EMBEDDED SYSTEMS LAB.

REPORT III

HACETTEPE UNIVERSITY

COMPUTER SCIENCE

DEPARTMENT

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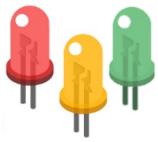
APPROACH LIGHTING SYSTEM

Three LEDs are lightened up with given order for 0.1 seconds each.

SWITCH IS NOT PRESSED: GREEN, YELLOW, RED, …

SWITCH IS PRESSED: RED, YELLOW, GREEN, …

STEP1: EQUIPMENT

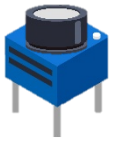


LEDS: Three 1.8V 2mA LEDs

$R = (V_{OH} – V_d)/I_d$

$= (3.0 – 1.8)/0.002$

$= 600\Omega$

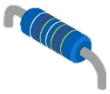


SWITCH: One B3F Tactile Switch

Switch is pressed: -0.1 mΩ

Switch is not pressed: +100 mΩ

RESISTORS: Three 470Ω resistors



RESISTORS: One 10kΩ resistor

Using 470Ω resistors:

$470\Omega = (3.0 – 1.8)/I_d$ $I_d = 0.0026$

Brighter light from LEDs is expected.

STEP1: I/O

One input for the switch and three outputs for the LEDs are decided.

INPUTS: PA5

OUTPUTS: PA4, PA6, PA7

PORTA initialization is done:

```
#define PA4  (*((volatile unsigned long *)0x40004040))
#define PA5  (*((volatile unsigned long *)0x40004080))
#define PA6  (*((volatile unsigned long *)0x40004100))
#define PA7  (*((volatile unsigned long *)0x40004200))

void PORTA_Init_4567(void){ volatile unsigned long delay;
  SYSCTL_RCGCGPIO_R |= 0x00000001;      // 1) activate clock for Port A
  delay = SYSCTL_RCGCGPIO_R;
  GPIO_PORTA_AMSEL_R &= ~0xF0;          // 2) disable analog on PA4-7
  GPIO_PORTA_PCTL_R &= ~0xFFFF0000;     // 3) PCTL GPIO on PA4-7
  GPIO_PORTA_DIR_R = 0xD0;              // 4) direction PA5 as input PA4, PA7, PA6 as output
  GPIO_PORTA_AFSEL_R &= ~0xF0;          // 5) PA4-7 regular port function
  GPIO_PORTA_DEN_R |= 0xF0;             // 6) enable PA4-7 digital port
}
```

ON

PA4: 0x10

PA6: 0x40

PA7: 0x80

OFF

PA4: 0x00

PA6: 0x00

PA7: 0x00

STEP2: SYSTICK TIMER

Loops are measured using SysTick Timer.

SYSTICK TIMER initialization is done:

```
#define NVIC_ST_CTRL_R      (*((volatile unsigned long *)0xE000E010))
#define NVIC_ST_RELOAD_R    (*((volatile unsigned long *)0xE000E014))
#define NVIC_ST_CURRENT_R   (*((volatile unsigned long *)0xE000E018))

void SysTick_Init(void){
  NVIC_ST_CTRL_R = 0;               // disable SysTick during setup
  NVIC_ST_CTRL_R = 0x00000005;      // enable SysTick with core clock
}
```

SYSTICK_WAIT and **SYSTICK_WAIT10MS** functions are created.

```
// The delay parameter is in units of the 80 MHz core clock. (12.5 ns)
void SysTick_Wait(unsigned long delay){
  NVIC_ST_RELOAD_R = delay-1;           // number of counts to wait
  NVIC_ST_CURRENT_R = 0;                // any value written to CURRENT clears
  while((NVIC_ST_CTRL_R&0x00010000)==0){ // wait for count flag
  }
}

// 800000*12.5ns equals 10ms
void SysTick_Wait10ms(unsigned long delay){
  unsigned long i;
  for(i=0; i<delay; i++){
    SysTick_Wait(800000);  // wait 10ms
  }
}
```

LEDs are lightened up 0.1 second each, SysTick_Wait10ms(10) function calls are performed.

