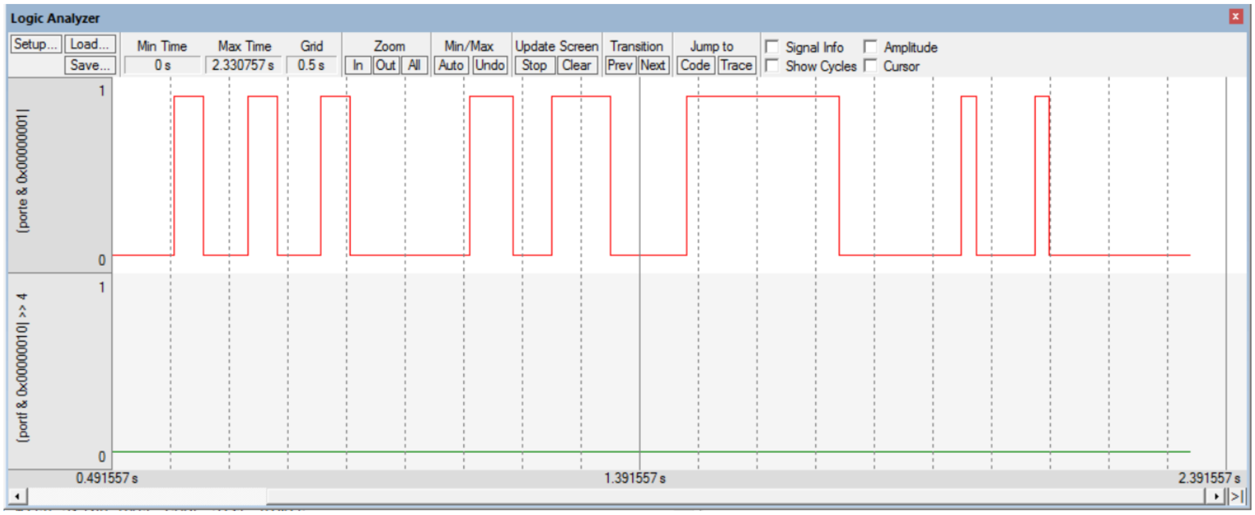
Daniel Canterino

Pranav Padmanabha

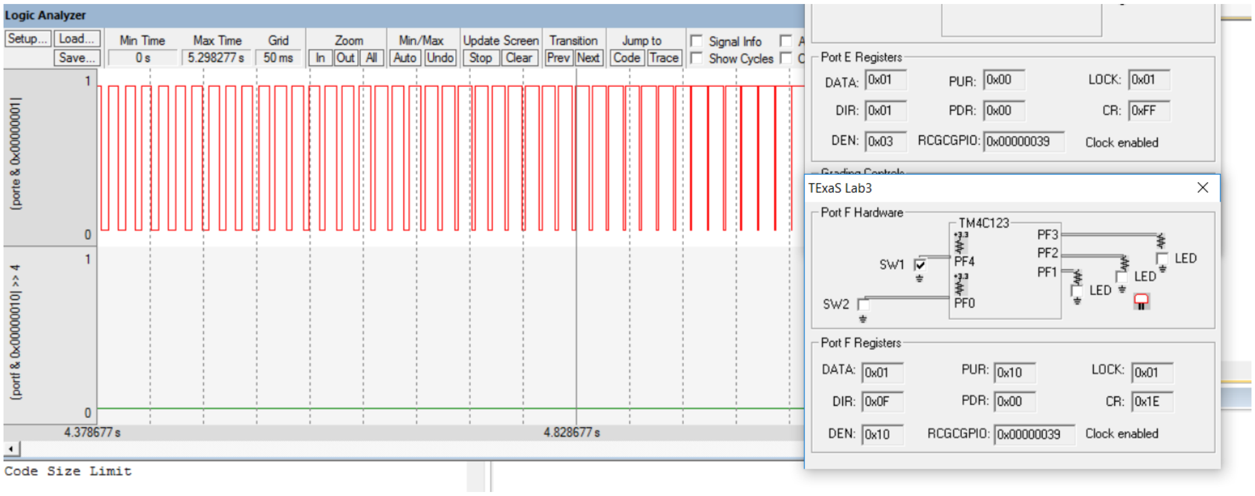
This image shows the duty cycle increasing by 20% each time the button is pressed



