Sprinkler Control Box
Design Specifications

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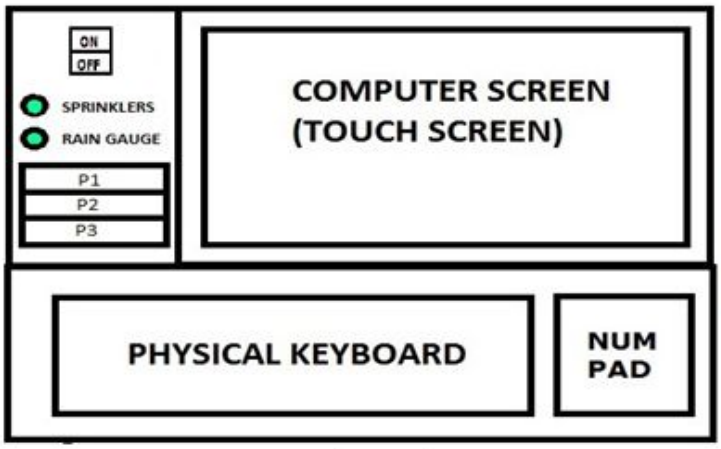
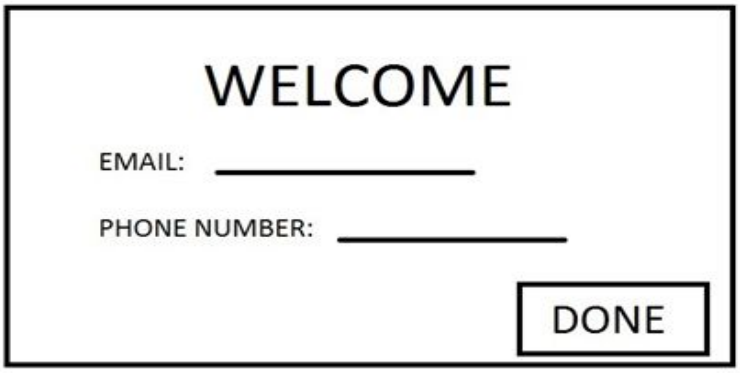
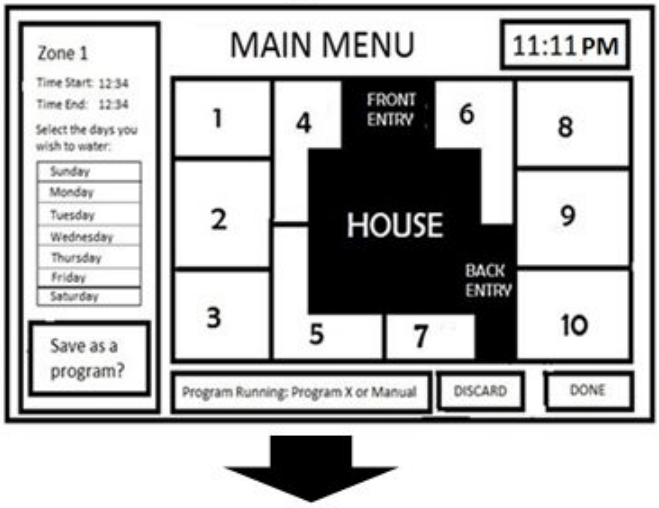
System Flow Chart:



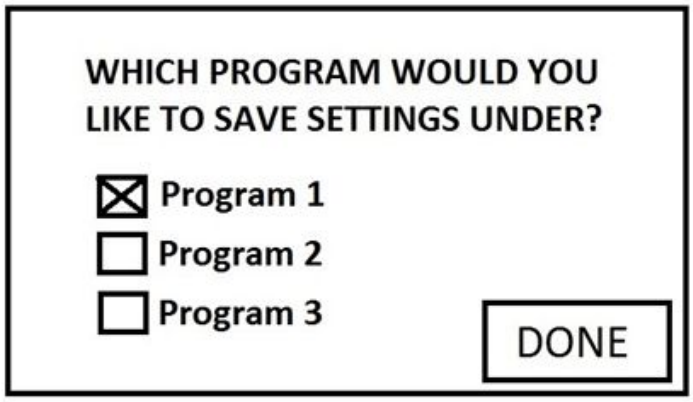
1. User walks up to the control box for the first time and pushes the on button.
2. The computer screen turns on. It is a touch screen.



3. User enters his or her email and phone number.
4. User hits done when finished. Once set, this screen will never appear again.



