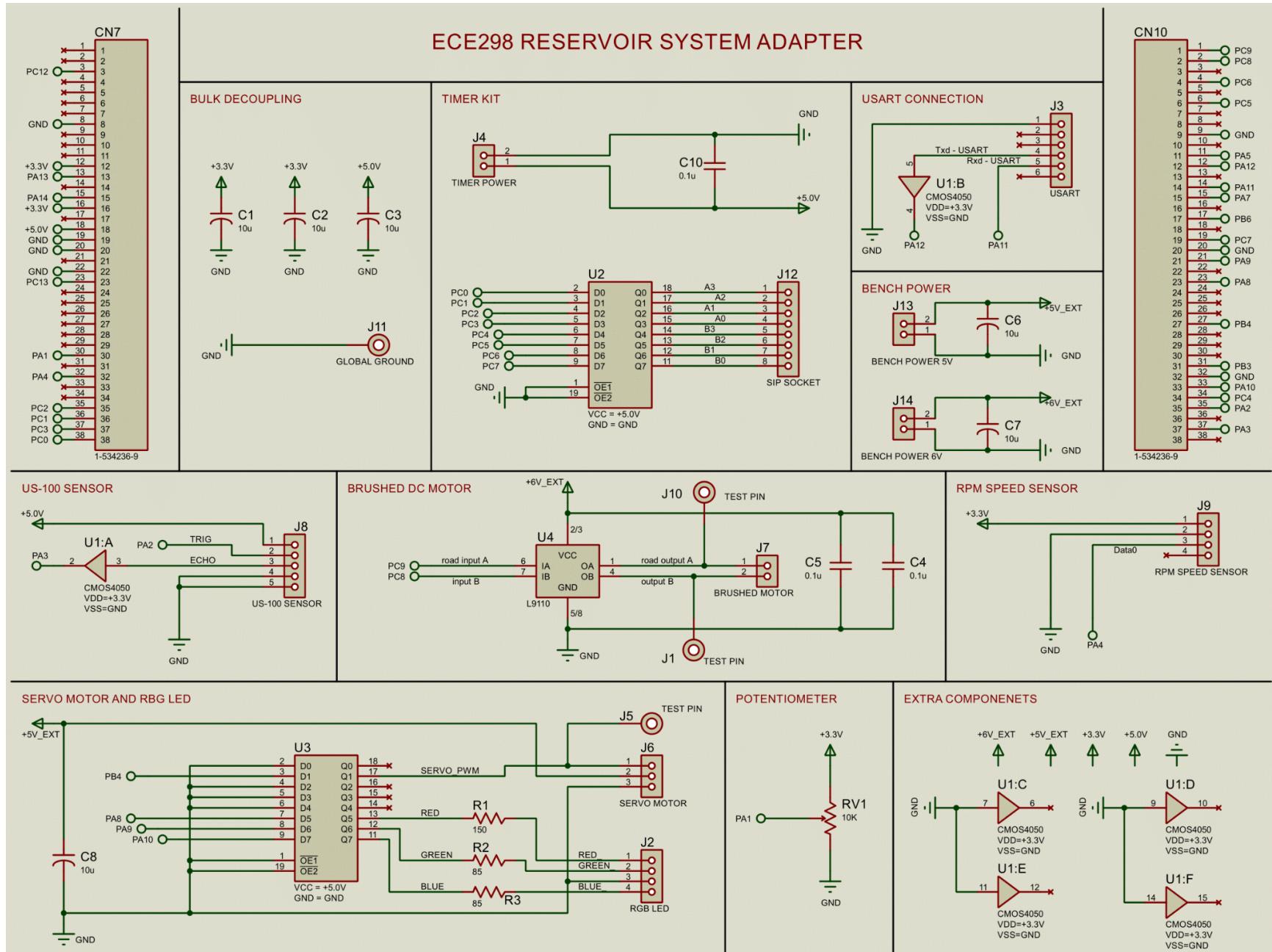


PROTOTYPE REPORT

Saad Syed & Kevin Patel

November 30, 2024

Prototype Schematic:



