Prototype Design

F2019 – Edit this document into a deliverable.

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| --- | --- | --- | --- |
| Lab Section: | 5 | Group: | 16 |

# Necessary Changes and Notes

**Answer these questions by editing and adding to Table 1 and Table 2 below.**

**Table 1:** What changes had to be made to get your Feasibility Model working as expected?

Table : Necessary Design Changes

|  |  |  |
| --- | --- | --- |
| # | Change | Reason/Notes |
| 1 | No longer planning to use UART to send commands. Will only be using it in testing context. | Doesn’t offer any additional value over other main components of the project. |
| 2 | We were originally planning to use 2 separate boards, in order to have access to enough GPIO pins. Will only be using one board. | We now realize that we have enough pins on a single board. |
| 3 | No longer planning to use interrupts for button presses (mainly, limit switches). | We use sufficiently small steps, that tight polling the button statuses should be responsive enough for our needs. Moreover, this simplifies our code. |
| 4 | LEDs will not be connected to their own GPIO pin. Instead, they will be wired in-line with the limit switches. | Reduces usage of GPIO pins, allowing us to consolidate the design to a single board. Also, these LEDs should only be on when the button is pressed, therefore there is no need to control them independently from the limit switch push buttons. |
| 5 | Changed the input resistance to the limit LEDs from 300Ω to 200Ω. | Changed this value so that we use less resistors (because at 300Ω, we’d need to use three 100Ω resistors), whereas we only use two 100 Ω resistors now. This resistance still allows us to limit the input current within the nominal range acceptable to drive the LED. |

**Table 2:** Lessons Learned – Is there anything you want to remember so that you don’t make the same mistake again? Or, not waste time on something you already figured out?

Table : Important Notes

|  |  |
| --- | --- |
| # | Note |
| 1 | As per the suggestion of the TA conducting our Feasibility Model demo, we investigated using hall effect sensors as our limit switches. We found that these were functionally equivalent to the push buttons (but with inverted output), however they also required their output to be amplified to 3.3v, in order to properly read their statuses. This adds unnecessary complexity to our design. Additionally, upon investigating similar products that exist already, we found that they commonly use physical limit switches, similar to our design. |
| 2 | We should always remember to initialize the required pins before attempting to use them. It is best to initialize them with all the other initializers (at the top of the file), since we disable interrupts in this section. |
| 3 | We sample the keypad buttons multiple times, in order to reduce possible noise on these inputs. |
| 4 | We purposefully omit debouncing the limit switch push buttons because, in the event of noise, the steppers will only skip one movement due to this noise and continue normally afterwards. |

# Signal Specifications

**Answer these questions by editing and adding to Table 3 below.**

**Table 3:** For all the important signals in your Prototype:

* Name the signal
* State which signal property is important (voltage, frequency, rise time, etc.)
* State whether you need to include a Test Point (TP) on the PCB so you can probe the signal
* State which software mode will let you test the signal as indicated
  + You may need to create a special test mode in your code to exercise the signal to its limits
* State the Minimum (Min), Nominal, and Maximum (Max) acceptable values for that signal property, as appropriate
* Include signals for attached components, modules, sensors, etc. Do not include power rails.

Notes: Signals requiring a test point will have the test point label specified under the Test Point Name column. When test point is not needed, the column will be left blank. We will only be testing Stepper out 1, as all 4 stepper driver signals are functionally equivalent (they alternate).

