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**Part d)** After you have debugged your system in simulation mode, you will implement it on the real board. Use the same ports you used during simulation. The first step is to interface three push button switches for the sensors. You should implement positive logic switches. *Do not place or remove wires on the protoboard while the power is on.* Build and test the switch circuits. You should also use the debugger to observe the input pin to verify the proper operation of the interface similar to Lab 8.

The next step is to build the six LED output circuits. Build the system physically in a shape that matches a traffic intersection. You will use the PF3-2-1 LED interface for the walk light (green for walk and red for don't walk). Write a simple main program to test the LED interface, similar to the way you tested Lab 8.

**Part e)** Debug your combined hardware/software system on the actual LaunchPad.

Help

During the real board grading you will have to push the sensors so that the four cases are tested (just west, just south, just walk, and all three).

## REAL-BOARD GRADER

DR. JONATHAN VALVANO: Let's walk through the steps

to get a grade for the lab 10 Real Board.

We take the number from edX, copy, we go over to Keil.

This is a Real Board, so we have to make sure

that the debugger is set up in Real Board mode, which it is.

We're going to build, which is to compile.

We're going to download the code for the Real Board.

Download, download, download.

We're going to now enter the debugger for the Real Board.

Just like most of the other Real Board graders,

we're going to interact with this window,

and the program has to be running in order to be graded.

So we start the running.

Our number from edX is going to be pasted right here.

That was our number.

OK.

And so when we're ready to start, we're going to push the grading button here.

OK.

And again, we're going to watch the action message

window to see what to do.

So we push the grading button here, and we see it tells me to wait.

So I'm over here waiting.

Waiting while it checks the initialization.

It checks all the settings to make sure it's configured properly,

and it says to release.

Push and hold the west switch.

This is the west switch.

Push and hold the west switch.

Now it says to push and hold the south switch.

There we are.

Push and hold the south switch.

Push and hold the west switch again.

Oh, it's very bossy.

OK, pushing.

Now it says push the Walk button.

So I'm pushing the walk button.

It's running through all the tests.

You can see the green light is on.

Now it wants me to push and hold all three buttons at once.

OK.

Pushing and holding all three.

And holding all three buttons down, checking the

Don't Walk, checking the Green, checking the South.

Almost there.

90 points.

Come on.

95.

We're getting closer.

Checking the walk button to see how it cycles through all of the sequences.

And the Walk light is on, and I passed.

100.

Good work.

All right.

We take this ASCII string, copy, we go back to edX, paste it in this field

here, and we push the check button.

**What Real TExaS is looking for in Lab 10.**

1) "Checking the TExaS_Init() in parameter" This verifies that the first parameter to TExaS_Init() is one of the enumerated types specified in TExaS.h with the expected number value. This first parameter tells TExaS which port you are using for inputs. If you are using the correct and unmodified TExaS.h for this lab, and if your program compiled, then this test will always pass.

2) "Checking the TExaS_Init() out parameter" This verifies that the second parameter to TExaS_Init() is one of the enumerated types specified in TExaS.h with the expected number value. This second parameter tells TExaS which port you are using for outputs. If you are using the correct and unmodified TExaS.h for this lab, and if your program compiled, then this test will always pass.

3) "Checking the SysTick control register" SysTick must get its clock from the system clock; SysTick interrupts must be disabled; SysTick must be enabled.

4) "Checking the input port clock" The GPIO module specified by the first parameter to TExaS_Init() must have its clock enabled in the legacy register RCGC2. If you use the new RCGCGPIO register, your program might work, but it will not pass this test.

5) "Checking the output port clock" The GPIO module specified by the second parameter to TExaS_Init() must have its clock enabled in the legacy register RCGC2. If you use the new RCGCGPIO register, your program might work, but it will not pass this test.

6) "Checking the Port F clock" GPIO Port F must have its clock enabled in the legacy register RCGC2. If you use the new RCGCGPIO register, your program might work, but it will not pass this test.