Logic Analyzer

Min Time: 0 s
Max Time: 2.330757 s
Grid: 0.5 s

This image shows the gradual increase/decrease that the led undergoes when breathing



Logic Analyzer

Min Time: 0 s
Max Time: 5.298277 s
Grid: 50 ms

Port E Registers

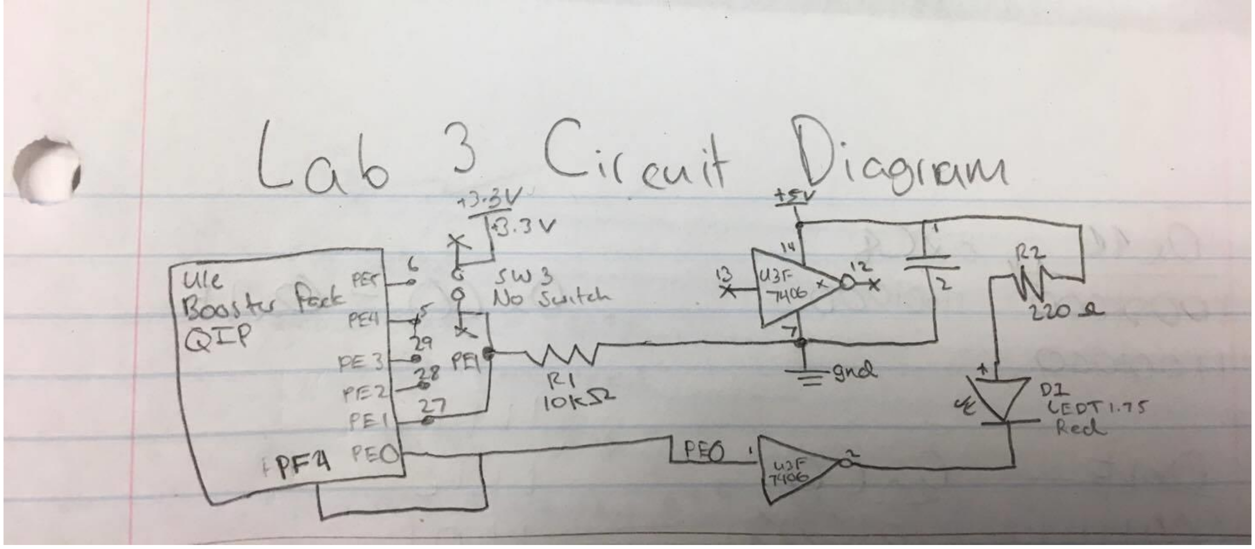
DATA: 0x01 PUR: 0x00 LOCK: 0x01
DIR: 0x01 PDR: 0x00 CR: 0xFF
DEN: 0x03 RCGCGPIO: 0x00000039 Clock enabled

TExaS Lab3

Port F Registers

DATA: 0x01 PUR: 0x10 LOCK: 0x01
DIR: 0x0F PDR: 0x00 CR: 0x1E
DEN: 0x10 RCGCGPIO: 0x00000039 Clock enabled

Code Size Limit



Switch Measurements

Parameter	Value	Units	Conditions
Resistance of the 10kΩ resistor, R1	9.92k	ohms	with power off and disconnected from circuit (measured with ohmmeter)
Supply Voltage, $V_{+3.3}$	3.24	volts	Powered (measured with voltmeter)
Input Voltage, V_{PE1}	0	volts	Powered, but with switch not pressed (measured with voltmeter)
Resistor current	0 0.01	mA	Powered, but switch not pressed $I=V_{PE1}/R1$ (calculated and measured with an ammeter)
Input Voltage, V_{PE1}	3.27	volts	Powered and with switch pressed (measured with voltmeter)
Resistor current	0.327 0.319	mA	Powered and switch pressed $I=V_{PE1}/R1$ (calculated and measured with an ammeter)

