Appendix A Requirement and Verification Table

As mentioned in Chapter 3, Table 5 in Appendix A contains our full Requirements and Verifications Table.

Requirement	Verification	Verification
		status
11.1 V DC Linear Rectifier	11.1 V DC Linear Rectifier	
1. $V_{out} = 11.1 \text{ V} \pm 0.1 \text{ V}$ at 200 mA	 Verification Process for Item 1: (a) Attach 22 Ω Resistor as load (b) Attach oscilloscope across load (c) Plug linear rectifier unit into wall (d) Ensure output voltage remains within 11.0 V and 11.2 V 	1. Y
11.1 V DC to 3.3 V DC Switch-Mode Regulators 1. $V_{out} = 3.3$ V \pm 0.3 V at 100 μ A	 11.1 V DC to 3.3 V DC Switch-Mode Regulators 1. Verification Process for Item 1: (a) Attach 33 kΩ resistor as load (b) Attach oscilloscope across load (c) Supply regulator with 11.1 V DC (d) Ensure output voltage remains 3 V and 3.6 V 	1. Y
11.1 V DC to 7.0 V DC Buck	11.1 V DC to 7.0 V DC Buck	
Converter 1. $V_{out} = 7.0 \text{ V} \pm 0.7 \text{ V}$ at 200 mA	 Converter 1. Verification Process for Item 1: (a) Attach 35 Ω resistor as load (b) Attach oscilloscope across load (c) Set NMOS gate voltage to 31.25 kHz square wave with 59.375% duty cycle (d) Buck converter with 11.1 V DC (e) Ensure output voltage remains 6.3 V and 7.7 V 	1. Y
	Continued	on next page

Table 5: System Requirements and Verifications

Requirement	Verification	Verification
_		Status
11.1 V LiPo Battery and Charger	11.1 V LiPo Battery and Charger	
1. Each of two batteries must store	1. Verification Process for Item 1:	1. Y
5500 mAh, -500 mAh tolerance, of	(a) Attach 5.5 Ω resistor bank as	2. Y
charge	load	
2. Battery must be unable to discharge	(b) Measure I and V at 5 minute	
if left plugged into charger without	intervals	
power	(c) Terminate test when any	
	$V_{cell} \le 3.2 \text{ V}$	
	(d) Perform midpoint Riemann	
	summation	
	(e) Ensure at least 5000 mAh ex-	
	tracted	
	2. Verification Process for Item 2:	
	(a) Fully charge battery	
	(b) Unplug charger from wall out-	
	(c) Allow to sit for 5 days	
	(d) Measure cell voltages	
	(e) Ensure battery has not dis-	
	charged beyond typical self-	
	discharge	
	<i>C</i> +:1	
	Continued	on next page