Schematic Netlist: (txt file also provided in dropbox)

```

● ● ● netlist.TXT
ISIS SCHEMATIC DESCRIPTION FORMAT 8.0
=====
Design: ECE298_RS_ADAPTER
Doc. no.: <NONE>
Revision: <NONE>
Author: <NONE>
Created: 2023-07-07
Modified: 2024-11-29

*PROPERTIES,0
*MODELDEFS,0

*PARTLIST,33
C1,ECE298_RS_CAP_10U_10U,CODE="Dioikey PCC2182TR-ND",EID=13,PACKAGE=CAPC2012X100
C2,ECE298_RS_CAP_10U_10U,CODE="Dioikey PCC2182TR-ND",EID=5,PACKAGE=CAPC2012X100
C3,ECE298_RS_CAP_10U_10U,CODE="Dioikey PCC2182TR-ND",EID=12,PACKAGE=CAPC2012X100
C4,CQ492ZHY5V7BB184_0_10U,CODE="Dioikey 311-1047-2-ND",EID=24,PACKAGE=CAPC1005X55
C5,CQ492ZHY5V7BB184_0_10U,CODE="Dioikey 311-1047-2-ND",EID=A,PACKAGE=CAPC1005X55
C6,ECE298_RS_CAP_10U_10U,CODE="Dioikey PCC2182TR-ND",EID=1F,PACKAGE=CAPC2012X100
C7,ECE298_RS_CAP_10U_10U,CODE="Dioikey PCC2182TR-ND",EID=23,PACKAGE=CAPC2012X100
C8,ECE298_RS_CAP_10U_10U,CODE="Dioikey PCC2182TR-ND",EID=1D,PACKAGE=CAPC2012X100
C9,CQ492ZRY5V7BB184_0_10U,CODE="Dioikey 311-1047-2-ND",EID=21,PACKAGE=CAPC1005X55
CN1,-534236-9,1,-534236-9,CODE=1-534236-9,EID=1,PACKAGE=ECE298_REVTRANS38DIL-1,SUPPLY_DC,CONNECTIVITY
CN1,1-534236-9,1-534236-9,CODE=1-534236-9,EID=2,PACKAGE=ECE298_REVTRANS38DIL-1,SUPPLY_DC,CONNECTIVITY
CN1,TER-TE,CONNECTIVITY
J1,ECE298_TERMINAL_VIA,"TEST PIN",EID=9,PACKAGE=PIN
J2,ECE298_RS_4PINREC,"RGB LED",EID=A,PACKAGE=CONN-SIL4
J3,25630501RP2_USART,CODE="NorComp_25630691RP2",EID=1A,PACKAGE=CON6_1X6_U_2563
J4,ECE298_RS_BENCH_POWER,"TIMER POWER",EID=F,PACKAGE=SIL-100-02R
J5,ECE298_TERMINAL_VIA,"TEST PIN",EID=D,PACKAGE=PIN
J6,ECE298_RS_3PINHDR,"SERVO MOTOR",EID=27,PACKAGE=SIL-100-03
J7,ECE298_RS_2PINHDR,"BUSHED MOTOR",EID=1,PACKAGE=SIL-100-02
J8,25630501RP2,"US-100 SENSOR",CODE="NorComp_25630501RP2",EID=28,PACKAGE=CON5_1X5_U_2563
J9,ECE298_RS_4PINREC,"RPM SPEED SENSOR",EID=29,PACKAGE=CONN-SIL
J10,ECE298_TERMINAL_VIA,"TEST PIN",EID=10,PACKAGE=PIN
J11,ECE298_TERMINAL_VIA,"GLOBAL GROUND",EID=1E,PACKAGE=PIN
