Appendix A Requirement and Verification Table

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

Table 5: System Requirements and Verifications

Requirement	Verification	Verification status
11.1 V DC Linear Rectifier 1. V_{out} = 11.1 V ± 0.1 V at 200 mA	**11.1 V DC Linear Rectifier** 1. 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 ± 0.3 V at 100 μA	**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 Converter 1. V_{out} = 7.0 V ± 0.7 V at 200 mA	**11.1 V DC to 7.0 V DC Buck 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

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

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Table 5 – continued from previous page

Requirement	Verification	Verification Status
Arrela Soil Moisture Sensor 1. Functions for 3.0 V $\leq V_{in} \leq$ 4.0 V 2. Analog Output Range 0-3.3 V 3. $I_{max} \leq$ 5 mA for V_{in} = 3.3 V	**11.1 V DC to 3.3 V DC Switch-Mode Regulators** 1. 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 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 short to simulate arid soil (g) Attach 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 in series with ammeter to V_{in} (c) Ensure $I_{max} \leq$ 5 mA	1. Y 2. Y 3. Y

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Table 5 – continued from previous page

Requirement	Verification	Verification Status
Phototransistor Bank 1. Functions for 3.0 V $\leq V_{in} \leq$ 4.0 V 2. Analog Output Range 0-3.3 V 3. $I_{max} \leq$ 5 mA for V_{in} = 3.3 V	**Phototransistor Bank** 1. Verification Process for Item 1: (a) Attach voltmeter to analog output pin (b) Attach variable voltage supply to V_{in} (c) Sweep from 3.0 V to 4.0 V and ensure analog output remains within ± 10% of original value 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 $V_{out} \leq$ 0.2 V (e) Remove 3 sheets of paper (f) Ensure $V_{out} \geq$ 3.1 V 3. Verification Process for Item 3: (a) Attach 3.3 V DC in series with ammeter to V_{in} (b) Ensure $I_{max} \leq$ 5 mA	1. Y 2. Y 3. Y
Minimum Dampness and Minimum Watering Time Knobs 1. Function for 3.0 V$\leq V_{out} \leq$ 3.6 V 2. 1.5 V $\leq V_{out} \leq$ 3.3 V	**Minimum Dampness and Minimum Watering Time Knobs** 1. Verification Process for Item 1: (a) Attach voltmeter to analog 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 ± 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 $\leq V_{out}$	1. Y 2. Y

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Requirement	Verification	Verification Status
Water Now and 6 Hour Suspend Push Buttons 1. Function for 9.0 V$\leq V_{out} \leq$ 12.6 V 2. Digital Output: 0 V and 2 V $\leq V_{out}$	**Water Now and 6 Hour Suspend Push Buttons** 1. 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 requirement 2 is still true 2. 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 $V_{out} \geq$ 2 V (d) When switch is pressed, ensure $V_{out} \leq$ 0.2 V	1. Y 2. Y
Controller: Digital Output 1. Digital 0 corresponds to $V_{out} \leq$ 0.2 V 2. Digital 1 corresponds to $V_{out} \geq$ 3.0 V	**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 $V_{out} \leq$ 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 $V_{out} \geq$ 3.0 V	1. Y 2. Y
Controller: Digital Input 1. Digital 0 corresponds to $V_{out} \leq$ 0.2 V 2. Digital 1 corresponds to $V_{out} \geq$ 3.0 V	**Controller: Digital Input** 1. 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 2. 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 (d) Ensure value obtained is 1	1. Y 2. Y

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Requirement	Verification	Verification Status
Controller: Analog Input 1. 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 cycle (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 $\pm$ 0.3 V (d) Sweep variable voltage source in increments of 0.1 V, measuring output voltages for each each input voltage	1. Y

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Requirement	Verification	Verification Status
Controller: Low Power Consumption 1. $I_{max} \leq 10$ mA at 3.3 V 2. $I_{max} \leq 100$ μA at 3.3 V	**Controller: Low Power Consumption** 1. Verification Process for Item 1: (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 $I_{ave} \leq 10$ 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 $I_{ave} \leq 100$ μA	1. Y 2. Y
Solenoid Valve 1. $I_{max} \leq 200$ mA at 7.0 V 2. Valve opens for $V_{in} \geq 7.0$ V	**11.1 V DC to 3.3 V DC Switch-Mode Regulators** 1. Verification Process for Item 1: (a) Power solenoid valve with 7.0 V, attaching an ammeter in series with supply (b) Ensure $I_{max} \leq 200$ mA when valve is open 2. Verification Process for Item 2: (a) Power solenoid valve with 7.0 V (b) Ensure valve opens properly	1. Y 2. Y