Table 5 – continued from previous page

Arrela Soil Moisture Sensor11.1 V DC to 3.3 V DC1. Functions for $3.0 V \le V_{in} \le 4.0 V$ Switch-Mode Regulators1. Y2. Analog Output Range $0.3.3 V$ Verification Process for Item 1:2. Y3. $I_{max} \le 5$ mA for $V_{in} = 3.3 V$ 1. Verification Process for Item 1:3. Y(a) Attach 200 Ω resistance between leads(b) Attach voltmeter to analog output pin3. Y(c) Attach variable voltage supply to V_{in} (d) Sweep from 3.0 V to 4.0 V and ensure analog output pin(e) Attach voltmeter to analog output remains within $\pm 10\%$ of original value2. Verification Process for Item 2:(a) Short leads to simulate saturated soil(b) Attach voltmeter to analog output pin(c) Attach 3.3 V DC to V_{in} (d) Ensure analog output is 0 V(e) Remove 3.3 V DC(f) Remove short to simulate arid soil(g) Attach 3.3 V DC to V_{in} (h) Ensure analog output is 3.3 V(g) Attach 3.3 V DC to V_{in} (h) Ensure analog output is 3.3 V(h) Ensure analog output is 3.3 V(h) Ensure analog output is 0.3 V(h) Ensure analog output is 3.3 V(h) Ensure analog output is 3.4 V(h) Ensure analog output is 0.3 V(h) Ensure analog output is 3.3 V(h) Ensure analog output is 3.3 V(h) Ensure analog output is 0.3 V DC to V_{in} (h) Ensure analog output is 3.3 V(h) Ensure analog output is 3.3 V(h) Ensure analog output is 0.3 V DC to V_{in} (h) Ensure analog output is 3.3 V(h) Ensure analog output is 3.3 V(h) Ensure $I_{max} \le 5$ mA(c) Ensure $I_{max} \le 5$ mA(c) Ensure $I_{max} \le 5$ mA	Requirement	Verification	Verification
1. Functions for $3.0 \text{ V} \le V_{in} \le 4.0 \text{ V}$ Switch-Mode Regulators1. Y2. Analog Output Range $0.3.3 \text{ V}$ 1. Verification Process for Item 1:2. Y3. $I_{max} \le 5 \text{ mA}$ for $V_{in} = 3.3 \text{ V}$ 1. Verification Process for Item 1:2. Y(a) Attach 200 Ω resistance between leads(b) Attach voltmeter to analog output pin3. Y(c) Attach variable voltage supply to V_{in} (d) Sweep from 3.0 V to 4.0 V and ensure analog output remains within $\pm 10\%$ of original value2. Verification Process for Item 2:(a) Short leads to simulate saturated soil(b) Attach voltmeter to analog output pin(c) Attach 3.3 V DC to V_{in} (d) Ensure analog output pin(c) Attach 3.3 V DC to V_{in} (d) Ensure analog output is 0 V(e) Remove 3.3 V DC(f) Remove short to simulate arid soil(g) Attach 3.3 V DC to V_{in} (h) Ensure analog output is 3.3 V3. Verification Process for Item 3:(a) Short leads to simulate arid soil(b) Attach 3.3 V DC to V_{in} (b) Attach 3.3 V DC to V_{in} (b) Attach 3.3 V DC to V_{in}			Status
2. Analog Output Range 0-3.3 V 3. $I_{max} \leq 5 \text{ mA}$ for $V_{in} = 3.3 \text{ V}$ 1. Verification Process for Item 1: 2. Y (a) Attach 200 Ω resistance between leads (b) Attach voltmeter to analog output pin (c) Attach variable voltage supply to V_{in} (d) Sweep from 3.0 V to 4.0 V and ensure analog output remains within $\pm 10\%$ of original value 2. Verification Process for Item 2: (a) Short leads to simulate saturated soil (b) Attach voltmeter to analog output pin (c) Attach 3.3 V DC to V_{in} (d) Ensure analog output is 0 V (e) Remove 3.3 V DC (f) Remove 3.3 V DC (f) Remove 3.3 V DC to V_{in} (h) Ensure analog output is 3.3 V 3. Verification Process for Item 3: (a) Short leads to simulate saturated soil (b) Attach 3.3 V DC to V_{in} (c) Attach 3.3 V DC to V_{in} (d) Ensure analog output is 3.3 V 3. Verification Process for Item 3: (a) Short leads to simulate saturated soil (b) Attach 3.3 V DC in series with ammeter to V_{in}	Arrela Soil Moisture Sensor	11.1 V DC to 3.3 V DC	
2. Analog Output Range 0-3.3 V 3. $I_{max} \leq 5 \text{ mA}$ for $V_{in} = 3.3 \text{ V}$ 1. Verification Process for Item 1: 2. Y (a) Attach 200 Ω resistance between leads (b) Attach voltmeter to analog output pin (c) Attach variable voltage supply to V_{in} (d) Sweep from 3.0 V to 4.0 V and ensure analog output remains within $\pm 10\%$ of original value 2. Verification Process for Item 2: (a) Short leads to simulate saturated soil (b) Attach voltmeter to analog output pin (c) Attach 3.3 V DC to V_{in} (d) Ensure analog output is 0 V (e) Remove 3.3 V DC (f) Remove 3.3 V DC (f) Remove 3.3 V DC to V_{in} (h) Ensure analog output is 3.3 V 3. Verification Process for Item 3: (a) Short leads to simulate saturated soil (b) Attach 3.3 V DC to V_{in} (c) Attach 3.3 V DC to V_{in} (d) Ensure analog output is 3.3 V 3. Verification Process for Item 3: (a) Short leads to simulate saturated soil (b) Attach 3.3 V DC in series with ammeter to V_{in}	1. Functions for 3.0 V $\leq V_{in} \leq 4.0$ V	Switch-Mode Regulators	1. Y
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	2. Analog Output Range 0-3.3 V	 Verification Process for Item 1: (a) Attach 200 Ω resistance between leads (b) Attach voltmeter to analog output pin (c) Attach variable voltage supply to V_{in} (d) Sweep from 3.0 V to 4.0 V and ensure analog output remains within ± 10% of original value Verification Process for Item 2: (a) Short leads to simulate saturated soil (b) Attach voltmeter to analog output pin (c) Attach 3.3 V DC to V_{in} (d) Ensure analog output is 0 V (e) Remove 3.3 V DC (f) Remove short to simulate arid soil (g) Attach 3.3 V DC to V_{in} (h) Ensure analog output is 3.3 V Verification Process for Item 3: (a) Short leads to simulate arid soil (b) Attach 3.3 V DC to V_{in} (c) Attach 3.3 V DC to V_{in} (d) Ensure analog output is 3.3 V 	2. Y
Continued on next page		Continued	on next page