J12,25630801RP2,"STP SOCKET",CODE="NorComp_25630801RP2",EID=C,PACKAGE=CON4_1X8_U_2663
J13,ECE298_RS_BENCH_POWER,"BENCH POWER 5V",EID=3,PACKAGE=SIL-100-02R
J14,ECE298_RS_BENCH_POWER,"BENCH POWER 5V",EID=1B,PACKAGE=SIL-100-02R
R1,9C04921A1500JLH3_150,CODE="Dioikey 311-150JDKR-ND",EID=15,PACKAGE=RES50KX49,PRIMTYPE=RESISTOR
R2,9C04921A1800JLH3_85,CODE="Dioikey 311-180JCT-ND",EID=16,PACKAGE=RES50KX49,PRIMTYPE=RESISTOR
R3,9C04921A2000JLH3_85,CODE="Dioikey 311-200JCT-ND",EID=14,PACKAGE=RES50KX49,PRIMTYPE=RESISTOR
RV1,ECE298_RS_POT10K,CODE="Dioikey 3361P-103GLFDKR-ND",EID=E,PACKAGE=TRIM_3361P_STATE
U1,ECE298_RS_CMOS4050,CMOS4050,EID_A=14,EID_B=18,EID_C=19,EID_D=1C,EID_E=20,EID_F=22,ITFMOD=CMOS,MODFILE=408UF,PACKAGE=DIL16,VDD=-3.3V,VOLTAGE=5V,VSS=GND
U2,ECE298_RS_74HCT541,,EID=B,GND=GND,PACKAGE=SO20W,PINSWAP="1,19",VCC=-5.0V
U3,ECE298_RS_74HCT541,,EID=6,GND=GND,PACKAGE=SO20W,PINSWAP="1,19",VCC=-5.0V
U4,ECE298_RS_L9110,L9110,EID=26,ITFMOD=TTL,PACKAGE=SO20W

*NETLIST,54
#00105,1
CN10,PS,8

PC12,2
PC12,GT
CN7,PS,3

PA5,2
PA5,GT
CN10,PS,11

PA7,2
PA7,GT
CN10,PS,15

PB6,2
PB6,GT
CN10,PS,17

PA13,2
PA13,GT
CN7,PS,13

PA14,2
PA14,GT
CN7,PS,1

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CN7,PS,13
PA14,2
PA14,GT
CN7,PS,15

PC13,2
PC13,GT
CN7,PS,23

PB3,2
PB3,GT
CN10,PS,31

RED_,3
RED_,LBL
J1,PS,1
J2,PS,1

RED_,3
RED_,LBL
R1,PS,2
U3,TS,13

BLUE_,3
BLUE_,LBL
R3,PS,1
J2,PS,4

BLUE_,3
BLUE_,LBL
R3,PS,2
U3,TS,11

PA2,4
TRIG,LBL
PA2,GT
J8,PS,2
CN10,PS,35

ECHO,3
ECHO,LBL
J8,PS,3
U1,IP,3

TXD - USART,3
TXD - USART,LBL
J3,PS,4
U1,IP,5

PA11,4
RXD - USART,LBL
PA11,GT
J3,PS,5
CN10,PS,14

PA12,3
PA12,GT
U1,OP,4
CN10,PS,12

ROAD OUTPUT A,4
ROAD OUTPUT A,LBL
J7,PS,1
J10,PS,1
U4,OP,1

OUTPUT B,4
OUTPUT B,LBL
J7,PS,2
J1,PS,1
U4,OP,4

PC9,4
PC9,GT
ROAD INPUT A,LBL
U4,IP,6
CN10,PS,1

PC8,4
PC8,GT
INPUT B,LBL
U4,IP,7
CN10,PS,1

PC5,4
PC5,GT
U2,IP,6
CN10,PS,34

PC6,3
PC6,GT
U2,IP,8
CN10,PS,4

