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CRITICAL DESIGN DOCUMENT

Automatic Indoor Grow Enclosure

EETD 4001
2024-12-11

Concept of operations:

Our project is about making Automatic Indoor Grow Enclosure (A.I.G.E.) the task of which is to keep plant growing in required conditions for it to develop healthy. Main functionalities consist from watering the plant, regulating temperature and humidity, giving light at specific time, have a constant airflow and show desired measurements on screen.

Display will show the important readings (Moister, Humidity, Vapor Pressure Deficit, and Temperature) to monitor the life of the plant in its vegetation stage. Will be updated and shown in real-time. Device will have initial setup by allowing user to choose desired temperature, humidity and moisture with buttons, through prompts when the device gets turned on.

Sensors will help with detecting and adjusting the vapor pressure deficit (VPD) level stable. VPD helps you identify the correct range of temperature and humidity to aim for in your grow space. Our ideal value for VPD would be around 1 kPa and we should make our value as close to it as possible to this, it should be no lower than 0.8 kPa and not bigger than 1.5 kPa.

Requirements:

1) LCD Display:

a) Shall incorporate an LCD display that is backlit and has 4 rows and can fit 20 characters in each line.
b) Shall display the soil moisture level.
c) The soil moisture level shall be shown as a percentage.
d) Shall display the current temperature of the enclosure
e) The enclosure's temperature shall be shown in Celsius.
f) Shall display the air vapor pressure deficit (VPD).
g) VPD shall be calculated from configured values and measured values.
h) The air vapor pressure deficit shall be shown as a ratio in kilopascals.
i) Interface to the LCD shall be via the UART peripheral.
j) LCD shall show prompt on initial configuration of humidity.
k) LCD shall show prompt on initial configuration of moisture.
l) LCD shall show prompt on initial configuration of temperature.
m) LCD shall show error screen in situation in which humidity and temperature are not compatible, producing poor VPD.

2) Temperature, humidity and moisture regulation system:

a) Temperature shall be measured with a sensor in Celsius.
b) Humidity shall be measured with sensor to determine the relative humidity in percentage.
c) A fan shall be used to aid in circulating airflow for temperature and humidity.
d) Fan shall turn on automatically to help circulate airflow

e) Fan shall be triggered when either humidity or temperature is above initial values made from LCD setup prompts.
f) Fan shall be controlled from the PIC.
g) Moisture sensor shall be placed bellow the indicated white warning line in soil.
h) Pump shall irrigate the plant.
i) Pump shall be controlled from the PIC
j) Pump shall start watering when moisture goes lower than desired when sensed.
k) Water tubing should be long enough to get from pump to enclosure.
l) Water shall be stored in the container.
m) Container should hold at least a liter of water.
n) Container should not be bigger than five liters for practicality.
o) Sensors shall be put on cables, so that they can be put into the enclosure for the plant.

3) Enclosure for the plant:

a) There shall be an enclosure that can fit the desired plants.
b) Enclosure shall be 30cm x 30cm x 50cm.
c) Enclosure shall fit the desired plant.
d) There shall be Grow light for heat and light for plants.
e) The light will turn off and on automatically.
f) The light should be independent from our other circuits.
g) Enclosure shall have mounting for fans, lights, cables for sensors and water tubing.
h) Enclosure will have small ventilation for circulating air.
i) There will be a fan for just air circulation.

4) Enclosure for electronics and LCD display:

a) There shall be an enclosure to store main logic components for the system to work.
b) Enclosure shall be a closed box shape.
c) Enclosure shall be easy to disassemble.
d) Enclosure should have long cables coming out of it for plant enclosure, water pump and power.
e) Electronics shall be powered from the wall outlet using 12V DC power supply.
f) There shall be one button for turning on the device.
g) There shall be up button and down buttons for selecting thresholds in initial prompts, that select humidity, temperature and moisture values on LCD.
h) There shall be OK button that confirms selected thresholds and moves on to another stage in initial setup using prompts.

