = (3.3-1.8-0.5)/0.01 = 100 Ω

Brightness = power = V*I

Software Driver (outputs)

Initialization (executed once at beginning)

1. Set *DIR* to 1 for output
2. Activate increased drive strength on output

Output to LED

1. Read from data output port
2. Modify bits as desired
3. Write to data output port

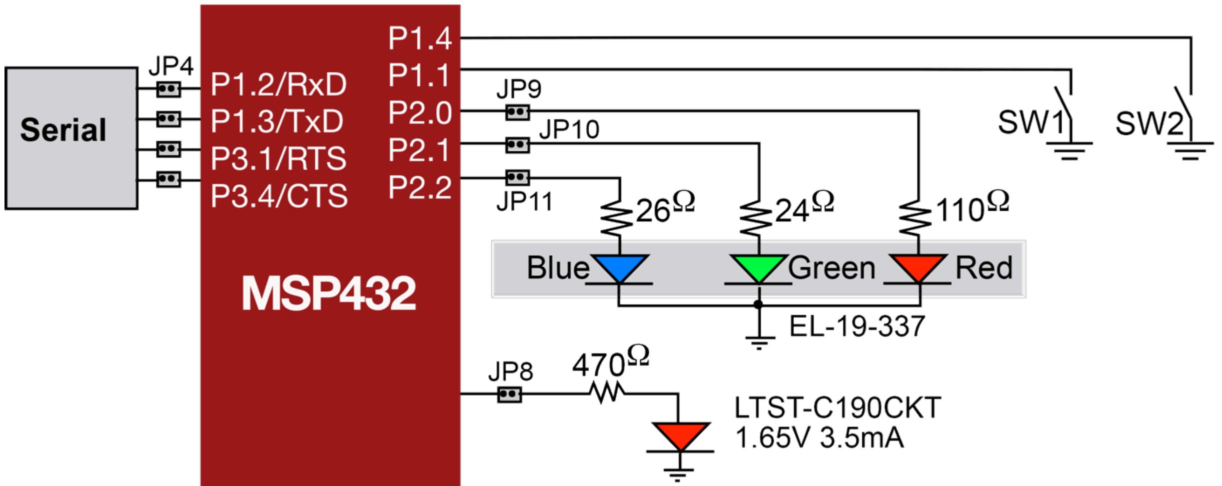
Set bit

```
data = P2->OUT;
data |= 0x01;
P2->OUT = data;
```

Clear bit

```
data = P2->OUT;
data = data&0xFE;
P2->OUT = data;
```

LaunchPad Switches and LEDs




```
P2->DS = 0x07;
```

The LEDs are positive logic

Software Driver (simple, not friendly)

```
#include "msp.h"
void Port2_Init(void){
  P2->DIR = 0x07;    // 1) make P2.2-P2.0 out
  P2->DS = 0x07;     // 2) activate increased drive strength
  P2->OUT = 0x00;    //    all LEDs off
}
void Port2_Output(uint8_t data){  // write P2.2-P2.0 outputs
  P2->OUT = data;
}
```

See **InputOutput_MSP432** example project

Software Driver (friendly)

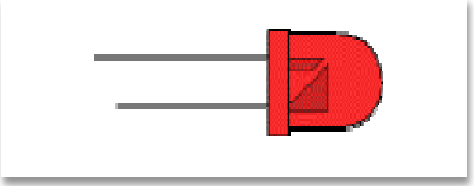
```
void Port2_Init(void){
  P2->DIR |= 0x07;    // 1) make P2.2-P2.0 out
  P2->DS |= 0x07;     // 2) activate increased drive strength
  P2->OUT &= ~0x07;   //    all LEDs off
}
void Port2_Output(uint8_t data){  // write P2.2-P2.0 outputs
  P2->OUT = (P2->OUT&0xF8)|data;
}
```

See **InputOutput_MSP432** example project

Application

Debugging

1. Control
2. Observability



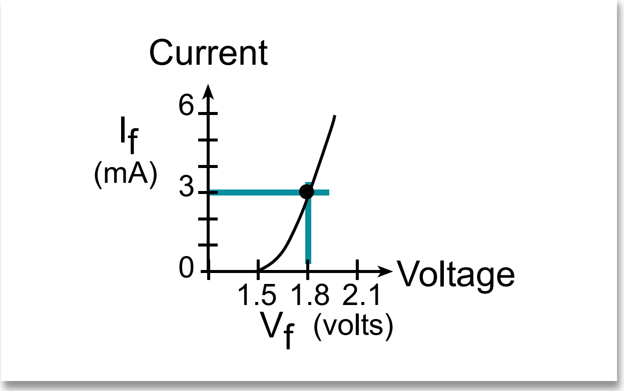
LEDs provide

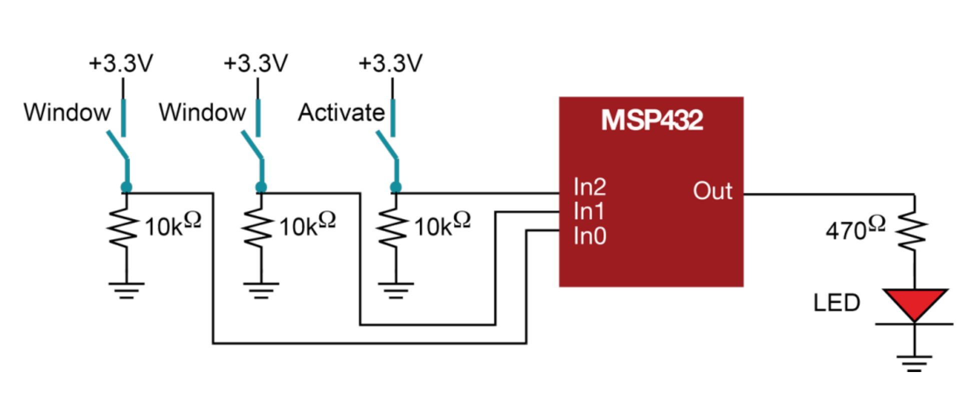
1. Diagnostic information for debugging (e.g., heartbeat)
2. Visualization of state (e.g., flashing rate signifies status)

Summary

- Positive and negative logic
- Ohm's Law for resistors
- LED nonlinear curve
- LED interface
  - Low current uses just a resistor
  - High current needs a driver
- Software driver
  - Initialization
  - Input/Output functions

$V_r = I_r * R$





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