```

```

CN10,PS,2
PA3,3
PA3,GT
U1,OP,2
CN10,PS,37

SERVO_PWM,4
SERVO_PWM,LBL
J6,PS,1
U3,TS,17
J5,PS,1

GREEN_,3
GREEN_,LBL
J2,PS,2
R2,PS,1

PB4,3
PB4,GT
U3,IP,3
CN10,PS,27

PA8,3
PA8,GT
U3,IP,7
CN10,PS,23

PA9,3
PA9,GT
U3,IP,8
CN10,PS,21

PA10,3
PA10,GT
U3,IP,9
CN10,PS,33

GREEN_,3
GREEN_,LBL
U3,TS,12
R2,PS,2

PA4,4
PA4,GT
DATA0,LBL
J9,PS,3
CN7,PS,32

PC0,3
PC0,GT
U2,IP,2
CN7,PS,38

PC1,3
PC1,GT
U2,IP,3
CN7,PS,36

PC2,3
PC2,GT
U2,IP,4
CN7,PS,35

PC3,3
PC3,GT
U2,IP,5
CN7,PS,37

PC4,3
PC4,GT
U2,IP,6
CN10,PS,34

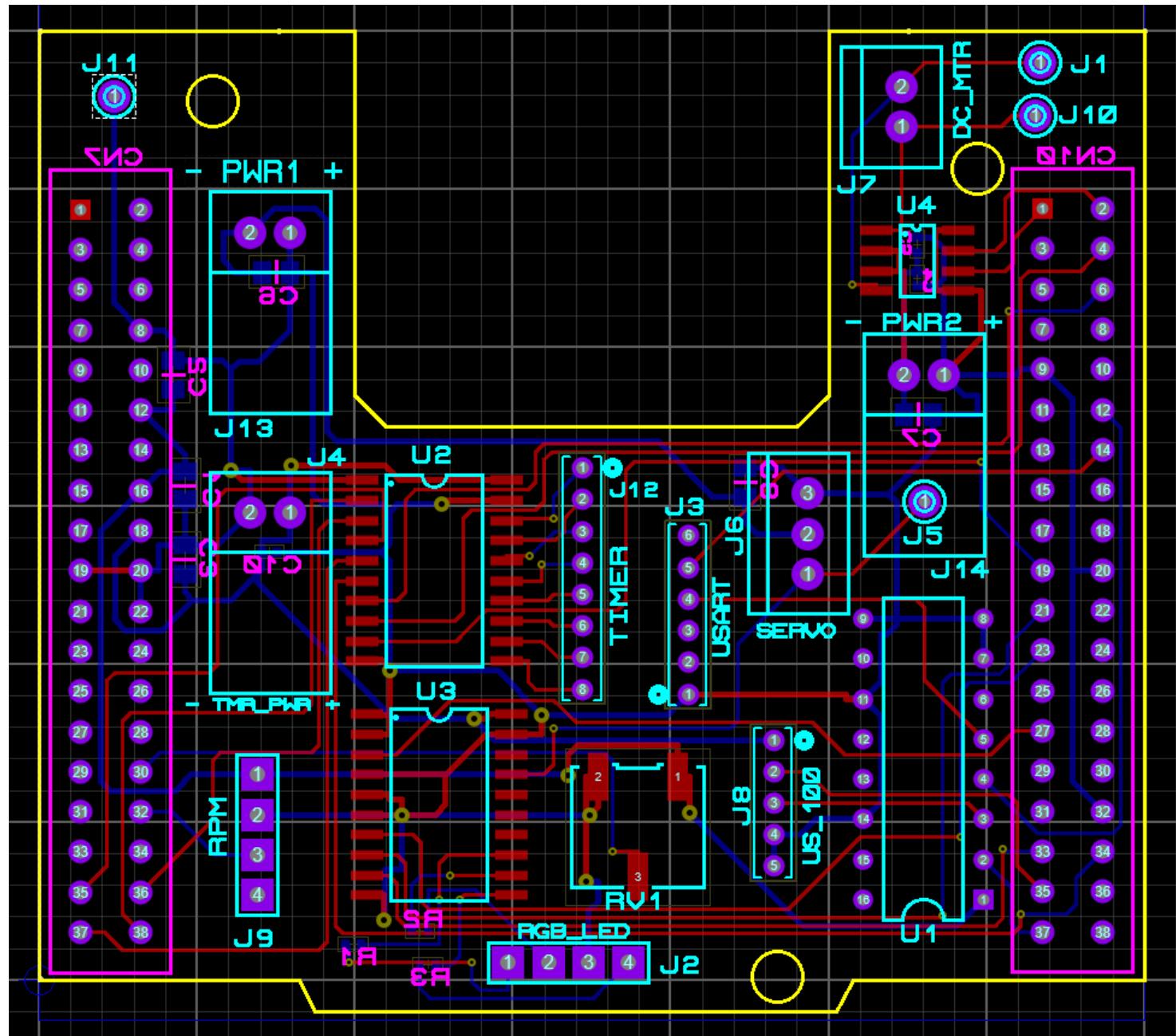
PC5,3
PC5,GT
U2,IP,7
CN10,PS,6

PC6,3
PC6,GT
U2,IP,8
CN10,PS,4