LED Measurements

Row	Parameter	Value	Units	Conditions
1	Resistance of the 220Ω resistor, R19	233	ohms	with power off and disconnected from circuit (measured with ohmmeter)
2	+5 V power supply V_{+5}	5.001	volts	(measured with voltmeter relative to ground, *notice that the +5V power is not exactly +5 volts*)
3	TM4C123 Output, V_{PE0} input to 7406	1.2	volts	with **PE0** = 0 (measured with voltmeter relative to ground)
s 4	7406 Output, V_{k-} LED k-	0.174	volts	with **PE0** = 0 (measured with voltmeter relative to ground)
5	LED a+, V_{a+} Bottom side of R19	2.128	volts	with **PE0** = 0 (measured with voltmeter relative to ground)
6	LED voltage	1.95	volts	calculated as V_{a+} - V_{k-}
7	LED current	0.0219 ———— 0.04	mA	calculated as (V_{+5} - V_{a+})/R19 and measured with an ammeter
8	TM4C123 Output, V_{PE0} input to 7406	3.28	volts	with **PE0** = 1 (measured with voltmeter relative to ground)
9	7406 Output, V_{k-} LED k-	2.98	volts	with **PE0** = 1 (measured with voltmeter relative to ground)
10	LED a+, V_{a+} Bottom side of R19	4.2(max)	volts	with **PE0** = 1 (measured with voltmeter relative to ground)
11	LED voltage	1.22	volts	calculated as V_{a+} - V_{k-}

