APPLICATION NOTE:

Designing a User Friendly Automatic registration system for use with MDM

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Abstract:
This document will outline design practices that should be taken into consideration while designing an automatic registration system, particularly for use with MDM. This includes the following topics: determining the best switches to use in your design, selecting an enclosure for your circuit, structure and orientation of LED’s in circuit, and maintaining the system’s user friendliness. This document will use examples of calculations used by Michigan State University’s Team 4 senior design project for use with a Multi-User computer system.

Keywords: MDM, transistors as switches, relays, circuit enclosures, user friendly, LED
Introduction:

The purpose of designing a registration system can vary. The reason for designing a registration system for MDM is because of MDM’s inability to prevent mistakes during the seat registration (associating monitor with keyboard and mouse). At start up MDM prompts for the user to select a key, usually a key F1-F12, and to right click the mouse. These steps allow MDM to identify which keyboard and mouse is associated with the appropriate monitor. The issue is that when you have multiple users attempting to log in at the same time, things can be associated incorrectly. For example, if User 2 is prompted to press F2 and another user, User 4, accidentally presses the F2 key then User 4’s keyboard will be associated to User 2’s monitor. It’s the exact same problem with the mice, if User 4 right clicks the mouse when it is User 2’s turn to click, then the mouse would then be associated to the incorrect monitor.

The automatic registration system will be developed to prevent these errors during the seat registration process.

Determining the best switches to use in your design:

When selecting switches to use in your registration device, you have to consider the limitations that each switch has. The purpose of a switch is to disconnect or connect a specific part of a circuit. In our case, activate a specific user and deactivate every other user. Therefore, there are less room for errors during MDM’s registration.

The switches I found that were more efficient for use in an automatic registration circuit are as follows:

Transistors as switches:

Using transistors there are limitations to what we can actually switch on or off. However, transistor switches are inexpensive and more reliable than using relays. The most commonly used transistor switch is the PNP type. The key to making a transistor operate as a switch is to get the transistor in saturation mode. To get the transistor in saturation mode we need to find the maximum load current for the device to be turned on and the minimum HFE of the transistor. For example, if we have a load that requires 200MA of current and a transistor with a minimum HFE of 200, we can then calculate the minimum base current required to saturate the transistor as follows:

\[
\text{Minimum base current} = \frac{200 \text{ MA}}{100} = 2 \text{ MA}
\]

It is important to make sure that the transistor saturates. You can do this by using 30% more current to ensure saturation, this isn’t enough current to damage the transistor and will operate fine. In this case we would use 2.6 MA. We must also select our supply voltage, since we are using USB devices the standard supply voltage is 5
volts. We can now calculate resistor R1 in the circuit as follows:

*Maximum Current Required* = 200MA  
*Supply Voltage* = 5 Volts  

\[ R1 = \frac{\text{Supply Voltage}}{\left( \frac{\text{Maximum Current Required}}{\text{Minimum HFE}} \times 2.6\text{MA} \right)} \]  
\[ R1 = \frac{5\text{V}}{(.2 / 200 \times 2.6)} \]  
\[ R1 = 1923.07 \text{ or } 2K \text{ for nearest standard value.} \]

Resistor R2 is not important to this circuit but used for stability and to insure that the transistor switch is completely turned off. This resistor insures that the base of the transistor does not become negative which would cause a very small amount of collector current to flow through the transistor. The value of this resistor is not that important but a value about 10 times R1 is usually chosen. For this circuit we will calculate R2 to be 10 times R1 as follows:

\[ R2 = 10 \times 2000 \]  
\[ R2 = 20K \]

To turn on our transistor switch all that is needed is to short resistor R1 to the negative ground.