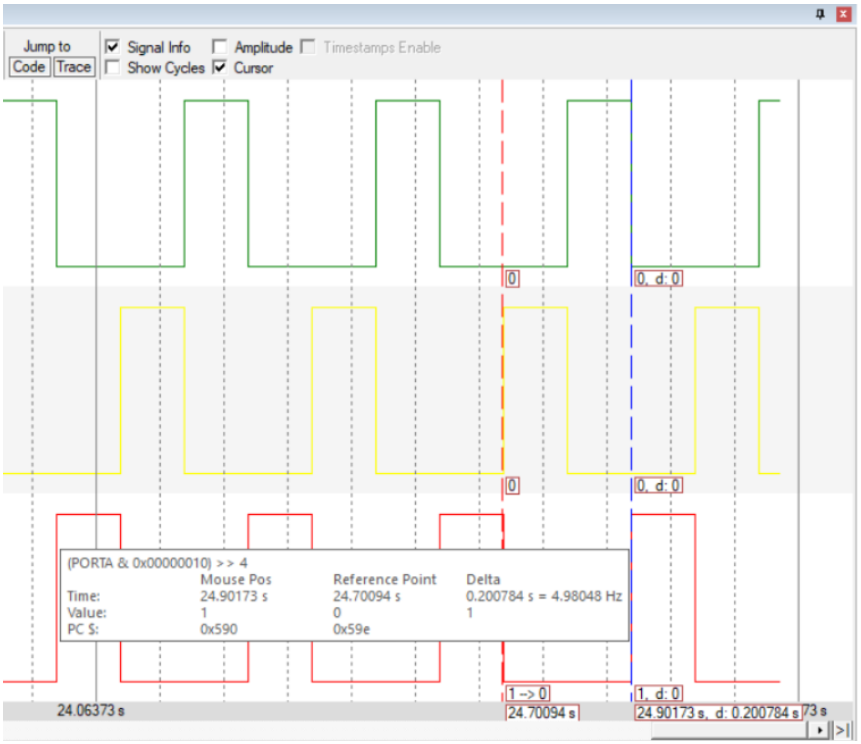
STEP3: PROGRAM

External circuit of the switch is implemented as negative logic and LEDs are as positive logic. When switch is not pressed, 1 is read from the **PA5** pin.

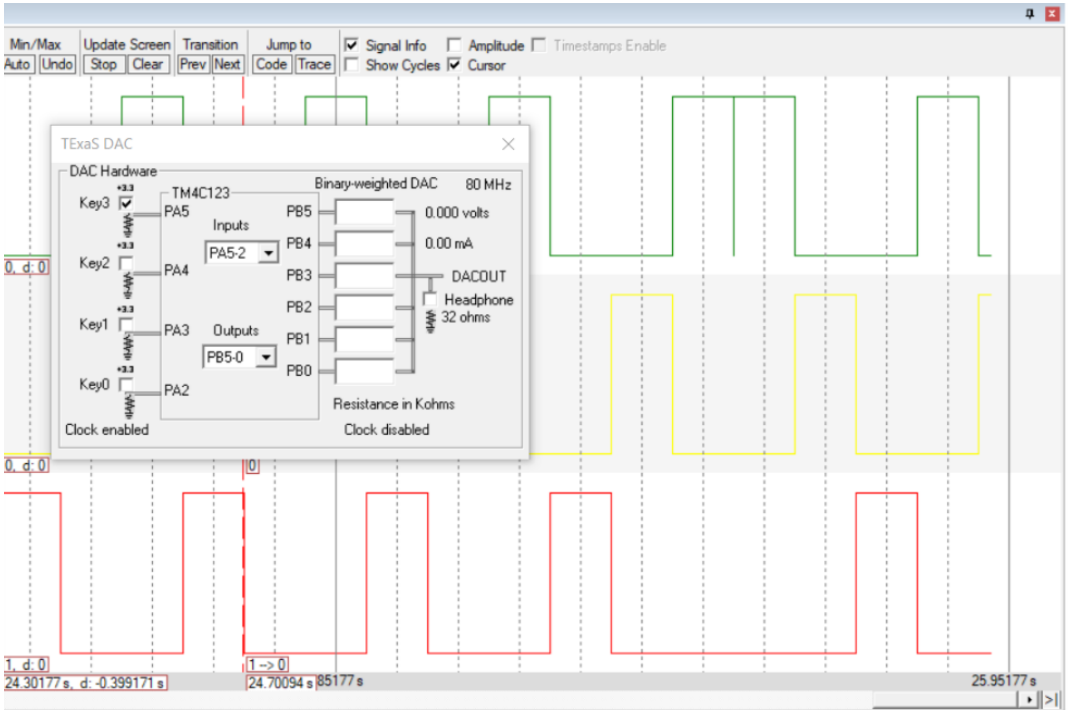
```
int main(void){
  SysTick_Init();
  PORTA_Init_4567();
  while(1){
    while(PA5&0x20){ // SWITCH IS NOT PRESSED
      PA7 = 0x80; SysTick_Wait10ms(10); PA7 = 0x00; // GREEN
      PA6 = 0x40; SysTick_Wait10ms(10); PA6 = 0x00; // YELLOW
      PA4 = 0x10; SysTick_Wait10ms(10); PA4 = 0x00; // RED
    }
    while(!(PA5&0x20)){ // SWITCH IS PRESSED
      PA4 = 0x10; SysTick_Wait10ms(10); PA4 = 0x00; // RED
      PA6 = 0x40; SysTick_Wait10ms(10); PA6 = 0x00; // YELLOW
      PA7 = 0x80; SysTick_Wait10ms(10); PA7 = 0x00; // GREEN
    }
  }
}
```