5. To set the duration for a zone, the user taps once on the desired block in diagram.
6. User fills left hand panel time start and time end settings for the specified zone, using the physical number pad for data entry.
7. To select the days for the sprinklers to water, user taps on the desired days (ex: Sunday) After a day is chosen, that day button will become green with white text. Zone background will turn light blue.
8. If user is finished, he or she hits done.



9. Alternatively, the user could also click "save as a program? button on the previous screen and will be directed to this screen.
10. User taps on box next to desired program number to save sprinkler settings under that program.
11. User hits done when finished.

Main Menu Description

The main menu contains a map that shows the relationship of each zone around the house. On the bottom of the display, the button furthest to the left displays the current running program, if any; otherwise, it shows that the system is under manual . The current time is displayed on the top right corner. After the first use, this is the screen that will always pop up when the user returns to set the sprinkler zones.

In the setting panel, the user can change the settings of a selected zone. He or she can set the time end and time start as well as the days he or she wants to turn on the sprinkler in the zone. If a day is selected, the day button will change to a dark green background with white text for confirmation. The contrast ratio is 7.99:1. (Utah State University, 2016). The days that are not set will remain with black text and white background. The contrast ratio is 21:1 (Utah State University, 2016).

Zones that are thus fully set will change to a light blue with black text as confirmation. The contrast ratio is 13.2:1. (Utah State University, 2016). The light blue color was chosen because it often represents water, thus helping to signify that the selected zone will be watered. Zones that are not set will remain with black text and white background and the sprinklers will not run. The chosen colors all met the WCAG AA and WCAG AAA color contrast standards for normal text (Utah State University, 2016). RGB and Hex# were used to code for the exact colors that will be used in the main menu screen (Refsnes Data, 2016). The user will thus be able to easily tell which zones are running, at what times and days, and which still need setting.

Main Menu Colors

Colors	Sample Color	Color Code
Black (text color for whole main menu screen)		RGB (0,0,0) Hex #: 000000
White (background color; text color for selected days)		RGB (255, 255, 255) Hex #: ffffff
Dark green (background color for selected days)		RGB (15,94,12) Hex#: 0f5e0c
Light blue (background color for completed zones)		RGB (146, 217, 222) Hex#: 92e9de

Once a user changes the setting of one zone as shown in the flow diagram, he or she can tap “Done” to save it or he can tap “discard” to cancel the change. If a user wants to save the current schedule of all zones as a program, he or she can tap “save as a program” and the system will lead the user to the program saving panel.

Main Display Specifications

Screen Size	Resolution	Density	Ratio	Pixel size	Illuminance	Contrast Ratio
13.3 in (33.78 cm) Length: 51.29cm Height: 32.06 cm	1280 x 800	113.5 ppi	16:10	0.2238 mm	100cd/m2	7:1

Font	Title Font Size	Subtitle Font Size	Regular Font Size
Calibri	22 points	18 points	12 points

Character Spacing	Line Spacing
0.25:1	3 points more than the font size

- The illuminance of the screen is 100cd/m2 while it may vary slightly for the characters displayed on the screen and the background (Ahlstrom, 2007).
- The contrast ratio of the display foreground to background is 7:1 (Ahlstrom, 2007).
- The viewing distance of the user is assumed to be less than 25 in, since there’s a frequently used control associated with our touchscreen, so the display and control shall be within normal reach and vision of the user (Ahlstrom, 2007).

- There's three font sizes used in our system for differentiation. The title font size is 22 points, subtitle font size is 18 points, and the regular font size of the screen is 12 points (Legge, 2011).

Regular Font Size	Settings body
Subtitle Font Size	Settings title: For example, "Zone 1"; button text, text on the mapping
Title Font Size	"Welcome", "Main Menu", Time, "Program 1"

- Calibri is the font of text used to display on the screen. According to research, Sans serif are preferred for electronic devices. Calibri is a sans serif font that has been specially designed for computer monitor displays (Federal Aviation Administration, 2016).
- We choose a white background with black text for the best text readability in any circumstances. Since the system is not expected to be used continuously within a long period of time, eyestrain is not considered when choosing the color (Green, 2004).
- The character spacing The character spacing ratio is 0.25:1 and the spacing is calculated based on the current font size. If the spacing is too closely, individual characters are difficult to distinguish, especially on electronic displays. A ratio of 0.25:1 are widely tested and used on computer monitors (Federal Aviation Administration, 2016).
- The line spacing for our display is 3 points more than the current font size to improve text legibility (Federal Aviation Administration, 2016).