Table : Hardware Signal Test Plan

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Signal (TP\*) | Test Point name | Property | Required Software Mode | Min | Nominal | Max |
| X Axis MIN | X\_MIN\_TEST | Voltage | Limit Switch test mode | 0 V | 3.3 V | 5 V |
| X Axis MAX | X\_MAX\_TEST | Voltage | Limit Switch test mode | 0 V | 3.3 V | 5 V |
| Y Axis MIN | Y\_MIN\_TEST | Voltage | Limit Switch test mode | 0 V | 3.3 V | 5 V |
| Y Axis MAX | Y\_MAX\_TEST | Voltage | Limit Switch test mode | 0 V | 3.3 V | 5 V |
| Keypad COL 1 |  | Voltage | Keypad Column 1 test mode |  | 3.3 V |  |
| Keypad COL 2 |  | Voltage | Keypad Column 2 test mode |  | 3.3 V |  |
| Keypad COL 3 |  | Voltage | Keypad Column 3 test mode |  | 3.3 V |  |
| Keypad ROW 1 | ROW\_1\_TEST | Voltage | Keypad Column [1|2|3] test mode |  | 3.3 V |  |
| Keypad ROW 2 | ROW\_2\_TEST | Voltage | Keypad Column [1|2|3] test mode |  | 3.3 V |  |
| Keypad ROW 3 | ROW\_3\_TEST | Voltage | Keypad Column [1|2|3] test mode |  | 3.3 V |  |
| Keypad ROW 4 | ROW\_4\_TEST | Voltage | Keypad Column [1|2|3] test mode |  | 3.3 V |  |
| Stepper 1 IN 1 | STEPPER\_1\_OUT\_TEST | Voltage | Stepper test mode | 0 V |  | 5V |
| Stepper 1 IN 2 |  | Voltage | Stepper test mode | 0 V |  | 5V |
| Stepper 1 IN 3 |  | Voltage | Stepper test mode | 0 V |  | 5V |
| Stepper 1 IN 4 |  | Voltage | Stepper test mode | 0 V |  | 5V |
| Stepper 2 IN 1 | STEPPER\_2\_OUT\_TEST | Voltage | Stepper test mode | 0 V |  | 5V |
| Stepper 2 IN 2 |  | Voltage | Stepper test mode | 0 V |  | 5V |
| Stepper 2 IN 3 |  | Voltage | Stepper test mode | 0 V |  | 5V |
| Stepper 2 IN 4 |  | Voltage | Stepper test mode | 0 V |  | 5V |

\*Indicates Test Point Required

# Signal Mapping

**Answer these questions by editing and adding to Table 4 below.**

**Table 4:** How will your Prototype design electrically connect to the LaunchPad?

MSP430FR4133 IC pin <--> BoosterPack pin on J1/J2 of the LaunchPad <--> Your Prototype

Table : Hardware Signal Connectivity

|  |  |  |  |
| --- | --- | --- | --- |
| Signal | MSP430FR4133 Pin | LaunchPad J1/J2 Pin | Prototype Connection |
| Stepper 1 IN 1 | P8.1 | J1 pin 2 | IC1 1B |
| Stepper 1 IN 2 | P1.1 | J1 pin 3 | IC1 2B |
| Stepper 1 IN 3 | P1.0 | J1 pin 4 | IC1 3B |
| Stepper 1 IN 4 | P2.7 | J1 pin 5 | IC1 4B |
| Stepper 2 IN 1 | P8.0 | J1 pin 6 | IC2 1B |
| Stepper 2 IN 2 | P5.1 | J1 pin 7 | IC2 2B |
| Stepper 2 IN 3 | P2.5 | J1 pin 8 | IC2 3B |
| Stepper 2 IN 4 | P8.2 | J1 pin 9 | IC2 4B |
| Keypad COL 2 | P8.3 | J1 pin 10 | J4 pin 1 |
|  |  |  |  |
| Keypad ROW 2 | P1.5 | J2 pin 1 | J5 pin 2 |
| Keypad ROW 3 | P1.4 | J2 pin 2 | J5 pin 1 |
| Keypad COL 3 | P1.3 | J2 pin 3 | J4 pin 5 |
| Keypad ROW 4 | P5.3 | J2 pin 4 | J4 pin 4 |
| Y Axis MIN | P5.2 | J2 pin 5 | J1 (3.3 V) |
| Y Axis MAX | P5.0 | J2 pin 7 | J1 (3.3 V) |
| X Axis MIN | P1.6 | J2 pin 8 | J1 (3.3 V) |
| X Axis MAX | P1.7 | J2 pin 9 | J1 (3.3 V) |
|  |  |  |  |
| Keypad COL 1 | P2.6 | J3 pin 1 | J4 pin 3 |
| Keypad ROW 1 | P4.0 | J3 pin 2 | J4 pin 2 |