STEP4: SIMULATION

1. RED LED STAYS 0.2 SECONDS OFF

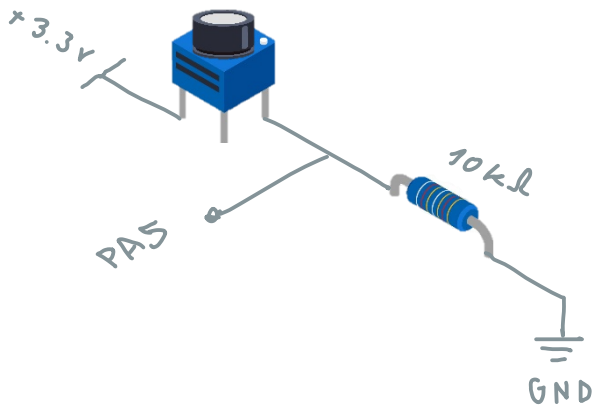


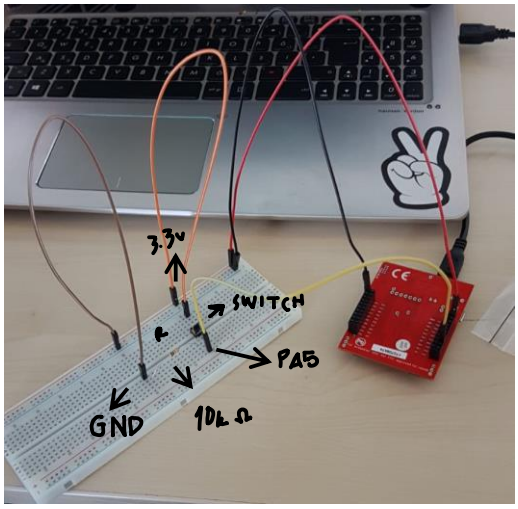
2. WHEN SWITCH IS PRESSED RED LED STAYS 0.4 SECONDS OFF