7) "Checking the input AMSEL reg." Since all inputs for this lab are digital, the analog functionality must be disabled for all input pins. The appropriate bits of the appropriate AMSEL register must be 0.

8) "Checking the output AMSEL reg." Since all outputs for this microcontroller are digital, the analog functionality must be disabled for all output pins. The appropriate bits of the appropriate AMSEL register must be 0.

9) "Checking the Port F AMSEL reg." Since the red and green LEDs (here used as “walk” and “don’t walk” lights) on Port F are digital, the analog functionality must be disabled for bits 1 and 3. Bits 1 and 3 of the GPIO_PORTF_AMSEL_R register must be 0.

10) "Checking the input port PCTL reg." All pins being used as inputs are standard GPIO inputs. The appropriate bit fields of the appropriate PCTL register must be 0.

11) "Checking the output port PCTL reg." All pins being used as outputs are standard GPIO outputs. The appropriate bit fields of the appropriate PCTL register must be 0.

12) "Checking the Port F port PCTL reg." The red and green LEDs on Port F are standard GPIO outputs. Bits 15-12 and 7-4 of the GPIO_PORTF_PCTL_R register must be 0.

13) "Checking the input direction register" To make a GPIO pin an input, clear the corresponding bit in the direction register. The appropriate bits of the appropriate DIR register must be 0.

14) "Checking the output direction register" To make a GPIO pin an output, set the corresponding bit in the direction register. The appropriate bits of the appropriate DIR register must be 1.

15) "Checking the Port F direction register" To make the pins connected to the red and green LEDs on Port F outputs, set bits 1 and 3 in the direction register. Bits 1 and 3 of the GPIO_PORTF_DIR_R register must be 1.

16) "Checking the input AFSEL register" No inputs for this lab use the alternate function, so the alternate function must be disabled for all input pins. The appropriate bits of the appropriate AFSEL register must be 0.

17) "Checking the output AFSEL register" No outputs for this lab use the alternate function, so the alternate function must be disabled for all output pins. The appropriate bits of the appropriate AFSEL register must be 0.

18) "Checking the Port F AFSEL register" The red and green LEDs on Port F do not use the alternate function, so the alternate function must be disabled for bits 1 and 3. Bits 1 and 3 of the GPIO_PORTF_AFSEL_R register must be 0.

19) "Checking the input pullup PUR register" No internal pull-up resistors are allowed. Switches must be positive logic. The appropriate bits of the appropriate PUR register must be 0.

20) "Checking the output pullup PUR register" Outputs do not need internal pull-up resistors. The appropriate bits of the appropriate PUR register must be 0.

21) "Checking the Port F pullup PUR register" The red and green LEDs on Port F do not need internal pull-up resistors. Bits 1 and 3 of the GPIO_PORTF_PUR_R register must be 0.

22) "Checking the input pulldown PDR register" External pull-down resistors must be used with the positive-logic switches. The appropriate bits of the appropriate PDR register must be 0.

23) "Checking the output pulldown PDR register" Outputs do not need internal pull-down resistors. The appropriate bits of the appropriate PDR register must be 0.

24) "Checking the Port F pulldown PDR register" The red and green LEDs on Port F do not need internal pull-down resistors. Bits 1 and 3 of the GPIO_PORTF_PDR_R register must be 0.

25) "Checking the input DEN register" Since all inputs for this lab are digital, the digital functionality must be enabled for all input pins. The appropriate bits of the appropriate DEN register must be 1.

26) "Checking the output DEN register" Since all outputs for this microcontroller are digital, the digital functionality must be enabled for all output pins. The appropriate bits of the appropriate DEN register must be 1.

27) "Checking the Port F DEN register" Since the red and green LEDs on Port F are digital, the digital functionality must be enabled for bits 1 and 3. Bits 1 and 3 of the GPIO_PORTF_DEN_R register must be 1.