Keyboard Specifications

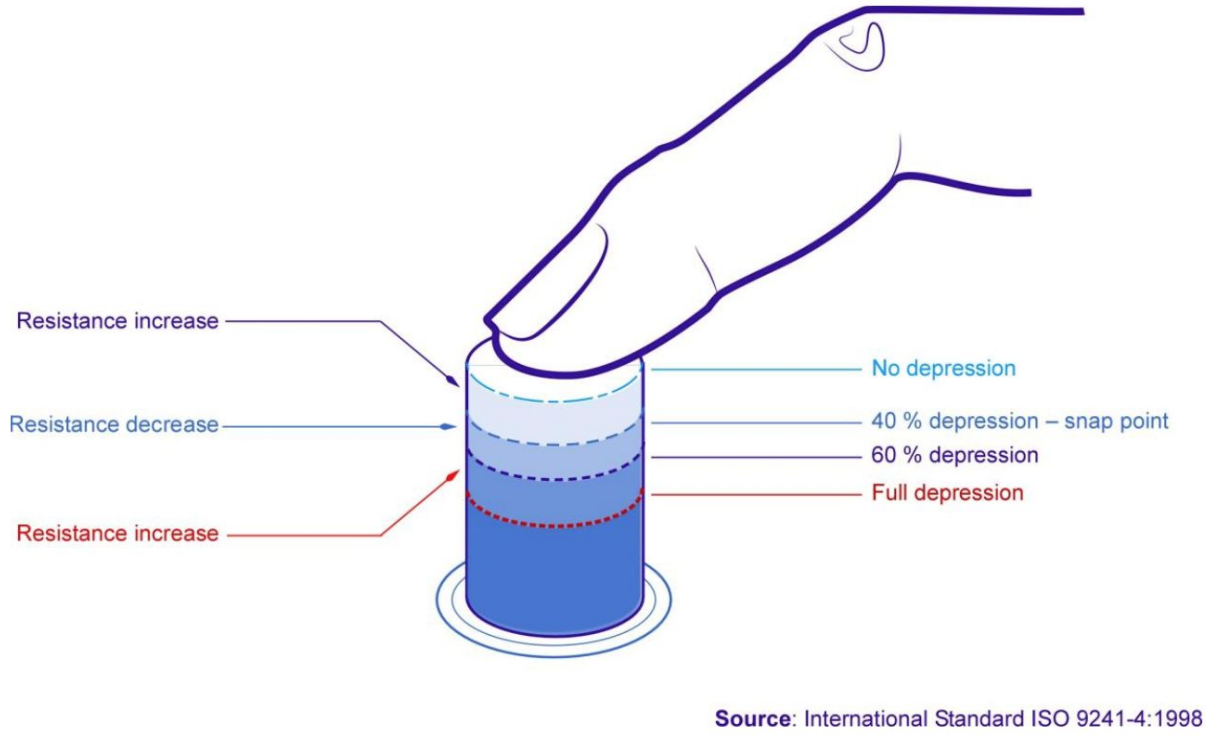
	Alphabet Keyboard	Number Pad
Layout	QWERTY[1] (Norman and Fisher, 1984)	Telephone (slightly modified) (Conrad and Hull, 1968)
Center to Center Spacing	14.5 mm (Pereira et al., 2013)	19 mm (Pereira et al., 2013)
Key Size	12 mm x 12 mm ("Human Integration," 2014, pg. 973)	17 mm x 17 mm (Pereira et al., 2013)
Displacement Required	1.6 mm ("Human Integration," 2014, pg. 973)	3 mm ("Human Integration," 2014, pg. 973)
Snap Point	0.64 mm ("Human Integration," 2014, pg. 973)	1.2 mm ("Human Integration," 2014, pg. 973)

- The letters on the keyboard will be capitalized (Sheedy et al., 2005)

[1] The QWERTY keyboard was selected because it will not be used often enough to be worth the marginal improvement of switching to a Dvorak keyboard (Norman and Fisher, 1984)

- The letters, numbers, and symbols on the keyboard will be 14 point (approx. 3.9 mm) Verdana font (Sheedy et al., 2005)
- Ridges 1 mm high and 5 mm long are located on the “F” and “J” keys of the QWERTY keyboard on on the “5” key of the number pad (Human Integration, 2014, pg. 975)
- The keyboard keys will be white (RGB 255, 255, 255) and the letters, numbers, and symbols will be black (RGB 0, 0, 0). These values will provide the maximum contrast between the keys and the rest of the device as well as between the keys and the writing on the keys. Although there are diminishing returns to increasing contrast, there is never a decrease in readability due to increased contrast (Legge, Rubin, and Luebker, 1987).