Project Breakdown:

Number	Name	Duration	Start	Finish	Notes
1	**Core system Component test**	**34 days**	**Wednesday, October 23, 2024**	**Monday, November 25, 2024**	
1.1	Irrigation system	3 days	Wednesday, October 23, 2024	Friday, October 25, 2024	Completed
1.1.1	Test Sensing component	1 day	Monday, October 28, 2024	Monday, October 28, 2024	Completed
1.1.2	Write working Irrigation code	1 day	Tuesday, October 29, 2024	Tuesday, October 29, 2024	Completed
1.1.3	Test system code with Hardware	1 day	Wednesday, October 30, 2024	Wednesday, October 30, 2024	Completed
1.2	VPD Regulation system	19 days	Thursday, November 7, 2024	Monday, November 25, 2024	Completed
1.2.1	Test Sensing components	5 days	Thursday, November 7, 2024	Friday, November 22, 2024	Completed
1.2.2	Write working VPD Regulation Code	7 days	Friday, November 22, 2024	Sunday, November 24, 2024	Completed
1.2.3	Test system code with Hardware	7 day	Sunday, November 24, 2024	Monday, November 25, 2024	Completed
2	**LCD Display Interface**	**3 days**	**Monday, November 25, 2024**	**Wednesday, November 27, 2024**	
2.1	Test Hardware components	1 day	Monday, November 25, 2024	Monday, November 25, 2024	Completed
2.2	Write working LCD code interface	1 day	Monday, November 25, 2024	Monday, November 25, 2024	Completed
2.3	Write working button controll code	1 day	Tuesday, November 26, 2024	Tuesday, November 26, 2024	Completed
2.4	Test system code with Hardware	2 days	Tuesday, November 26, 2024	Wednesday, November 27, 2024	Completed
3	**Enclosure Designing**	**9 days**	**Wednesday, November 27, 2024**	**Thursday, December 5, 2024**	
3.1	PCB Design	1 days	Tuesday, November 26, 2024	Tuesday, November 26, 2024	Completed
3.2	Enclosure designs	4 days	Wednesday, November 27, 2024	Monday, December 2, 2024	Completed
3.3	Hardware intergration	2 days	Tuesday, December 3, 2024	Wednesday, December 4, 2024	Completed
3.4	System hardware & Software intergratio	1 day	Thursday, December 5, 2024	Thursday, December 5, 2024	Completed
4	**Final Modifications & calibrations**	**5 days**	**Friday, December 6, 2024**	**Tuesday, December 10, 2024**	
4.1	Demo day & presentaion	5 days	Friday, December 6, 2024	Tuesday, December 10, 2024	Completed

Final Code:

Code link

Hardware Design:

FIGURE 1 – PLANT ENCLOSURE BUILD

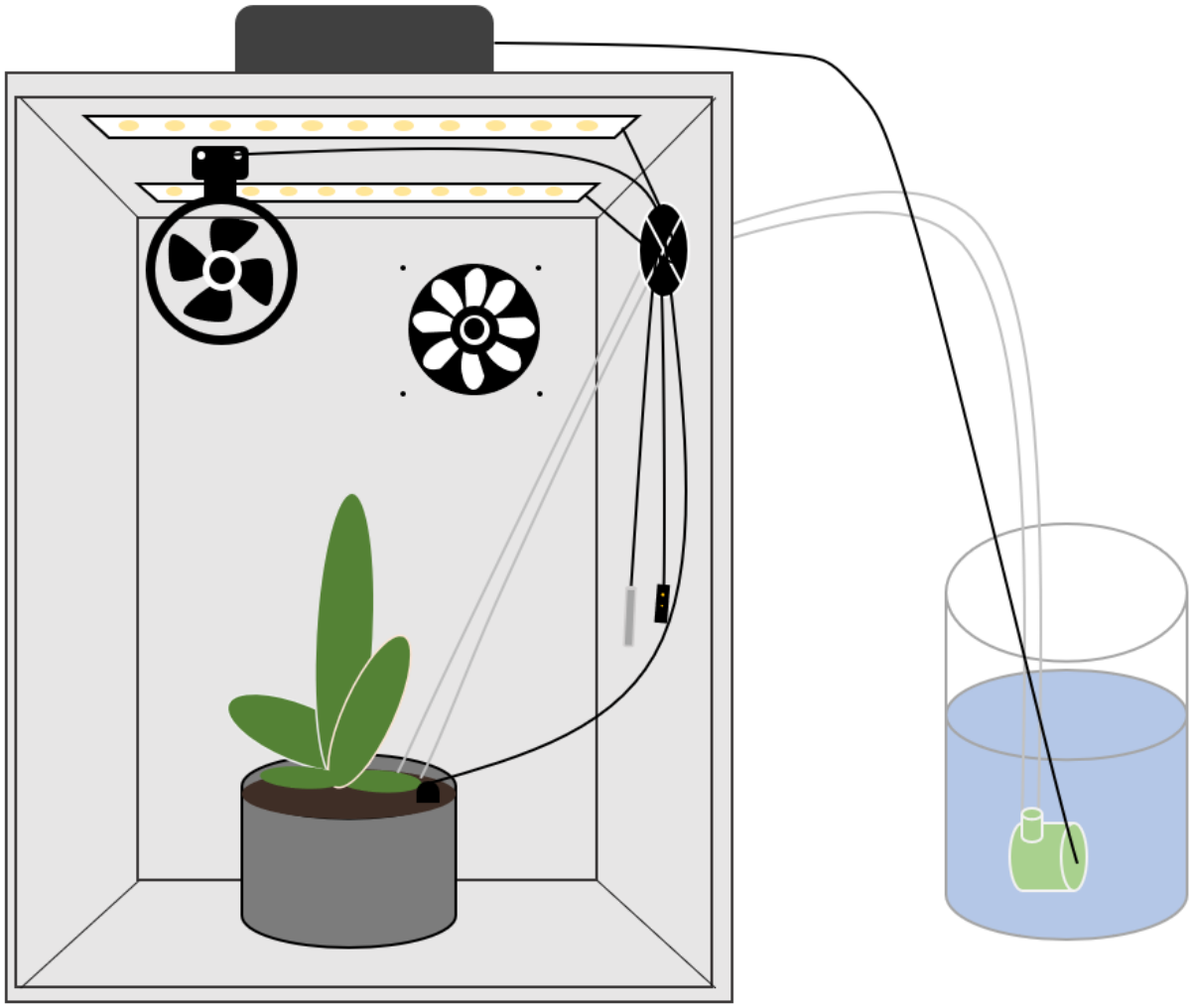