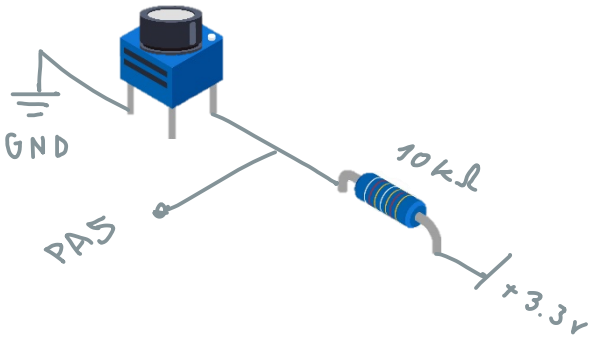
STEP5: SWITCHES

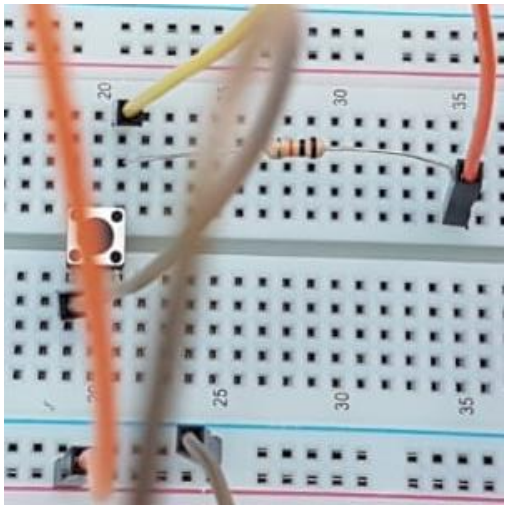
1. BUILD POSITIVE LOGIC SWITCH





2. BUILD NEGATIVE LOGIC SWITCH

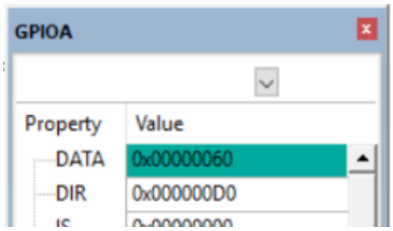


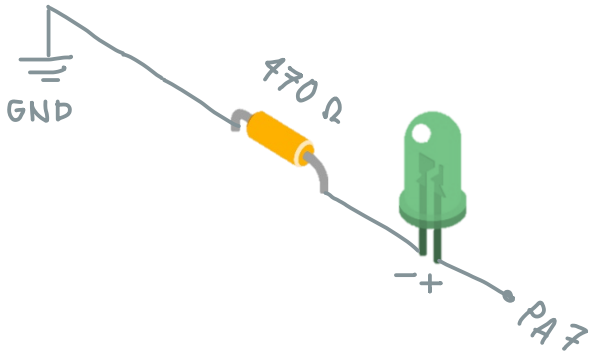