Table 5 – continued from previous page

StatusPhototransistor Bank1. Functions for $3.0 V \le V_{in} \le 4.0 V$ 2. Analog Output Range $0.3.3 V$ 1. Verification Process for Item 1:1. Y3. $I_{max} \le 5 \text{ mA for } V_{in} = 3.3 V$ (a) Attach voltmeter to analog output pin3. Y(b) Attach variable voltage supply to V_{in} (c) Sweep from 3.0 V to 4.0 V and ensure analog output remains within $\pm 10\%$ of original value3. Y(c) Sweep from 3.0 V to 4.0 V and ensure analog output remains within $\pm 10\%$ of original value2. Verification Process for Item 2:(a) Cover sensors with 3 sheets of paper to simulate night(b) Attach voltmeter to analog output pin(c) Attach $3.3 V DC$ to V_{in} (d) Ensure $V_{out} \le 0.2 V$ (e) Remove 3 sheets of paper (f) Ensure $V_{out} \ge 0.2 V$ (f) Ensure $V_{out} \ge 3.1 V$ 3. Verification Process for Item 3:(a) Attach $3.3 V DC$ to V_{in} (b) Ensure $I_{max} \le 5 \text{ mA}$ Minimum Dampness and Minimum Watering Time Knobs1. Function for $3.0 V \le V_{out} \le 3.6 V$ 2. $1.5 V \le V_{out} \le 3.3 V$ (b) Attach variable voltage supply(c) Attach variable voltage supply		Verification	Verification
1. Functions for $3.0 \ V \le V_{in} \le 4.0 \ V$ 1. Verification Process for Item 1:1. Y2. Analog Output Range $0-3.3 \ V$ (a) Attach voltmeter to analog output pin2. Y3. $I_{max} \le 5 \ mA$ for $V_{in} = 3.3 \ V$ (b) Attach variable voltage supply to V_{in} 3. Y(c) Sweep from $3.0 \ V$ to $4.0 \ V$ and ensure analog output remains within $\pm 10\%$ of original value2. Verification Process for Item 2:3. Y(a) Cover sensors with 3 sheets of paper to simulate night(b) Attach voltmeter to analog output pin(c) Attach voltmeter to analog output pin(c) Attach $3.3 \ V \ DC$ to V_{in} (d) Ensure $V_{out} \le 0.2 \ V$ (e) Remove $3 \ Sheets$ of paper(f) Ensure $V_{out} \le 0.2 \ V$ (e) Remove $3 \ Sheets$ of paper(f) Ensure $V_{out} \le 0.1 \ V$ 3. Verification Process for Item 3:3. V(a) Attach $3.3 \ V \ DC$ in series with ammeter to V_{in} (b) Ensure $I_{max} \le 5 \ MA$ 1. YMinimum Dampness and Minimum Watering Time Knobs1. Y1. Y1. Function for $3.0 \ V \le V_{out} \le 3.6 \ V$ 1. Verification Process for Item 1:1. Y(a) Attach voltmeter to analog output pin2. Y			Status
2. Analog Output Range 0-3.3 V 3. $I_{max} \leq 5 \text{ mA}$ for $V_{in} = 3.3 \text{ V}$ (a) Attach voltmeter to analog output pin2. Y 3. Y3. $I_{max} \leq 5 \text{ mA}$ for $V_{in} = 3.3 \text{ V}$ (a) Attach voltmeter to analog output pin2. Y 3. Y(b) Attach variable voltage supply to V_{in} (c) Sweep from 3.0 V to 4.0 V and ensure analog output remains within $\pm 10\%$ of original value3. Y(a) Cover sensors with 3 sheets of paper to simulate night (b) Attach voltmeter to analog output pin (c) Attach 3.3 V DC to V_{in} (d) Ensure $V_{out} \leq 0.2 \text{ V}$ (e) Remove 3 sheets of paper (f) Ensure $V_{out} \geq 3.1 \text{ V}$ (a) Attach 3.3 V DC to V_{in} (b) Ensure $I_{max} \leq 5 \text{ mA}$ 3. Verification Process for Item 3: (a) Attach 3.3 V DC in series with ammeter to V_{in} (b) Ensure $I_{max} \leq 5 \text{ mA}$ Minimum Dampness and Minimum Watering Time Knobs 1. Function for $3.0 \text{ V} \leq V_{out} \leq 3.6 \text{ V}$ 2. $1.5 \text{ V} \leq V_{out} \leq 3.3 \text{ V}$ Minimum Dampness and Minimum Watering Time Knobs 1. Verification Process for Item 1: (a) Attach voltmeter to analog output pin1. Y 2. Y	Phototransistor Bank	Phototransistor Bank	