12	LED current	3.6 3.4	mA	calculated as $(V_{+5} - V_{a+})$/R19 and measured with an ammeter

```
;****************** main.s ***************
; Program written by: Daniel Canterino and Pranav Padmanabha
; Date Created: 2/4/2017
; Last Modified: 2/4/2017
; Brief description of the program
;   The LED toggles at 8 Hz and a varying duty-cycle
; Hardware connections (External: One button and one LED)
;  PE1 is Button input  (1 means pressed, 0 means not pressed)
;  PE0 is LED output (1 activates external9 LED on protoboard)
;  PF4 is builtin button SW1 on Launchpad (Internal)
;        Negative Logic (0 means pressed, 1 means not pressed)
; Overall functionality of this system is to operate like this
;   1) Make PE0 an output and make PE1 and PF4 inputs.
;   2) The system starts with the the LED toggling at 8Hz,
;      which is 8 times per second with a duty-cycle of 20%.
;      Therefore, the LED is ON for (0.2*1/8)th of a second
;      and OFF for (0.8*1/8)th of a second.
;   3) When the button on (PE1) is pressed-and-released increase
;      the duty cycle by 20% (modulo 100%). Therefore for each
;      press-and-release the duty cycle changes from 20% to 40% to 60%
;      to 80% to 100%(ON) to 0%(Off) to 20% to 40% so on
;   4) Implement a "breathing LED" when SW1 (PF4) on the Launchpad is pressed:
;      a) Be creative and play around with what "breathing" means.
;         An example of "breathing" is most computers power LED in sleep mode
;        (e.g., https://www.youtube.com/watch?v=ZT6siXyIjvQ).
;      b) When (PF4) is released while in breathing mode, resume blinking at 8Hz.
;        The duty cycle can either match the most recent duty-
;        cycle or reset to 20%.
;      TIP: debugging the breathing LED algorithm and feel on the simulator is impossible.
; PortE device registers
GPIO_PORTE_DATA_R  EQU 0x400243FC
GPIO_PORTE_DIR_R   EQU 0x40024400
GPIO_PORTE_AFSEL_R EQU 0x40024420
GPIO_PORTE_DEN_R   EQU 0x4002451C
; PortF device registers
GPIO_PORTF_DATA_R  EQU 0x400253FC
GPIO_PORTF_DIR_R   EQU 0x40025400
GPIO_PORTF_AFSEL_R EQU 0x40025420
GPIO_PORTF_PUR_R   EQU 0x40025510
GPIO_PORTF_DEN_R   EQU 0x4002551C

GPIO_PORTF_CR_R    EQU 0x40025524;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;

SYSCTL_RCGCGPIO_R  EQU 0x400FE608
               PRESERVE8;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
      IMPORT  TExaS_Init
      AREA    |.text|, CODE, READONLY, ALIGN=2
      THUMB
      EXPORT  Start
Start
 ; TExaS_Init sets bus clock at 80 MHz
     BL  TExaS_Init ; voltmeter, scope on PD3
     CPSIE  I    ; TExaS voltmeter, scope runs on interrupts
```

```
          LDR R1, = SYSCTL_RCGCGPIO_R          ;ACTIVATE THE CLOCK FOR PORT F AND PORT E
          LDR R0, [R1]
          ORR R0, R0, #0x30                        ;SET BIT 4 AND 5 TO TURN ON CLOCK
          STR R0, [R1]

          NOP
          NOP

          LDR R1, =GPIO_PORTF_DIR_R            ;SET PORT F PIN 4 AS INPUT
          MOV R0, #0x00
          STR R0, [R1]

          LDR R1, =GPIO_PORTE_DIR_R            ;SET PORT E PIN 0 AS OUTPUT AND PIN 1 AS
INPUT
          MOV R0, #0x01
          STR R0, [R1]

          LDR R1, =GPIO_PORTF_PUR_R            ;ENABLE PULL UP FOR PIN 4
          MOV R0, #0x10
          STR R0, [R1]

          LDR R1, =GPIO_PORTF_DEN_R            ;ENABLE PORT F DIGITAL PORT
          MOV R0, #0x10
          STR R0, [R1]

          LDR R1, =GPIO_PORTE_DEN_R            ;ENABLE PORT E DIGITAL PORT
          MOV R0, #0x03
```

```
                    STR R0, [R1]

;                   LDR      R1, =GPIO_PORTF_CR_R
;                   MOV R0, #0xFF
;                   STR R0, [R1]



                              MOV R5, #2

loop

CHECK               MOV R2, #0


                              LDR      R1, =GPIO_PORTF_DATA_R                          ;checks to see if the
switch on the board has been pressed
                              LDR R0, [R1]
                              MOV R2, R0
                              AND R2, R2, #0x10
                              CMP R2, #0
                              BEQ BREATH                                                                      ;if
pressed go to the breathing function



;;;;;;;;;;;;;;;CHECK PORT F;;;;;;;;;;;;;;;;;;
                              LDR      R1, =GPIO_PORTE_DATA_R                                    ;check to see if
the button has been pressed
                              LDR R0, [R1]
                              AND R2, R0, #0x02
                    CMP     R2, #0x02

                    BEQ     RELEASE
        ;if it has go to wait till its been released

                    BNE DET_STATE                                       ;if not pressed,
execute the current state


                    B    loop


BREATH      BL BREATH_WORK                                              ;do the breath
function

                    B CHECK
        ;once done, go back and check to see if new buttons have been pressed


RELEASE             MOV R2, #0                                              ;stay
here till button has been released

                    LDR R1, =GPIO_PORTE_DATA_R

                    LDR     R0, [R1]

                    AND     R2, R0, #0x02

                    CMP     R2, #0x02

                    BEQ     RELEASE

                    BL  ADD_STATE                                       ;once released,
go to the next state


ADD_STATE   ADD R5, R5, #2                                      ;sets next state

DET_STATE   CMP     R5, #12                                             ;this function
will check to see what state should be executed. once the state is identified, it is executed

                    BEQ ZERO

                    CMP R5, #0

                    BEQ ZERO

                    CMP R5, #2

                    BEQ TWENTY
```

```
                        CMP R5, #4
                        BEQ FOURTY
                        CMP R5, #6
                        BEQ SIXTY
                        CMP R5, #8
                        BEQ EIGHTY
                        BL  HUNDY

ZERO            MOV     R5, #0                                          ;zero percent
duty cycle
                        BL TURN_OFF
                        BL CHECK

;;;;;;;;;;;; R6 WILL BE COUNTER FOR ON R7 WILL BE INVERSE;;;;;;;;;;;;;;R7=100-R6

TWENTY                  MOV R5, #2                                                  ;twenty
percent duty cycle
                        BL TURN_ON
                        MOV R6, #20
                        MOV R7, #80
TWENTY_D        BL      DELAY
                        SUB R6, R6, #1
                        CMP R6, #0
                        BNE TWENTY_D
                        BL TURN_OFF
TWENTY_O        BL DELAY
                        SUB R7, R7, #1
                        CMP R7, #0
                        BNE TWENTY_O
                        BL      CHECK



FOURTY                  MOV     R5, #4                                                   ;fourty
percent duty cycle

                        BL TURN_ON

                        MOV R6, #40

                        MOV R7, #60

FOURTY_D        BL      DELAY

                        SUB R6, R6, #1

                        CMP R6, #0

                        BNE FOURTY_D

                        BL TURN_OFF

FOURTY_O        BL DELAY

                        SUB R7, R7, #1

                        CMP     R7, #0

                        BNE FOURTY_O

                        BL      CHECK



SIXTY           MOV R5, #6                                                       ;sixty percent
duty cycle

                        BL TURN_ON

                        MOV R6, #60

                        MOV R7, #40

SIXTY_D                 BL      DELAY

                        SUB R6, R6, #1
                        CMP R6, #0
                        BNE SIXTY_D
                        BL TURN_OFF
SIXTY_O                 BL DELAY
                        SUB R7, R7, #1
                        CMP     R7, #0
                        BNE SIXTY_O
                        BL      CHECK



EIGHTY          MOV R5, #8                                                      ;eighty percent
duty cycle
                        BL TURN_ON
                        MOV R6, #80
                        MOV R7, #20
EIGHTY_D        BL      DELAY
                        SUB R6, R6, #1
                        CMP R6, #0
                        BNE EIGHTY_D
                        BL TURN_OFF
EIGHTY_O        BL DELAY
                        SUB R7, R7, #1
                        CMP     R7, #0
                        BNE EIGHTY_O
                        BL      CHECK
```

```
HUNDY           MOV R5, #10                                                             ;hundred
percent duty cycle

                        BL TURN_ON

                        BL CHECK




TURN_ON                 LDR R1, =GPIO_PORTE_DATA_R                      ;turns on LED

                        LDR     R0, [R1]

                        ORR     R0, #0x01

                        STR     R0, [R1]

                        BX  LR


TURN_OFF        LDR R1, =GPIO_PORTE_DATA_R                              ;turns off LED

                        LDR     R0, [R1]

                        BIC     R0, #0x01

                        STR     R0, [R1]

                        BX  LR



DELAY           MOV R0, #20000                                          ;ASSUMING THAT THIS DELAY IS
WILL BE FOR 1.25 MILLI SECOND = 1 percent of an 1/8th of a second

WAIT            SUBS R0, R0, #1

                        CMP     R0, #0

                        BNE WAIT

                        BX      LR



;;;;;;;;;;;;;;;; R6 HAS THE OFF DELAY TIME;;;;;;;;; R7 HAS THE ON DELAY TIME
```