```

PC7,3	CN7,PS,1
PC7,GT	CN7,PS,14
U2,IP,9	CN10,PS,7
CN10,PS,19	CN10,PS,38
A3,3	CN10,PS,36
A3,LBL	CN10,PS,10
U2,TS,18	CN7,PS,9
J12,PS,1	CN7,PS,7
A2,3	CN7,PS,6
A2,LBL	CN7,PS,5
U2,TS,17	CN7,PS,4
J12,PS,2	CN7,PS,33
A1,3	CN7,PS,31
A1,LBL	CN7,PS,29
U2,TS,16	CN7,PS,27
J12,PS,3	CN7,PS,26
A0,3	CN7,PS,25
A0,LBL	CN7,PS,24
U2,TS,15	CN7,PS,23
J12,PS,4	CN7,PS,11
B3,3	CN7,PS,10
B3,LBL	+3.3V,8,CLASS=POWER
U2,TS,14	+3.3V,PR
J12,PS,5	U1,PP,1
B2,3	RV1,PS,1
B2,LBL	J9,PS,1
U2,TS,13	C2,PS,1
J12,PS,6	C1,PS,1
B1,3	CN7,PS,16
B1,LBL	CN7,PS,12
U2,TS,12	B1,PS,1
J12,PS,7	CN7,PS,18
B0,3	+5V_EXT,5,CLASS=POWER
B0,LBL	+5V_EXT,PR
U2,TS,11	J13,PS,2
J12,PS,8	C6,PS,1
PA1,3	J6,PS,2
PA1,GT	C8,PS,1
RV1,PS,3	+6V_EXT,7,CLASS=POWER
CN7,PS,30	+6V_EXT,PR
{NC},51	J14,PS,2
U1,PS,13	C7,PS,1
U1,PS,16	C5,PS,2
U1,OP,15	C4,PS,2
U1,OP,10	U4,PP,2
U1,OP,12	U4,PP,2
U1,OP,6	GND,45,CLASS=POWER
J9,PS,4	GND,PR
U3,TS,18	J14,PS,1
U3,TS,14	C7,PS,2
U3,TS,16	J13,PS,1
U3,TS,15	C6,PS,2
CN10,PS,3	U1,PP,8
CN7,PS,28	U1,IP,9
J3,PS,6	U1,IP,14
J3,PS,3	U1,IP,7
J3,PS,2	U1,IP,11
CN10,PS,29	RV1,PS,2
CN10,PS,30	J4,PS,2
CN10,PS,28	C10,PS,2
CN10,PS,26	U2,PP,10
CN10,PS,25	U2,IP,1
CN10,PS,24	U2,IP,19
CN10,PS,22	J9,PS,2
CN10,PS,18	J11,PS,1
CN10,PS,16	U3,PP,10
CN10,PS,13	J6,PS,3
CN10,PS,5	C8,PS,2
CN7,PS,34	U3,IP,2
CN7,PS,21	U3,IP,4
CN7,PS,17	U3,IP,5
CN7,PS,2	U3,IP,6