Resistance Specifications for Both Keyboards	
Initial Resistance	0.275 N (“Human Integration,” 2014, pg. 973)
Resistance at Snap Point	0.55 N (“Human Integration,” 2014, pg. 973)
Resistance Profile Between Zero Depression and Snap Point	Linear: $R = 0.6875y + 0.275$ y = percent depressed (decimal)
Resistance Profile Between Snap Point and 60% Depression	Linear: $R = -0.6875(y - .4) + 0.55$ y = percent depressed (decimal)
Resistance Profile Between 60% Depression and Full Depression	Linear: $R = 0.6875(y - .6) + 0.4125$ y = percent depressed (decimal)



(“Human Integration,” 2014, pg. 973)

Although not all keyboard specifications are optimal, this was done intentionally to reduce the size of the QWERTY keyboard to fit the intended size of the device. The QWERTY keyboard will only be used for entering in email addresses for alerts. Although other data can be entered using the numbers on the QWERTY keyboard, a more optimal number pad is provided for the more common numerical data entry.

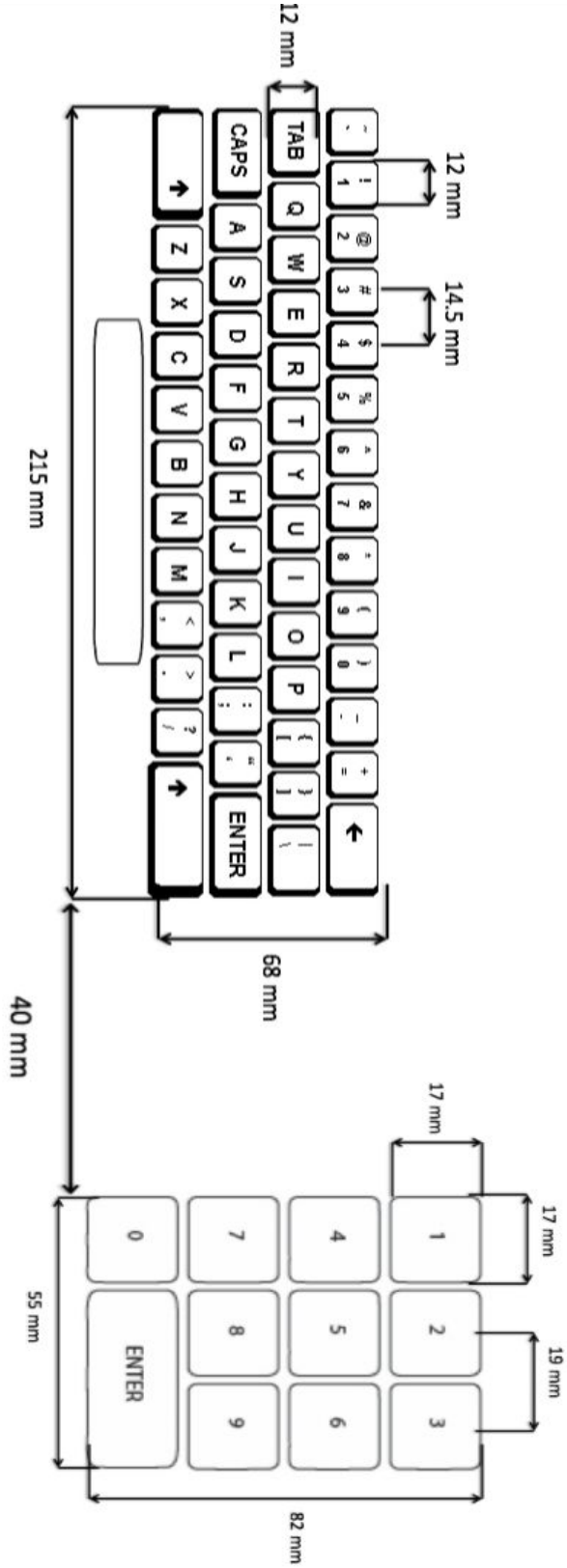


Image created in part from a blank template found online (Daskeyboard, 2011)