;;;;;This subroutine will increase the duty cycle everytime providing a increased glow until 100 percent duty cycle. Then it does the reverse.

```
BREATH_WORK PUSH{LR}
                      MOV R6, #100
                      MOV R7, #0

BACK            MOV R8, R6;;;;;;R8 NOW HAS VALUE EQUIVALENT TO R6
                      MOV R9, R7;;;;;;R9 NOW HAS VALUE EQUIVALENT TO R7
                      BL TURN_OFF
BREATH_OFF    BL DELAY_B
                      SUB R8, R8, #1
                      CMP R8, #0
                      BNE BREATH_OFF
                      BL TURN_ON
BREATH_ON     BL DELAY_B
                      SUB R9, R9, #1
                      CMP R9, #-1
                      BNE BREATH_ON
                      SUB R6, R6, #1
                      ADD R7, R7, #1
                      CMP R6, #0
                      BNE BACK

                      MOV R6, #100
                      MOV R7, #0

BACK_2          MOV R8, R6
                      MOV R9, R7
                      BL TURN_ON
```

```
BREATH_ON_2  BL DELAY_B
                        SUB R8, R8, #1
                        CMP R8, #0
                        BNE BREATH_ON_2
                        BL TURN_OFF
BREATH_OF_2   BL DELAY_B
                        SUB R9, R9, #1
                        CMP R9, #-1
                        BNE BREATH_OF_2
                        SUB R6, R6, #1
                        ADD R7, R7, #1
                        CMP R6, #0
                        BNE BACK_2

                        POP {LR}
                        BX LR




DELAY_B                 MOV R0, #2500                       ;this is decreased delay for the breathing to make the transitions smoother.
WAIT_B          SUBS R0, R0, #1
                        CMP     R0, #0
                        BNE WAIT_B
                        BX      LR
```

```
ALIGN      ; make sure the end of this section is aligned

END        ; end of file
```