28) "Checking all switches released" Release all switches and allow your machine to settle to its initial state. The initial state is not specified in the assignment. To pass this test, you have 10 seconds for all three switch input pins to read a 0 at the same time. All switches must be positive-logic.

29) "Checking west switch pressed" Press and hold the switch that corresponds to the car sensor in the west lane while releasing the other two switches. To pass this test, you have 10 seconds for the west switch input pin to read a 1 while the other two input pins read a 0.

30) "Checking west green/south red" Keep holding the west switch while releasing the other two switches. Your FSM should eventually cycle to the state where the west lane is green, the south lane is red, and the “walk” LED is red. How long this takes depends on the length of your delays and how many states are between the initial state and the “west green” state. The assignment requires your delays to be unrealistically short for ease of testing. To pass this test, you have 30 seconds for the west green LED, south red LED, and “don’t walk” LEDs to be on. All other LEDs must be off.

31) "Checking south switch pressed" Press and hold the switch that corresponds to the car sensor in the south lane while releasing the other two switches. To pass this test, you have 10 seconds for the south switch input pin to read a 1 while the other two input pins read a 0.

32) "Checking west yellow/south red" Keep holding the south switch while releasing the other two switches. Your FSM should quickly cycle to the “west yellow” state. To pass this test, you have 10 seconds for the west yellow LED, south red LED, and “don’t walk” LEDs to be on. All other LEDs must be off.

33) "Checking west red/south green" Keep holding the south switch while releasing the other two switches. Your FSM should quickly cycle to the “south green” state. To pass this test, you have 10 seconds for the west red LED, south green LED, and “don’t walk” LEDs to be on. All other LEDs must be off.

34) "Checking west switch pressed" Press and hold the switch that corresponds to the car sensor in the west lane while releasing the other two switches. To pass this test, you have 10 seconds for the west switch input pin to read a 1 while the other two input pins read a 0.

35) "Checking west red/south yellow" Keep holding the west switch while releasing the other two switches. Your FSM should quickly cycle to the “south yellow” state. To pass this test, you have 10 seconds for the west red LED, south yellow LED, and “don’t walk” LEDs to be on. All other LEDs must be off.

36) "Checking west green/south red" Keep holding the west switch while releasing the other two switches. Your FSM should quickly cycle to the “west green” state. To pass this test, you have 10 seconds for the west green LED, south red LED, and “don’t walk” LEDs to be on. All other LEDs must be off.

37) "Checking walk switch pressed" Press and hold the switch that corresponds to the pedestrian sensor while releasing the other two switches. To pass this test, you have 10 seconds for the walk switch input pin to read a 1 while the other two input pins read a 0.

38) "Checking west yellow/south red" Keep holding the walk switch while releasing the other two switches. Your FSM should quickly cycle to the “west yellow” state. To pass this test, you have 10 seconds for the west yellow LED, south red LED, and “don’t walk” LEDs to be on. All other LEDs must be off.

39) "Checking west red/south red" Keep holding the walk switch while releasing the other two switches. Your FSM should quickly cycle to the “walk” state. To pass this test, you have 10 seconds for the west red LED and south red LED to be on. The “walk” LEDs should be green, but it will be checked in the next step (this step only looks at Port A, Port B, or Port E and the “walk”/”don’t walk” LEDs are on Port F). All other LEDs must be off.

40) "Checking "walk" light on" Keep holding the walk switch while releasing the other two switches. Your FSM should already be in the “walk” state. To pass this test, you have 10 seconds for the “walk” LEDs to be green. The 10 second window is not strictly needed. Realistically, it is a good idea to force all lanes of traffic and pedestrians to briefly stop for a short time. This makes it less likely that someone running a questionably legal yellow light will still be in the intersection at the beginning of someone else’s green light. This functionality is not required and not graded.