3. $I_{max} \leq 5 \text{ mA for } V_{in} = 3.3 \text{ V}$ output pin3. Y(b) Attach variable voltage supply to V_{in} (c) Sweep from 3.0 V to 4.0 V and ensure analog output remains within $\pm 10\%$ of original value3. Y(c) Sweep from 3.0 V to 4.0 V and ensure analog output remains within $\pm 10\%$ of original value2. Verification Process for Item 2: (a) Cover sensors with 3 sheets of paper to simulate night (b) Attach voltmeter to analog output pin (c) Attach 3.3 V DC to V_{in} (d) Ensure $V_{out} \leq 0.2 \text{ V}$ (e) Remove 3 sheets of paper (f) Ensure $V_{out} \leq 0.1 \text{ V}$ (a) Attach 3.3 V DC to vin (b) Ensure $I_{max} \leq 5 \text{ mA}$ 3. Verification Process for Item 3: (a) Attach 3.3 V DC in series with ammeter to V_{in} (b) Ensure $I_{max} \leq 5 \text{ mA}$ Minimum Dampness and Minimum Watering Time Knobs 1. Function for $3.0 \text{ V} \leq V_{out} \leq 3.6 \text{ V}$ 2. $1.5 \text{ V} \leq V_{out} \leq 3.3 \text{ V}$ Minimum Dampness and Minimum Value inMatch voltmeter to analog output pin1. Y(a) Attach voltmeter to analog output pin2. Y	1. Functions for 3.0 V $\leq V_{in} \leq 4.0$ V	1. Verification Process for Item 1:	1. Y
3. $I_{max} \leq 5 \text{ mA for } V_{in} = 3.3 \text{ V}$ output pin3. Y(b) Attach variable voltage supply to V_{in} (c) Sweep from 3.0 V to 4.0 V and ensure analog output remains within $\pm 10\%$ of original value3. Y(c) Sweep from 3.0 V to 4.0 V and ensure analog output remains within $\pm 10\%$ of original value2. Verification Process for Item 2: (a) Cover sensors with 3 sheets of paper to simulate night (b) Attach voltmeter to analog output pin (c) Attach 3.3 V DC to V_{in} (d) Ensure $V_{out} \leq 0.2 \text{ V}$ (e) Remove 3 sheets of paper (f) Ensure $V_{out} \leq 0.2 \text{ V}$ (e) Remove 3 sheets of paper (f) Ensure $V_{out} \leq 3.1 \text{ V}$ 3. Verification Process for Item 3: (a) Attach 3.3 V DC in series with ammeter to V_{in} (b) Ensure $I_{max} \leq 5 \text{ mA}$ 1. YMinimum Dampness and Minimum Watering Time Knobs 1. Function for $3.0 \text{ V} \leq V_{out} \leq 3.6 \text{ V}$ 2. $1.5 \text{ V} \leq V_{out} \leq 3.3 \text{ V}$ Minimum Dampness and Minimum Vatering Time Knobs 1. Verification Process for Item 1: (a) Attach voltmeter to analog output pin1. Y		(a) Attach voltmeter to analog	2. Y
Minimum Dampness and Minimum Watering Time KnobsMinimum Dampness and Minimum Watering Time KnobsMinimum Dampness and Minimum Vatual ≤ 3.3 VMinimum Dampness and Minimum (a) Attach voltmeter to analog output pinMinimum Dampness and Minimum Vatering Time KnobsMinimum Dampness and Minimum Vatual ≤ 3.3 V1. Y1. Function for $3.0 \vee \leq V_{out} \leq 3.6$ V $2. 1.5 \vee \leq V_{out} \leq 3.3$ VMinimum Dampness for Item 1: (a) Attach voltmeter to analog output pin1. Y		-	
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$ \begin{array}{c c} \text{ensure analog output remains} \\ \text{within} \pm 10\% \text{ of original value} \\ 2. \ \text{Verification Process for Item 2:} \\ (a) \ \text{Cover sensors with 3 sheets of} \\ paper to simulate night \\ (b) \ \text{Attach voltmeter to analog} \\ output pin \\ (c) \ \text{Attach 3.3 V DC to } V_{in} \\ (d) \ \text{Ensure } V_{out} \leq 0.2 \ \text{V} \\ (e) \ \text{Remove 3 sheets of paper} \\ (f) \ \text{Ensure } V_{out} \geq 3.1 \ \text{V} \\ 3. \ \text{Verification Process for Item 3:} \\ (a) \ \text{Attach 3.3 V DC in series with} \\ ammeter to \ V_{in} \\ (b) \ \text{Ensure } I_{max} \leq 5 \ \text{mA} \\ \end{array} $			
within $\pm 10\%$ of original value2. Verification Process for Item 2: (a) Cover sensors with 3 sheets of paper to simulate night (b) Attach voltmeter to analog output pin (c) Attach 3.3 V DC to V_{in} (d) Ensure $V_{out} \le 0.2$ V (e) Remove 3 sheets of paper (f) Ensure $V_{out} \ge 3.1$ V 3. Verification Process for Item 3: (a) Attach 3.3 V DC in series with ammeter to V_{in} (b) Ensure $I_{max} \le 5$ mAMinimum Dampness and Minimum Watering Time Knobs 1. Function for 3.0 V $\le V_{out} \le 3.6$ V 2. 1.5 V $\le V_{out} \le 3.6$ V (a) Attach voltmeter to analog output pin1. Verification Process for Item 1: (a) Attach voltmeter to analog output pin			