On/Off Rocker Switch Specifications

We wanted the on/off switch to be one of the first items that the user sees and thus chose to place it in the top left hand corner, near head level for easy access. The on/off switch will be a vertically oriented rocker switch with an audible click when a person presses down and selects the “on” or “off” positions. This is to provide additional confirmation for the user that the intended action has occurred. The “ON” and “OFF” labels will be in white, bold, capital letters, use Calibri font, and be 4.2 mm in height (12 points), meeting text standards and recommendations (Federal Aviation Administration, 2016). The ON label will be on a dark green background and the OFF label will be on a dark red background. We chose these colors because they would match the user’s conceptual model for green and red colors (Department of Defense,1999). Thus, we built in additional redundancy into the system to help the reader grasp the meaning of the switch.

Rocker Switch Color Specifications

Colors	Sample Color	Color Code	Contrast Ratio
White (text font color)		RGB (255, 255, 255) Hex #: ffffff	1:1
Dark green- ON label (background color)		RGB (15,94,12) Hex#: 0f5e0c	7.99: 1
Dark red- OFF label (background color)		RGB (140, 38, 22) Hex#: 8c2616	8.74: 1

These colors were chosen because they met the WCAG AA and WCAG AAA color contrast standards for normal text. With a contrast ratio of 7.99: 1 for dark green in comparison to white and 8.74:1 for dark red in comparison to white, both colors are well above AA and AAA color contrast standards of 4.5: 1 and 7:1 respectively for normal text (Utah State University, 2016; Refsnes Data, 2016).

Rocker Switch Specifications

Length	Width	Height	Slope of angle above nominal plane	Switch Resistance
26 mm (13 mm per half)	19 mm	3.2 mm	30 degrees	5 N

The switch resistance is within the recommended range of 2.8 N- 11 N and the remainder of the specifications meet the minimum standard guidelines for rocker switches (Department of Defense, 1999).

Indicator Lights Specifications

We will be using LED lights that are 13 mm in diameter to indicate to the user the current status of the system (Department of Defense, 1999). These lights will be on the left hand side, below the power switch, next to the screen so it is easily within the user's eye level. For light colors, we selected red, amber, and green because these are often used for stop lights and thus, users can readily and intuitively apply that same understanding for a quick evaluation of the system.

LED Wavelength Specifications

Light Color	Wavelength	Sample Color	Color Code	Luminance
Red	700 nm		Rgb (255,0,0) Hex#: ff0000	3.5 cd/m2
Yellow	570 nm		Rgb (225,255,0) Hex#: e1ff00	3.5 cd/m2
Green	500 nm		Rgb (0,255,146) Hex#: 00ff92	3.5 cd/m2

LED Indicator States

LED label	Color	Meaning
Sprinklers	Red	Sprinklers broken/inoperational at this time
	Yellow	Sprinklers are not operating because rain gauge has detected rain, sprinklers temporarily off
	Green	Sprinklers are working at this time and spraying water at specified time periods
Rain gauge	Red	Rain gauge broken/ inoperational at this time
	Green	Rain gauge is working at this time and sensing rain patterns

We chose the meaning of these lights based on guidelines for selecting wavelengths, colors, and luminance for military standards (Department of Defense, 1999; Academo, 2016). Each LED will always be lit at one of these two (for rain gauge) or three (for sprinklers) color states, signalling the independent status of each system. These LEDs will be spaced 6 mm apart from edge-to-edge on the control panel, the minimum distance used to separate buttons (Tillman, 2016). The sprinkler LED will be above the rain gauge LED, as it is the more critical system to view. Once the system is repaired, the LED will switch from red to green, indicating the system is again ready for use.

Alarm Specifications

Along with the red light on the LED, the user will also hear an auditory alarm, signalling that the system is not working. There will be two alarms, one for the sprinkler at 659 Hz and one for the rain gauge at 523 Hz. These alarms will be identical in all other respects and if the entire system is inoperational they will sound together in unison. Once the appropriate system is repaired, the associated alarm will stop sounding immediately and the LED will turn green, thus providing dual feedback that the system is working properly again.

Both alarms will be chime signals, which are often used to attract attention in fast-paced and somewhat noisy environments, like hospitals or malls(Tillman, 2016). We believe the garage location, where the sprinkler control box will be located, might have many distractions, such as the car starting, garage door opening, or wind blowing, so we wanted an alarm that would not be obscured by these distractions.