FIGURE 2 – ELECTRONICS ENCLOSURE TOP

FIGURE 3 – ELECTRONICS ENCLOSURE BACK

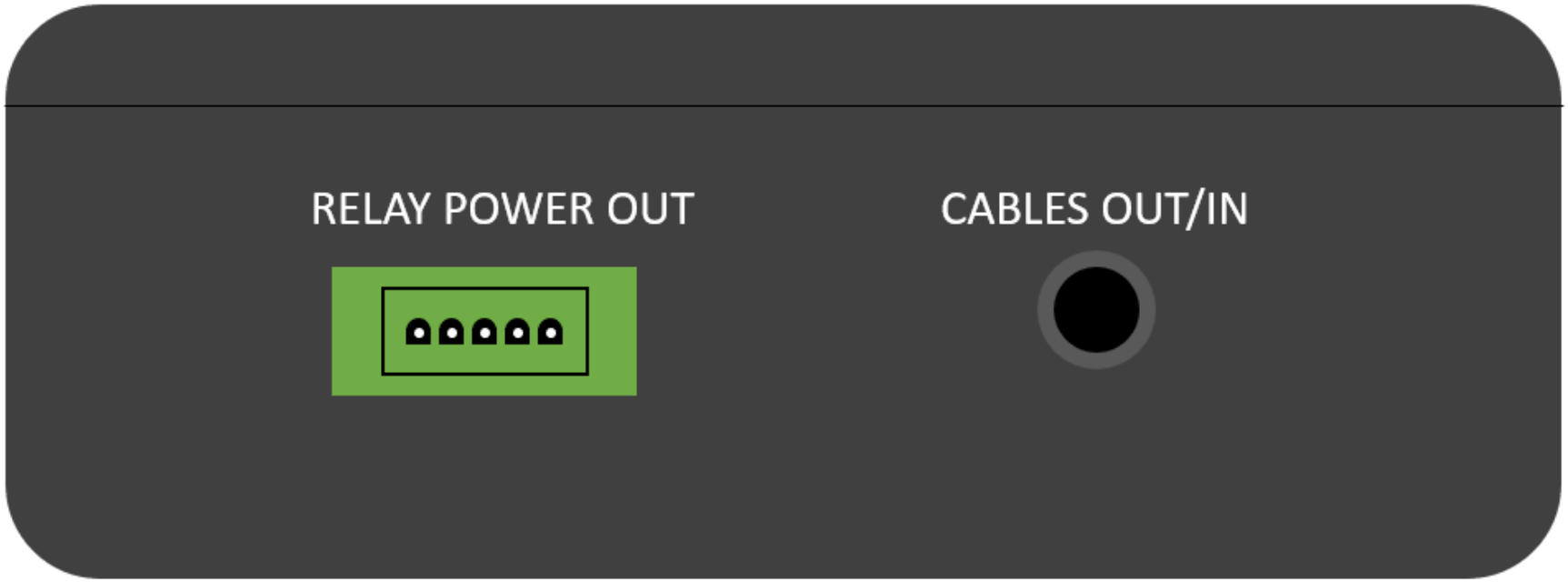