2. Verification Process for Item 2: (a) Cover sensors with 3 sheets of paper to simulate night (b) Attach voltmeter to analog output pin (c) Attach 3.3 V DC to V_{in} (d) Ensure $V_{out} \le 0.2$ V (e) Remove 3 sheets of paper (f) Ensure $V_{out} \ge 3.1$ V 3. Verification Process for Item 3: (a) Attach 3.3 V DC in series with ammeter to V_{in} (b) Ensure $I_{max} \le 5$ mAMinimum Dampness and Minimum Watering Time Knobs 1. Function for 3.0 V $\le V_{out} \le 3.6$ V 2. 1.5 V $\le V_{out} \le 3.6$ V (a) Attach voltmeter to analog output pin1. Y 2. Y			
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$\begin{array}{c c} \mbox{paper to simulate night}\\ (b) \mbox{ Attach voltmeter to analog}\\ \mbox{output pin}\\ (c) \mbox{ Attach 3.3 V DC to } V_{in}\\ (d) \mbox{ Ensure } V_{out} \leq 0.2 \ V\\ (e) \mbox{ Remove 3 sheets of paper}\\ (f) \mbox{ Ensure } V_{out} \geq 3.1 \ V\\ \mbox{ 3. Verification Process for Item 3:}\\ (a) \mbox{ Attach 3.3 V DC in series with}\\ \mbox{ ammeter to } V_{in}\\ (b) \mbox{ Ensure } I_{max} \leq 5 \ mA \end{array}$			
$\begin{array}{c c} \text{output pin} \\ (c) \text{ Attach } 3.3 \text{ V DC to } V_{in} \\ (d) \text{ Ensure } V_{out} \leq 0.2 \text{ V} \\ (e) \text{ Remove } 3 \text{ sheets of paper} \\ (f) \text{ Ensure } V_{out} \geq 3.1 \text{ V} \\ 3. \text{ Verification Process for Item } 3: \\ (a) \text{ Attach } 3.3 \text{ V DC in series with} \\ ammeter \text{ to } V_{in} \\ (b) \text{ Ensure } I_{max} \leq 5 \text{ mA} \\ \end{array}$ $\begin{array}{c} \textbf{Minimum Dampness and Minimum} \\ \textbf{Watering Time Knobs} \\ 1. \text{ Function for } 3.0 \text{ V} \leq V_{out} \leq 3.6 \text{ V} \\ 2. 1.5 \text{ V} \leq V_{out} \leq 3.3 \text{ V} \\ \end{array}$ $\begin{array}{c} \textbf{Minimum Dampness and Minimum} \\ \textbf{Watering Time Knobs} \\ \textbf{Watering Time Knobs} \\ 1. \text{ Verification Process for Item 1:} \\ (a) \text{ Attach voltmeter to analog} \\ output pin \\ \end{array}$			
$ \begin{array}{c c} (c) \mbox{ Attach } 3.3 \mbox{ V DC to } V_{in} \\ (d) \mbox{ Ensure } V_{out} \leq 0.2 \mbox{ V} \\ (e) \mbox{ Remove } 3 \mbox{ sheets of paper} \\ (f) \mbox{ Ensure } V_{out} \geq 3.1 \mbox{ V} \\ 3. \mbox{ Verification Process for Item } 3: \\ (a) \mbox{ Attach } 3.3 \mbox{ V DC in series with} \\ ammeter \mbox{ to } V_{in} \\ (b) \mbox{ Ensure } I_{max} \leq 5 \mbox{ mA} \\ \hline \end{tabular} $			
(d) Ensure $V_{out} \le 0.2$ V (e) Remove 3 sheets of paper (f) Ensure $V_{out} \ge 3.1$ V 3. Verification Process for Item 3: (a) Attach 3.3 V DC in series with ammeter to V_{in} (b) Ensure $I_{max} \le 5$ mAMinimum Dampness and Minimum Watering Time Knobs 1. Function for 3.0 V $\le V_{out} \le 3.6$ V 2. 1.5 V $\le V_{out} \le 3.3$ VMinimum Dampness and Minimum Vatering Time Knobs 1. Verification Process for Item 1: (a) Attach voltmeter to analog output pin1. Y 2. Y			
(e) Remove 3 sheets of paper (f) Ensure $V_{out} \ge 3.1 \text{ V}$ (f) Ensure $V_{out} \ge 3.1 \text{ V}$ (g) Attach 3.3 V DC in series with ammeter to V_{in} (b) Ensure $I_{max} \le 5 \text{ mA}$ Minimum Dampness and Minimum Watering Time KnobsMinimum for $3.0 \text{ V} \le V_{out} \le 3.6 \text{ V}$ 1. Function for $3.0 \text{ V} \le V_{out} \le 3.6 \text{ V}$ 2. $1.5 \text{ V} \le V_{out} \le 3.3 \text{ V}$			