Prototype Proteus PCB:



Pre-Production Check (PPC) Report:

```
Pre-Production Check
File: N:\ECE-298\STM32\Workspace\ECE298_RS_Adapter.pdsprj
Date: December 3, 2024, 3:07:58 PM
TEST: Connectivity.
PASS: Connectivity valid.
TEST: Object validity.
PASS: Objects valid.
TEST: DRC valid.
PASS: No DRC errors.
TEST: Zone overlap.
Imaging Copper Layer TOP
Imaging Copper Layer I1
Imaging Copper Layer I2
Imaging Copper Layer I3
Imaging Copper Layer I4
Imaging Copper Layer I5
Imaging Copper Layer I6
Imaging Copper Layer I7
Imaging Copper Layer I8
Imaging Copper Layer I9
Imaging Copper Layer I10
Imaging Copper Layer I11
Imaging Copper Layer I12
Imaging Copper Layer I13
Imaging Copper Layer I14
Imaging Copper Layer BOT
Processing images

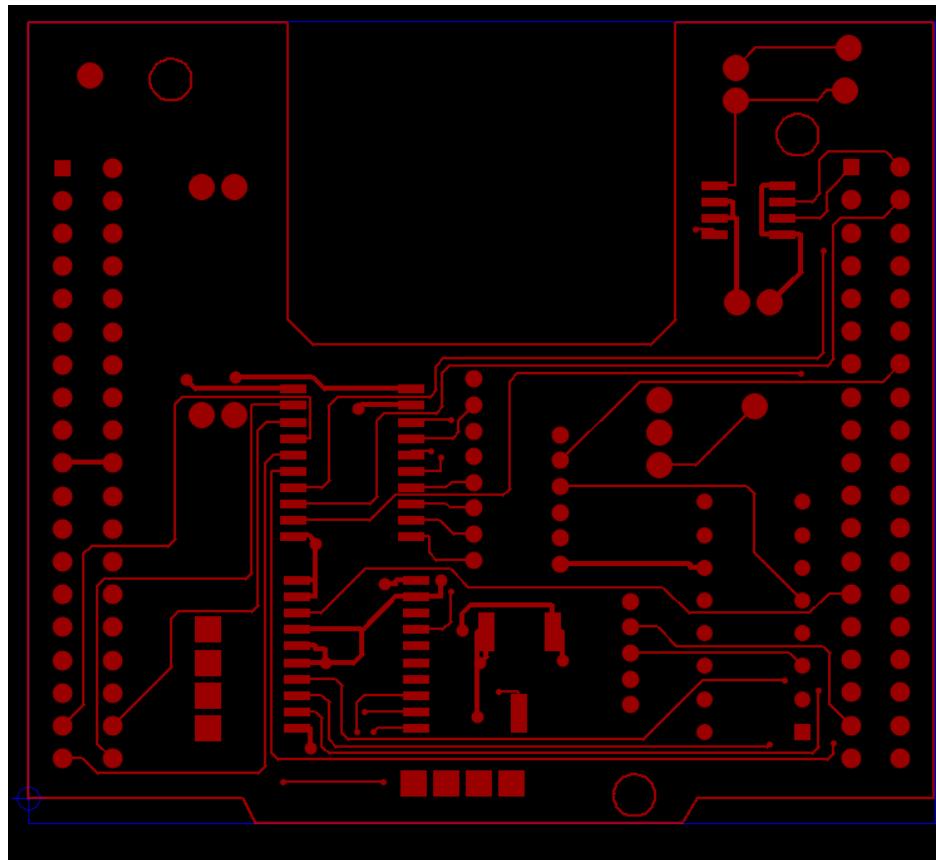
PASS: No overlap detected.
TEST: Duplicate part IDs.
PASS: All part IDs are unique.
TEST: Unplaced components.
PASS: All components placed.
TEST: Board edge.
PASS: Board edge complete.
TEST: Components outside board edge.
PASS: Components within board edge.
TEST: General object validation tests.
PASS: General validation.
TEST: Length matched routes.
PASS: Length matched routes.
TEST: Differential Pairs.
PASS: Differential Pairs.
TEST: Layer Stackup and Drill Sets.
PASS: Layer stackup valid.
TEST: Validate vias.
PASS: Via validation.
TEST: stitching-vias connectivity.
PASS: Stitching Vias.
TEST: Validate traces.
This may take a while on larger boards.
PASS: Trace validation.
TEST: DRC room rules.
PASS: DRC room rules.
TEST: Via overlaps and drill ranges.
PASS: Via overlaps and drill ranges.
Pre-production check end:
0 errors, 0 failed, 0 warnings, 17 passed.
```