STEP6: LEDS

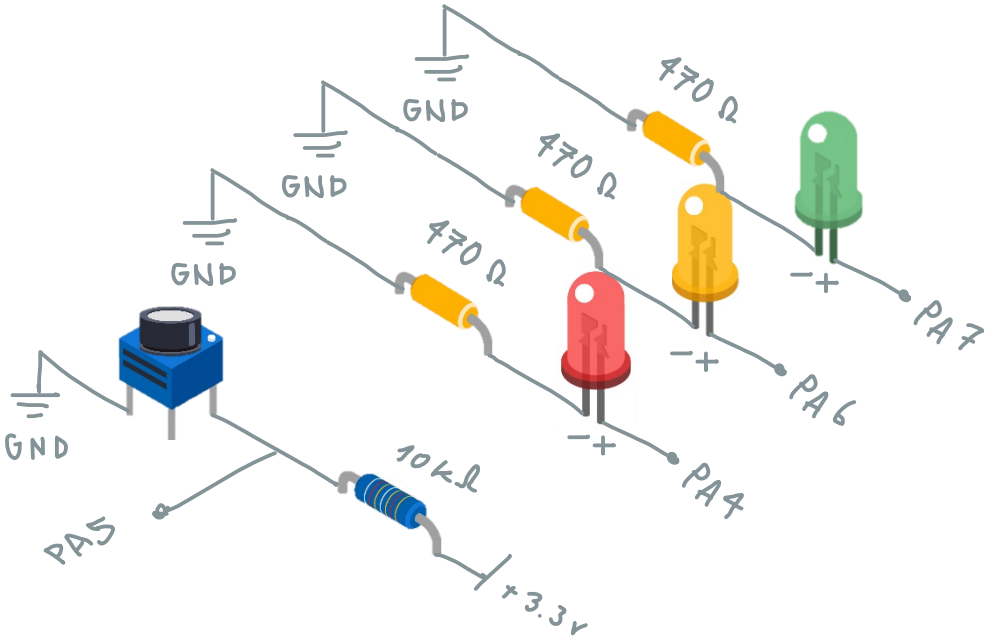
1. BUILD POSITIVE LOGIC LEDS

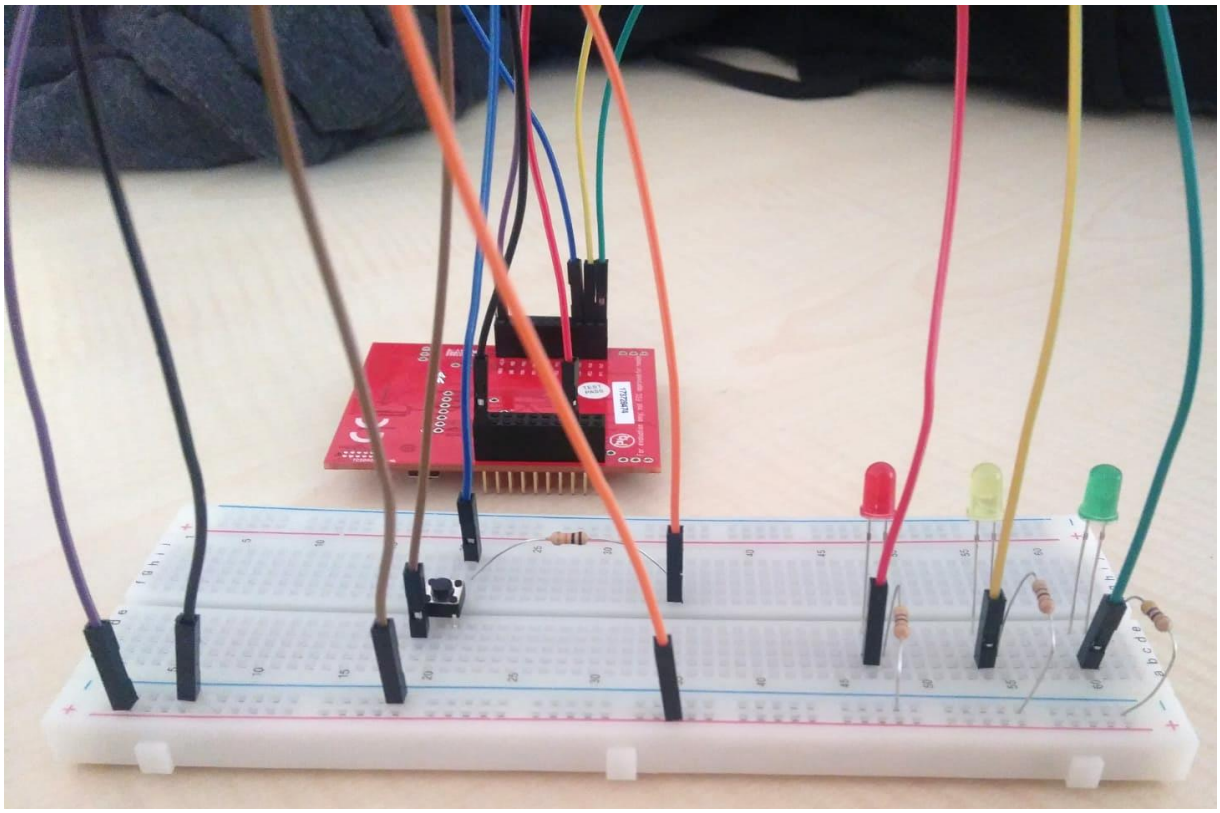
While switch is not pressed (PA5 is 1) and yellow LED (PA6) is lightened up GPIOA DATA register is read 0x00000060.