(f) Ensure $V_{out} \ge 3.1 \text{ V}$ 3. Verification Process for Item 3: (a) Attach 3.3 V DC in series with ammeter to V_{in} (b) Ensure $I_{max} \le 5 \text{ mA}$ Minimum Dampness and Minimum Watering Time Knobs 1. Function for $3.0 \text{ V} \le V_{out} \le 3.6 \text{ V}$ 2. $1.5 \text{ V} \le V_{out} \le 3.3 \text{ V}$ Minimum Dampness and Minimum Vatering Time Knobs (a) Attach voltmeter to analog output pin			
3. Verification Process for Item 3: (a) Attach 3.3 V DC in series with ammeter to V_{in} (b) Ensure $I_{max} \leq 5 \text{ mA}$ Minimum Dampness and Minimum Watering Time Knobs 1. Function for $3.0 \text{ V} \leq V_{out} \leq 3.6 \text{ V}$ 2. $1.5 \text{ V} \leq V_{out} \leq 3.3 \text{ V}$ Minimum Dampness and Minimum Watering Time Knobs 1. Verification Process for Item 1: (a) Attach voltmeter to analog output pin1. Y 2. Y		(e) Remove 3 sheets of paper	
(a) Attach 3.3 V DC in series with ammeter to V_{in} (b) Ensure $I_{max} \leq 5 \text{ mA}$ Minimum Dampness and Minimum Watering Time KnobsMinimum Dampness and Minimum Watering Time Knobs1. Function for $3.0 \text{ V} \leq V_{out} \leq 3.6 \text{ V}$ 2. $1.5 \text{ V} \leq V_{out} \leq 3.3 \text{ V}$ Minimum Dampness for Item 1: (a) Attach voltmeter to analog output pin		(f) Ensure $V_{out} \ge 3.1 \text{ V}$	
ammeter to V_{in} (b) Ensure $I_{max} \leq 5 \text{ mA}$ Minimum Dampness and Minimum Watering Time KnobsMinimum Dampness and Minimum Watering Time Knobs1. Function for $3.0 \text{ V} \leq V_{out} \leq 3.6 \text{ V}$ 2. $1.5 \text{ V} \leq V_{out} \leq 3.3 \text{ V}$ Minimum Dampness and Minimum Watering Time Knobs1. Verification Process for Item 1: (a) Attach voltmeter to analog output pin1. Y 2. Y		3. Verification Process for Item 3:	
(b) Ensure $I_{max} \le 5 \text{ mA}$ Minimum Dampness and Minimum Watering Time KnobsMinimum Dampness and Minimum Watering Time Knobs1. Function for $3.0 \text{ V} \le V_{out} \le 3.6 \text{ V}$ 1. Verification Process for Item 1: (a) Attach voltmeter to analog output pin1. Y		(a) Attach 3.3 V DC in series with	
Minimum Dampness and Minimum Watering Time KnobsMinimum Dampness and Minimum Watering Time Knobs1. Y1. Function for $3.0 \text{ V} \le V_{out} \le 3.6 \text{ V}$ 1. Verification Process for Item 1: (a) Attach voltmeter to analog output pin2. Y		ammeter to V_{in}	
Watering Time KnobsWatering Time Knobs1. Y1. Function for $3.0 \text{ V} \le V_{out} \le 3.6 \text{ V}$ 1. Verification Process for Item 1:2. Y2. $1.5 \text{ V} \le V_{out} \le 3.3 \text{ V}$ (a) Attach voltmeter to analog output pin1. Y		(b) Ensure $I_{max} \leq 5 \text{ mA}$	
Watering Time KnobsWatering Time Knobs1. Y1. Function for $3.0 \text{ V} \le V_{out} \le 3.6 \text{ V}$ 1. Verification Process for Item 1:2. Y2. $1.5 \text{ V} \le V_{out} \le 3.3 \text{ V}$ (a) Attach voltmeter to analog output pin1. Y	nimum Dampness and Minimum	Minimum Dampness and Minimum	
1. Function for $3.0 \ V \le V_{out} \le 3.6 \ V$ 1. Verification Process for Item 1:2. Y2. $1.5 \ V \le V_{out} \le 3.3 \ V$ (a) Attach voltmeter to analog output pin			1. Y
2. $1.5 \text{ V} \le V_{out} \le 3.3 \text{ V}$ (a) Attach voltmeter to analog output pin	-		
output pin			
		-	
(b) Attach variable voltage supply			
to V_{in}			
(c) Sweep from 3.0 V to 3.6 V and			
ensure analog output remains within $\pm 25\%$ of original value			
within $\pm 25\%$ of original value		-	
2. Verification Process for Item 2:			
(a) Set knob to 0			
(b) Attach voltmeter to analog		-	
output pin			
(c) Attach 3.3 V to V_{in}			
(d) Ensure 1.4 V $\leq V_{out} \leq 1.6$ V			
(e) Sweep knob to maximum			
(f) Ensure 3.1 V $\leq V_{out}$		(f) Ensure 3.1 V $\leq V_{out}$	
Continued on next pa			