Chime Alarm Specifications

Alarm Type	Associated LED	Frequency	Decibel Level (dBa)	Duration of Burst	Pulses/ Burst	Time between bursts
Chime	Sprinkler	659 Hz	78 dBa	750 ms	3	30 s
Chime	Rain Gauge	523 Hz	78 dBa	750 ms	3	30 s

For frequency and decibel information, frequencies between 500 - 1000 Hz were found to be most audible and chimes played at 78 dBa at 3 ft as a standard (Tillman, 2016).. We selected 523 Hz and 659 Hz (high C and high E on the piano) because these frequencies were both within the recommended range and played notes frequently used in other alarm recommendations (Pacheco, 2016; Sessa, 2012). In the event both alarms should sound together, we specifically selected E because it played a major third with C, a pleasing sound for users, which would not annoy the user too much if it played constantly while the user waited for repairs.

As for the alarm pattern, we will have a single note (either high C or E depending on which system is broken) play in regular 30 second bursts, with 3 pulses (200 ms of tone followed by 50 ms of silence) per burst (Sessa, 2012). To select alarm specifications, we selected medium priority alarm guidelines because we felt the sprinkler control box was not quite high priority but wanted more urgency than low priority (Sessa, 2012). Thus, we believe that this alarm system meets all our design criteria and will be easily heard and understood.

Program Button Specifications

Right below the LED lights will be 3 horizontally oriented rectangular push buttons labeled P1, P2, and P3 for Program 1, Program 2, and Program 3 respectively. The user simply has to push a different program button to switch between sprinkler programs. The labels will be in bold, capital letters, Calibri, black font against a forest green background (Federal Aviation Administration, 2016) Since no standards were available for rectangular shaped push buttons, our team decided to use a commercial grade button, Gamesman Large Rectangular Push Button for Konami, to get length and width dimensions (Suzohapp, 2016). The other specifications are based on published push button specifications (Tillman, 2016).

Push Button Specifications

Length	Width	Resistance	Displacement	Button Separation (from centers)
34.8 mm	15.8 mm	3 N	3 mm	19 mm

Push Button Lighting Specifications

Colors	Sample Color	Color Code	Contrast Ratio
White (text font color)		RGB (255, 255, 255) Hex #: ffffff	1:1
Dark green- ON label (background color)		RGB (15,94,12) Hex#: 0f5e0c	1:7.99

LED Push Button Specifications:

Light Color	Wavelength	Sample Color	Color Code	Luminance
Green	500 nm		Rgb (0,255,146) Hex#: 00ff92	3.5 cd/m2

These colors were chosen for the same reasons as the rocker switch colors and we chose to preserve it in the program push buttons for consistency in user design. The push buttons will be lit with a 500 nm green LED that will provide lighting in the dark. Thus, the user will still be able to see which program the sprinklers are running on, based on the button that is pressed.

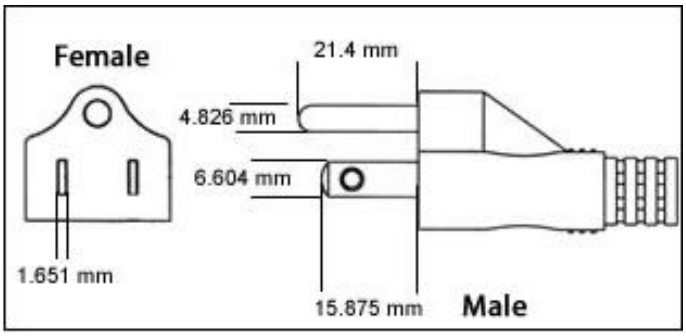
Physical Power Switch

Since our sprinkler control box will be used by users in the United States, we plan on powering our device with a 3 prong, Type B plug that operates at an electric potential of 120 V and current of 15 amps. (Power Plug & Outlets, 2016). This plug will be connected to a 10 foot long cord, so the user can adjust and place the control box in a range of locations around the garage. We chose not to have a battery back-up into the device since the sprinklers are a relatively

non-critical function in comparison to other devices (like lights, refrigerators etc.) and we would prefer that such back-up electricity be used for those functions instead.

Power Plug Specifications:

Plug Type	Blade Dimensions	Ground Pin Dimensions	Blade-to- Blade Separation	Blade- to- Ground Pin Separation
Type B	15.8 mm (length) x 6.6 mm (width) x 1.6 mm (thickness)	21.4 mm length (4.8 mm diameter)	12.7 mm	11.9 mm



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