**Relays:**  
A relay is just a small switch that is activated by the electromagnet inside. When power is applied to the relay’s coil, the electromagnet becomes active and pulls across the switching contacts. There are several types of relay switches: single pole-single throw, single pole-double throw, double pole-double throw, etc.
The simplest relay is a single pole-single throw (SPST) design, this is the most efficient relay for our design. Single pole-single throw describes the switching part of the relay where when it's activated, one wire (a "single pole") can be connected only one way (a "single throw"). Just like an on/off switch, when you power up the relay's coil, the connection is made; when you un-power the coil, the connection is broken. The single pole-double throw relay is best because we only need the circuit to disconnect and connect the keyboards and mice at a specific time.

Selecting a enclosure:
After you have completed the design and building of your circuit it is very important to find the appropriate casing for your circuit. The best way to begin selecting an enclosure is to consider the environment that your circuit will be placed. Design Team 4 is implementing a design that will be transported to Tanzania to be use by the students there. Therefore, the team has to consider the extreme temperatures, dust, and the fact the students may disconnect components from the automatic registration circuit. All of the factors play a key roll in selecting enclosures for a circuit.

The enclosure we’ve found most suitable for our design is the:

*BUD INDUSTRIES - CU-3281 - Style A Utilibox Enclosure*

**Description**
- Style A Utilibox Enclosure
- Body Material: Plastic
- External Height: 1.87"
- External Width: 3.1"
- External Depth: 4.6"
The reason this enclosure was chosen, was because of its appropriate size and the cost (around $7.02US). The enclosure is made out of plastic which means it would be easier to drill holes in the top to mount LED’s or buttons for control. Also, we can put the USB connectors, to the keyboards and mice, inside of the enclosure. Therefore, it limits the possibility of students being able to disconnect cables.

Structure and orientation of LED’s in circuit:
The structure and orientation of LED’s are very important when building this circuit for students to use. You cannot assume the level of knowledge the user may have when designing and placing the LED’s. People are visual learners and it is only natural for people to associate colors with actions for the registration circuit.

For the design of the LED’s. The circuit would start with a blinking GREEN LED. Once the user presses the start button to associate their keyboard and mouse with their monitor, that same LED will turn a solid GREEN, to let the user know it is time to register their keyboard and mouse. While this is happening all other keyboard and mice are disconnected from the computer through the automatic registration hub, every other user will also have a solid YELLOW LED on, letting them know to WAIT until it is their turn to register. When the registering user hits the done button on their automatic registration hub, every other user’s LED turns a flashing GREEN and the process starts over again until every user has registered. If a user that has registered forgets to press their done button on their hub then the RED LED will begin to flash letting them to know that they have forgot to press done, and to allow other users to register.

When you are selecting your LEDs to be used in your circuit, you have to
consider the idea that they have to be mounted outside the enclosure. Therefore, the lights are visible to the students. It is great to find LED’s that can be screwed in or mounted to the top of the enclosure. Perhaps, even taking an ordinary LED and placing it throw a drilled hole through the enclosure and then filling any spaces with silicone adhesive.

Designing your LED’s and placing them on the enclosure next to the buttons will make the design more user friendly and intuitive. A sample design is below:

![USB Registration Hub Diagram]

The LED display that you’ve designed for your registration circuit will later have to be programmed in pseudo code. The pseudo code is for the programming of the microcontroller that will be used in your circuit. An example of the code to be used for our circuit:

```
$start$ = <0>
$done$ = <0>
$user$ = <0>

while $<1$
    if $<start>=1$
        Turn LED solid green;
    else
        Green LED blinks continuously;
    endif
    while $<user=1$
        Do not allow other users to register;
        Blink Yellow LED’s for other users;
    endwhile
    if $<done!=1$
        Blink Red LED continuously;
    endif
```
Conclusion:
Designing a registration system to be used for MDM is very essential when you have young children using the system. It’s very important to ensure that you’re design is user friendly. Otherwise, the design will be useless. Be sure that the enclosure you select for your circuit will be sustainable to it’s environment. In addition, when selecting your switches as well as the buttons to be used in your circuit be sure your calculations are correct, especially if you plan to use transistors as switches, I have found that these are the easiest to over saturate and burn out.

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