Table 5 – continued from previous page

Water Now and 6 Hour Suspend Push ButtonsWater Now and 6 Hour Suspend Push Buttons1. Y1. Function for 9.0 V $V_{out} \le 12.6$ V 2. Digital Output: 0 V and 2 V $\le V_{out}$ 1. Verification Process for Item 1: (a) Attach voltmeter to analog output pin (b) Attach variable voltage supply to V_{in} 1. Y2. Digital Output: 0 V and 2 V $\le V_{out}$ 2. Verification Process for Item 2: (a) Attach variable voltage supply to V_{in} 1. Y(a) Controller: Digital Output(a) Attach voltmeter to V_{out} 2. Y(b) Attach voltmeter to $V_{out} \le 0.2$ V(a) Attach 11.1 V to V_{in} (b) Attach voltmeter to $V_{out} \le 0.2$ V(d) When switch is pressed, cnsure $V_{out} \le 0.2$ V(c) Digital 0 corresponds to $V_{out} \le 0.2$ V2. Y(d) When switch is pressed, cnsure $V_{out} \le 0.2$ V1. Y2. Digital 1 corresponds to $V_{out} \ge 3.0$ V2. Verification Process for Item 1: (a) Power controller with 3.3 V (b) Upload code setting all digital pins to OUTPUT LOW (c) Probe each pin to ensure $V_{out} \le 0.2$ V1. Y2. Digital 1 corresponds to $V_{out} \le 0.2$ V2. Verification Process for Item 1: (a) Power controller with 3.3 V (b) Upload code setting all digital pins to OUTPUT HIGH (c) Probe each pin to ensure $V_{out} \ge 3.0$ V1. Y2. Digital 1 corresponds to $V_{out} \ge 3.0$ V1. Verification Process for Item 1: (a) Power controller with 3.3 V (b) Attach all digital pins to 0.2 V (c) Upload code setting all digitatial pins to 0.2 V (c) Upload code setting all digitatial pins to 0.3 V (c) Upload code setting all digitatial pins to 0.3 V (c) Upload code setting all digitatial pins to 0.3 V (c) Upload code setting al	Requirement	Verification	Verification
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	Water Now and 6 Hour Suspend Push Buttons 1. Function for 9.0 V≤ Vout ≤ 12.6 V	Water Now and 6 Hour Suspend Push Buttons1. Verification Process for Item 1:(a) Attach voltmeter to analog output pin(b) Attach variable voltage supply to V_{in} (c) Sweep from 9.0 V to 12.6 V and ensure verification require- ment 2 is still true2. Verification Process for Item 2:(a) Attach 11.1 V to V_{in} (b) Attach voltmeter to V_{out} (c) When switch is not pressed, ensure $V_{out} \ge 2 V$ (d) When switch is pressed, ensure	Status 1. Y
1. Digital 0 corresponds to $V_{out} \le 0.2$ V1. Verification Process for Item 1: (a) Power controller with 3.3 V (b) Attach all digital pins to 0.2 V (c) Upload code setting all digital pins to INPUT and printing the values via Serial 	 Digital 0 corresponds to V_{out} ≤ 0.2 V Digital 1 corresponds to V_{out} ≥ 3.0 	 Controller: Digital Output 1. Verification Process for Item 1: (a) Power controller with 3.3 V (b) Upload code setting all digital pins to OUTPUT LOW (c) Probe each pin to ensure Vout ≤ 0.2 V 2. Verification Process for Item 2: (a) Power controller with 3.3 V (b) Upload code setting all digital pins to OUTPUT HIGH (c) Probe each pin to ensure 	
(d) Ensure value obtained is 1	1. Digital 0 corresponds to $V_{out} \leq 0.2$ V	 Verification Process for Item 1: (a) Power controller with 3.3 V (b) Attach all digital pins to 0.2 V (c) Upload code setting all digital pins to INPUT and printing the values via Serial (d) Ensure value obtained is 0 Verification Process for Item 2: (a) Power controller with 3.3 V (b) Attach all digital pins to 3.0 V (c) Upload code setting all digital pins to INPUT and printing the values via Serial 	