FIGURE 4 – CIRCUIT BOARD LAYOUT

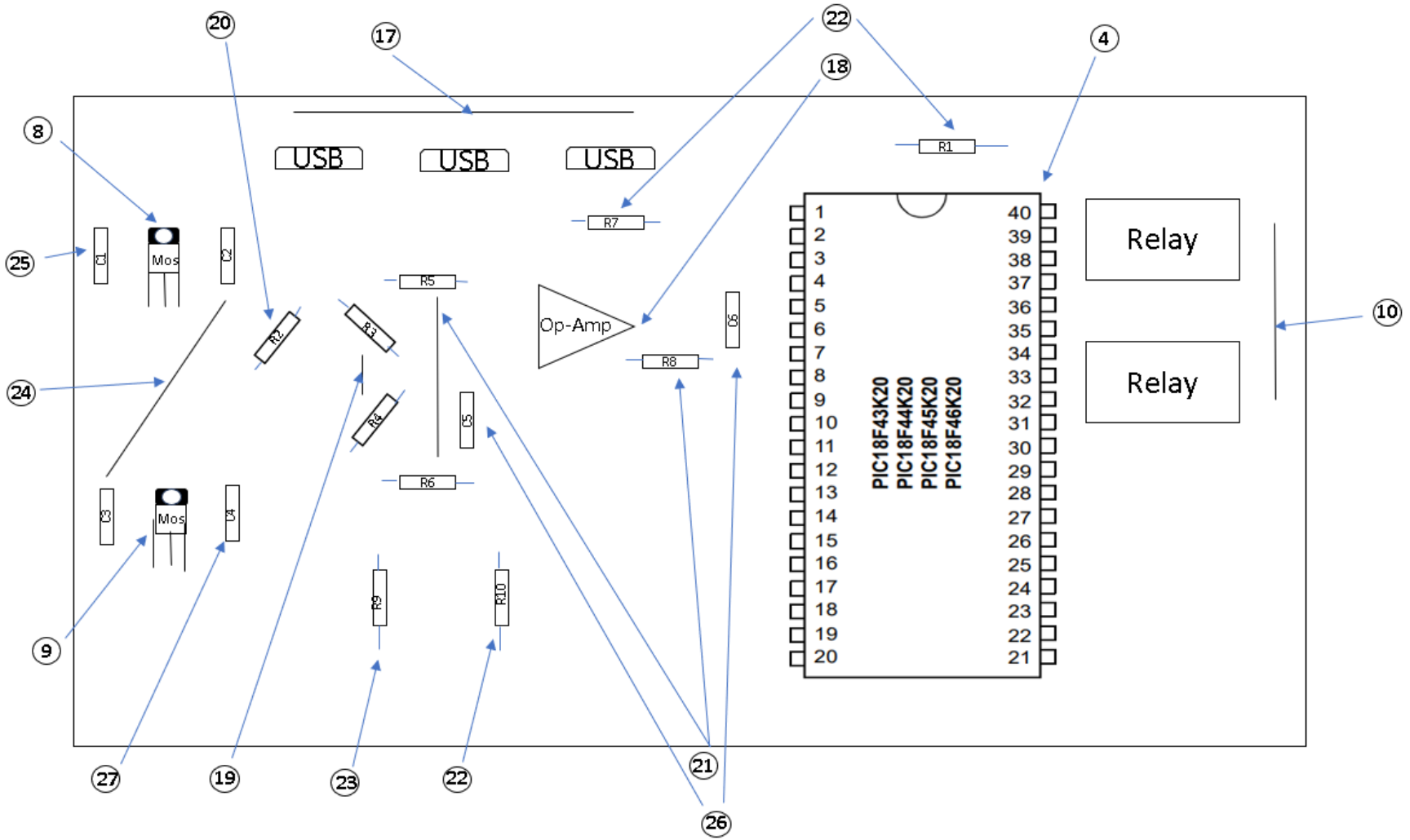