41) "Checking all switches pressed" Press and hold the switches that correspond to the car sensor in the west lane, the car sensor in the south lane, and the pedestrian sensor. To pass this test, you have 10 seconds for all three switch input pins to read a 1 simultaneously. Do not be sloppy about this; be careful to press all three buttons as close to simultaneously as possible. As soon as you press a car sensor, your FSM will proceed to the next step, flash the “walk” LEDs red-off-red, and continue. If you are slow pressing all three switches, the TExaS real-board grader may miss seeing the “walk” LEDs flash and incorrectly penalize you in the next test.

42) "Checking west red/south red" Keep holding all three switches. Your FSM should quickly cycle to the “don’t walk 1” state. To pass this test, you have 10 seconds (minus your physical reaction time) for the west red LED and south red LED to be on. The “walk” LED should be flashing red, which will be checked in the next steps (this step only looks at Port A, Port B, or Port E and the “walk”/”don’t walk” LEDs are on Port F). All other LEDs must be off.

43) "Checking "don't walk" light on" Keep holding all three switches. Your FSM should already be in the “don’t walk 1” state. To pass this test, you have 10 seconds for the “walk” LEDs to be red. The 10 second window is not strictly needed.

44) "Checking "don't walk" light off" Keep holding all three switches. Your FSM should quickly cycle to the “don’t walk 2” state. To pass this test, you have 10 seconds for the “walk” LEDs to be dark (i.e. “walk” and “don’t walk” off).

45) "Checking "don't walk" light on" Keep holding all three switches. To pass this test, you have 10 seconds for the “walk” LEDs to be red. At this point, the “walk” LED has flashed red-off-red at least once, which is all that is required to demonstrate to TExaS that the LED has flashed. Additional flashes are not graded.

46) "Checking west green/south red" Keep holding all three switches. Your FSM should eventually cycle to the state where the west lane is green, the south lane is red, and the “walk” LED is red. All other LEDs must be off. To pass this test, you have 30 seconds to reach this state. Your solution can step through any valid states before reaching this state as long as it does not take too long.

47) "Checking west red/south green" Keep holding all three switches. Your FSM should eventually cycle to the state where the west lane is red, the south lane is green, and the “walk” LED is red. All other LEDs must be off. To pass this test, you have 30 seconds to reach this state. Your solution can step through any valid states before reaching this state as long as it does not take too long.

48) "Checking "walk" light on" Keep holding all three switches. Your FSM should eventually cycle to the state where the west lane is red, the south lane is red, and the “walk” LED is green. All other LEDs must be off. To pass this test, you have 30 seconds to reach this state. Your solution can step through any valid states before reaching this state as long as it does not take too long.

**“Background Tests”: Situations That Will Immediately Cause You to Fail.**

Crash! South green LED and green “walk” LED are on simultaneously.
Crash! West green LED and green “walk” LED are on simultaneously.
Crash! South yellow LED and green “walk” LED are on simultaneously.
Crash! West yellow LED and green “walk” LED are on simultaneously.
Crash! West green LED and south green LED are on simultaneously.
Crash! West green LED and south yellow LED are on simultaneously.
Crash! West yellow LED and south green LED are on simultaneously.
Crash! West yellow LED and south yellow LED are on simultaneously.
Invalid State for American Traffic Lights: West red LED and west yellow LED are on simultaneously.
Invalid State for American Traffic Lights: West red LED and west green LED are on simultaneously.
Invalid State for American Traffic Lights: West yellow LED and west green LED are on simultaneously.
Invalid State for American Traffic Lights: South red LED and south yellow LED are on simultaneously.
Invalid State for American Traffic Lights: South red LED and south green LED are on simultaneously.
Invalid State for American Traffic Lights: South yellow LED and south green LED are on simultaneously.
Invalid State for American Traffic Lights: Green “walk” LED and red “don’t walk” LED are on simultaneously, causing the LED to appear yellow-ish.

and artificial intelligence.

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Help