Table 5 – continued from previous page

Requirement	Verification	Verification
-		Status
Controller: Analog Input Properly quantize analog inputs to 0-1023 	 Controller: Analog Input 1. Verification Process for Item 1: (a) Power controller with 3.3 V (b) Attach all analog pins to variable voltage source (c) Upload code setting all digital pins to INPUT and printing the values via Serial (d) Slowly sweep input voltage and check for proper quantization 	1. Y
Controller: Pulse Width Modulation 1. f = 31.25 kHz on pin 5	Controller: Pulse Width Modulation 1. Verification Process for Item 1: (a) Power controller with 3.3 V (b) Attach oscilloscope probe to output of pin 5 (c) Upload code setting pin 5 to square wave with 50% duty cy- cle (d) Using oscilloscope functions, verify that f = 31.25 kHz	1. Y
Controller: V_{in} Tolerance 1. Device can function for 3.0 V $\leq V_{in} \leq 3.6$ V	 Controller: V_{in} Tolerance 1. Verification Process for Item 1: (a) Power controller with variable voltage source, starting at V_{in} = 3.0 V (b) Upload code setting all pins to OUTPUT HIGH (c) Probe each output voltage, ensuring V_{out} = 3.3 V ± 0.3 V (d) Sweep variable voltage source in increments of 0.1 V, measuring output voltages for each each input voltage 	1. Y
	Continued	on next page

Table 5 – continued from previous page

Requirement	Verification Verificati		
		Status	
Controller: Low Power	Controller: Low Power		
Consumption	Consumption	1. Y	
1. $I_{max} \le 10 \text{ mA at } 3.3 \text{ V}$	1. Verification Process for Item 1:	2. Y	
2. $I_{max} \leq 100 \ \mu \text{A}$ at 3.3 V	 (a) Power controller with 3.3 V, attaching an ammeter in series with supply (b) Execute crop maintenance program for 1000 iterations, measuring average current consumed (c) Ensure I_{ave} ≤ 10 mA 2. Verification Process for Item 2: (a) Power controller with 3.3 V, attaching an ammeter in series with supply (b) Place controller in SLEEP_MODE_PWR_DOWN sleep state for 5 minutes, measuring average current consumed (c) Ensure I_{ave} ≤ 100 μA 		
Solenoid Valve 1. $I_{max} \leq 200 \text{ mA at } 7.0 \text{ V}$ 2. Valve opens for $V_{in} \geq 7.0 \text{ V}$	11.1 V DC to 3.3 V DCSwitch-Mode Regulators1. Verification Process for Item 1:(a) Power solenoid valve with 7.0V, attaching an ammeter in series with supply(b) Ensure $I_{max} \leq 200$ mA when valve is open2. Verification Process for Item 2:(a) Power solenoid valve with 7.0V(b) Ensure valve opens properly	1. Y 2. Y	

Table 5 – continued	l from	previous	page
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