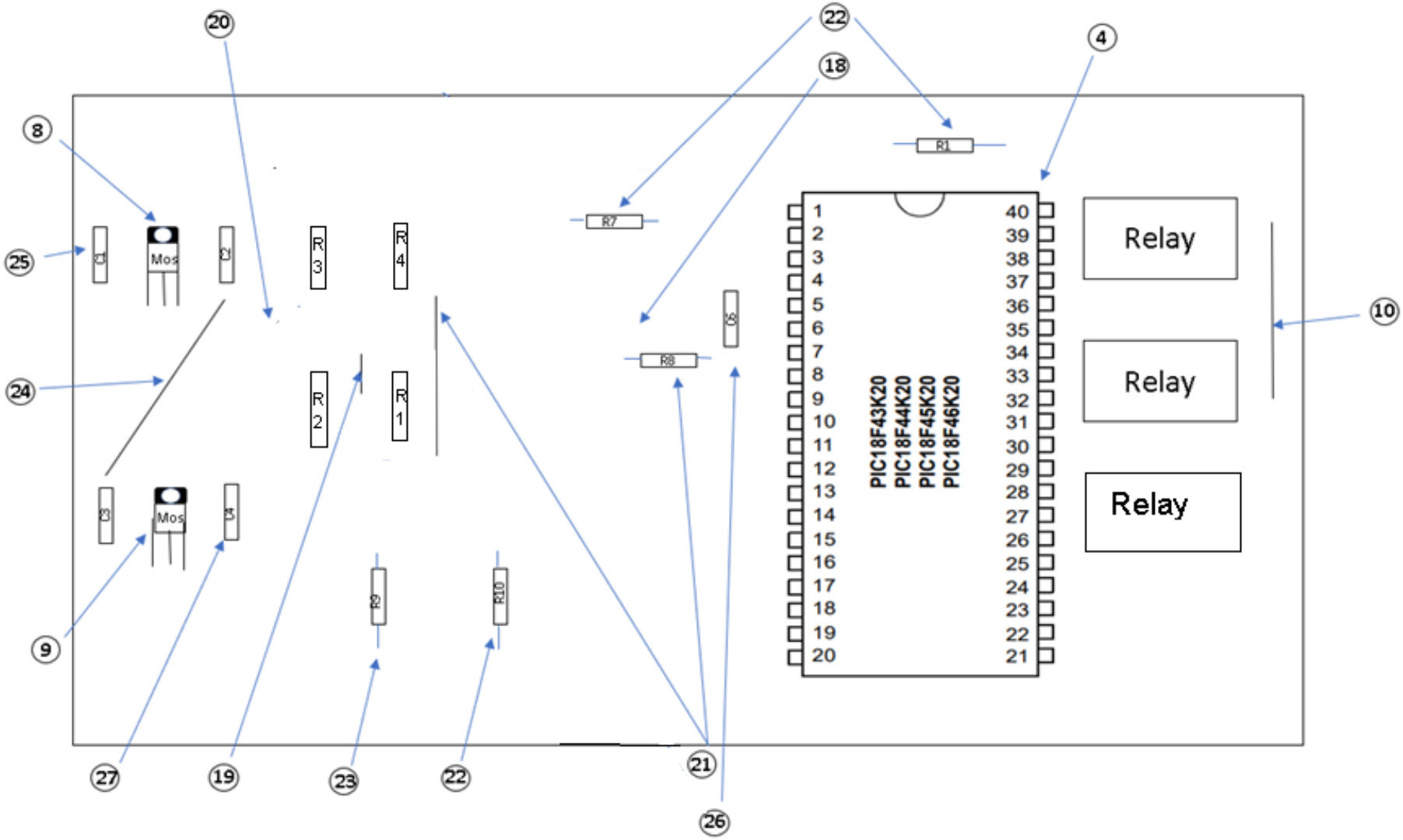
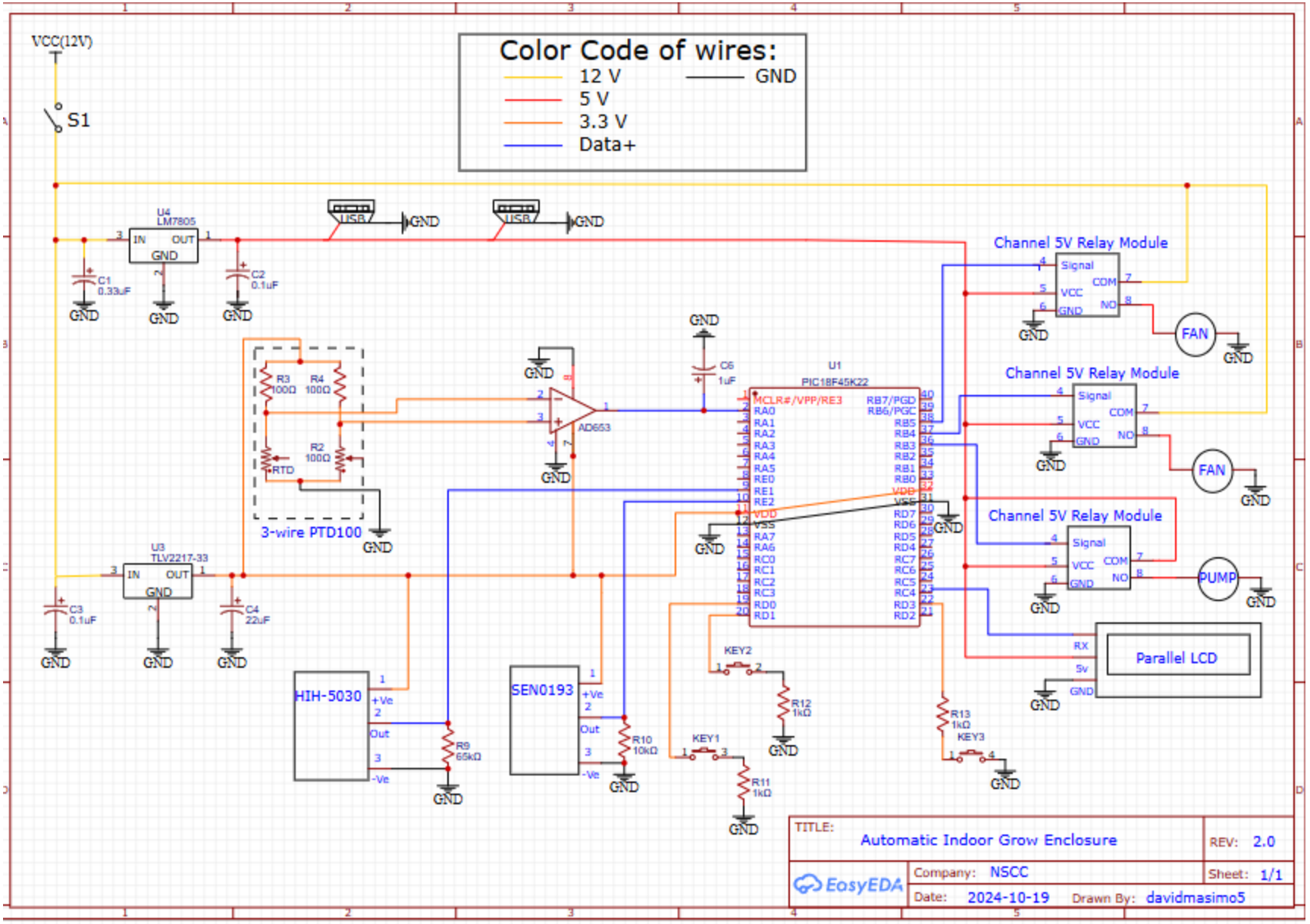