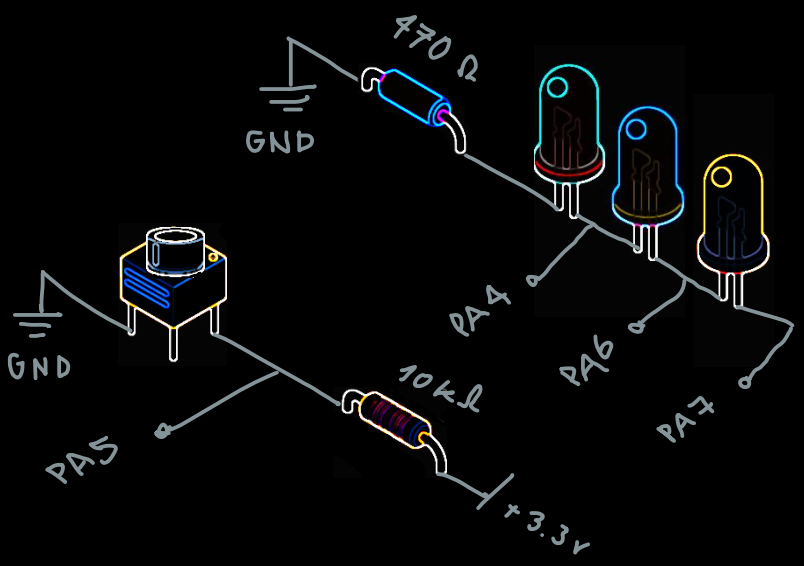


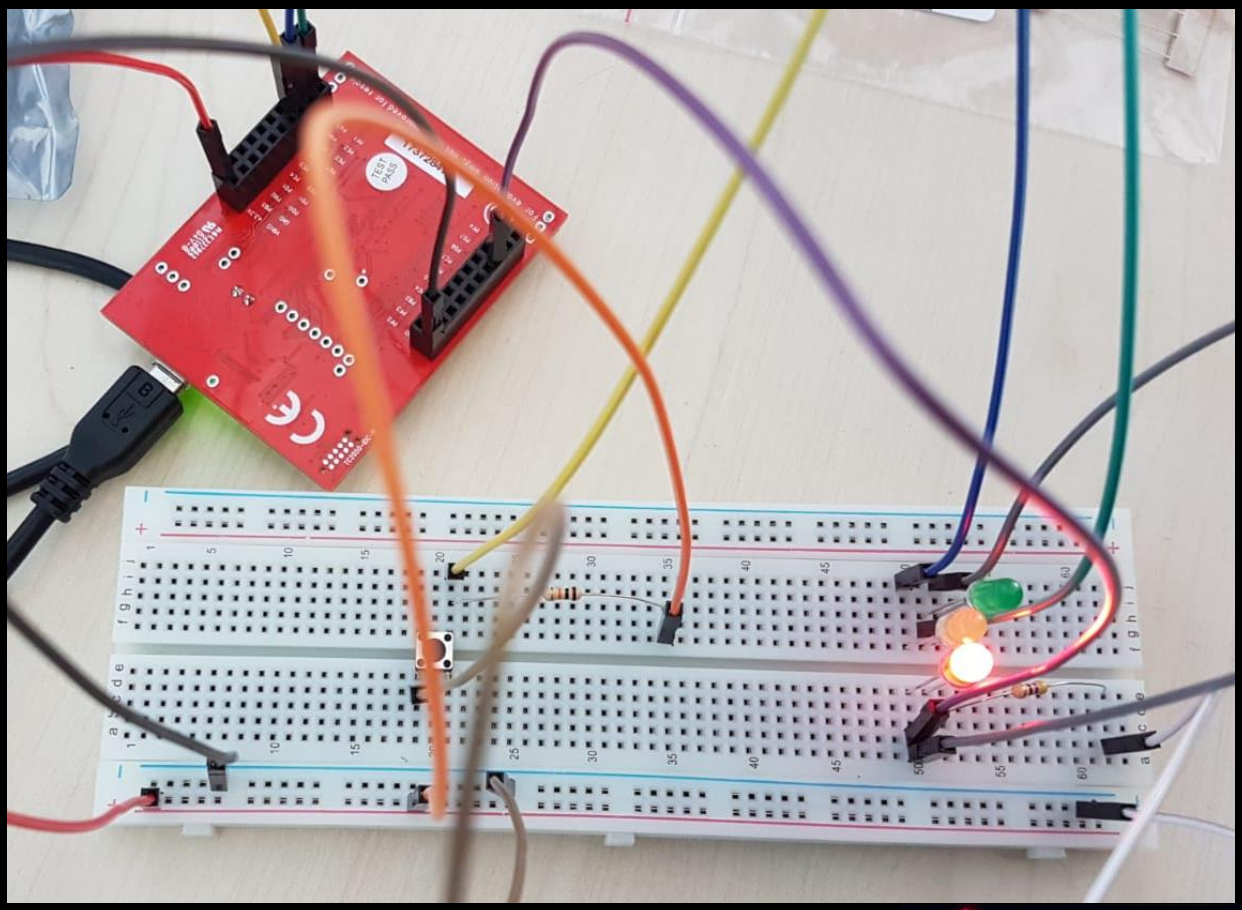
STEP7: CIRCUIT DESIGN





BONUS EXPERIMENT





BUT IT WORKED!...?