TABLE 1 – PARTS LIST

Item	Qty	Part Number	Description
1	1	PB187-6	Intake Fan
2	1	FBL09A12H	Exhaust Fan
3	1	27976	Parallax Serial LCD
4	1	Pic18f45k20	Microcontroller
5	1	PT100 RTD	Temperature sensor
6	1	HIH- 4010	Humidity Sensor
7	1	SEN0193	Soil Moister Sensor
8	1	Fp0125 LM7805C	12V to 5V voltage regulator
9	1	BCM394E TLV2217-33	12V to 3.3V voltage regulator
10	2	JT-DC3V-4.5	5V Relay
11	2	Kullsinss LED Grow Lights	Grow Lights
12	1	JT-DC3W	Mini Water Pump
13	1	TP30	Vinyl Tubing
14	1	EADP-30FB A	Power brick 12V
15	1	Single pole	Switch
16	3	Push Button	Key button(1,2,3)
17	3	USB Port	Repurposed USB Port
18	1	AD623	Instrumentation Amplifier
19	2	UXB02070F1000BR100	100 Ω Resistor(R3,R4)
20	1	3362p	100 Ω Adjustable pot(R2)
22	1		100k Ω Adjustable pot(R2)
23	3	CF14JT10K0	10k Ω Resistor (R1,R7,R10)
24	1	MFR-25FTF52-65K	65k Ω Resistor (R9)
25	5	UKT1H0R1MDD1TD	0.1uF Capacitor(C2,C3)
26	2	URS1HR33MDD1TD	0.33uF Capacitor(C1,C3)
28	1	URZ1HR22MDD1TD	22uF Capacitor (C4)
29	1	TBD	Water Tank
30	1		4 Terminal connectors

FIGURE 5 – CIRCUIT SCHEMATIC




Color Code of wires:
12 V
5 V
3.3 V
Data+
GND
VCC(12V)
S1
U4
LM7805
IN
OUT
GND
C1
0.33uF
C2
0.1uF
USB
U3
TLV2217-33
C3
0.1uF
C4
22uF
R3
100Ω
R4
100Ω
R2
100Ω
RTD
3-wire PTD100
AD653
C6
1uF
U1
PIC18F45K22
MCLR#/VPP/RE3
RB7/PGD
RB6/PGC
VDD
VSS
HIH-5030
+Ve
Out
-Ve
R9
65kΩ
SEN0193
R10
10kΩ
KEY1
KEY2
KEY3
R11
1kΩ
R12
1kΩ
R13
1kΩ
Channel 5V Relay Module
Signal
VCC
COM
NO
FAN
PUMP
Parallel LCD
RX
5v
TITLE:
Automatic Indoor Grow Enclosure
REV: 2.0
EasyEDA
Company: NSCC
Sheet: 1/1
Date: 2024-10-19
Drawn By: davidmasimo5

Test Procedures:

Test	Requirement	Test Steps	Pass/Fail
1	**1, 4**	Turn on the device with on/off switch and see if LCD screen is on. LCD should start by giving you the first prompt for setup. That will show that device received the power required for it to work.	
2	**1, 4**	After turning device on go through setup prompts that tell you to put temperature, humidity and moisture (Make sure that the water pump tubing is put in the plant already together with moisture sensor). After that it should show the screen confirming inputted values with threshold VPD and then will show real time measurements and measured VPD value. That will show that buttons are working.	
3	**2**	To test temperature and its regulation by fan, hold the temperature sensor in your hand or other warm object that is warmer than the threshold temperature from setup prompt, and keep it on sensor. If LCD shows that temperature went higher and regulation fan is spinning, then everything works.	
4	**2**	To test humidity and its regulation by fan, exhale on the humidity sensor or use some other means to give vapor to sensor to test the threshold humidity from setup prompt. If LCD shows that humidity went higher and regulation fan is spinning, then everything works.	
5	**2**	To test moisture and its regulation by water pump, put water pump tubing into some container that would hold water. Then hold the moisture sensor in the air (make sure that there is no water on it) to test the threshold moisture from setup prompt (it will	

		make moisture go to 0% or close to it). If LCD shows that humidity went higher and pump starts to putout water then its good. To test if pump can stop pumping water, put sensor in water. If water stops coming out of pump, then everything works.	
6	**3**	To test the lights, make sure it's powered through USB power brick. Then when its light up, through light controller buttons, configure the lights to a needed configuration (select light color, dimming and light cycle). When setup is complete, the light color and dimming should be visible right away, but the light cycle can be only checked after one is complete (if placed for 6 hours, then check the lights after 6 hours of work, it should be off by then).	
7	**3**	To test the circulation fan, use same procedure as for temperature and humidity regulation fan, logic should be same for both.	