Close

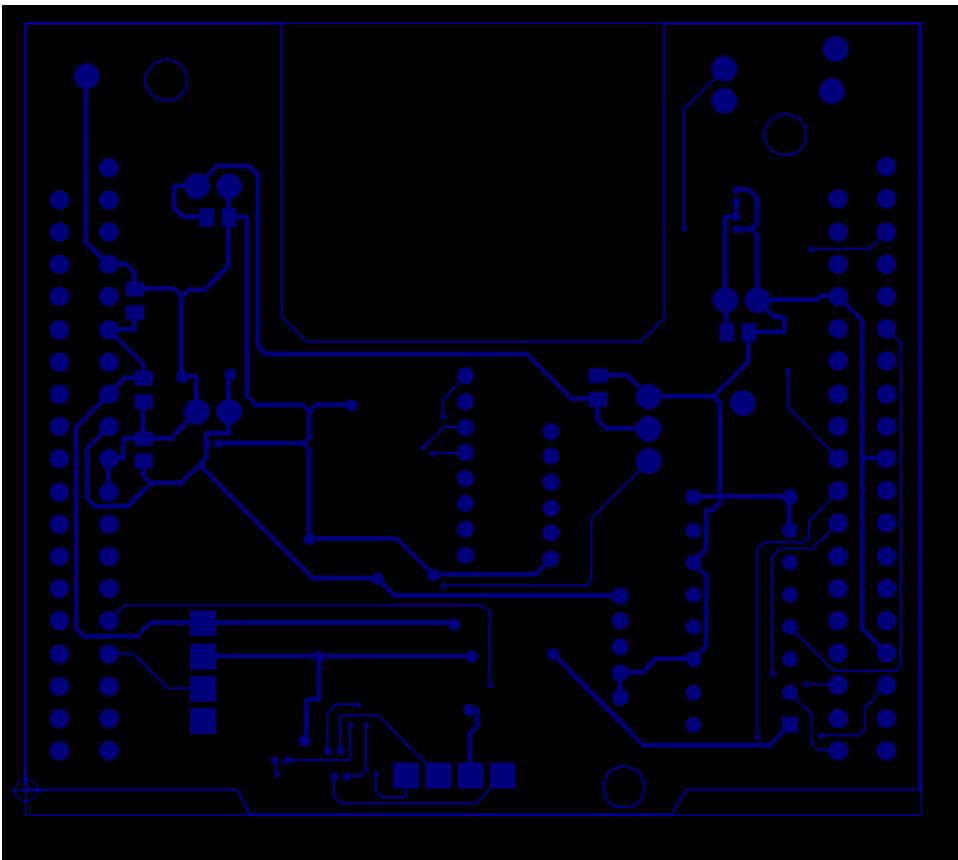
Gerber Files:

Copper Files:

Top Copper:

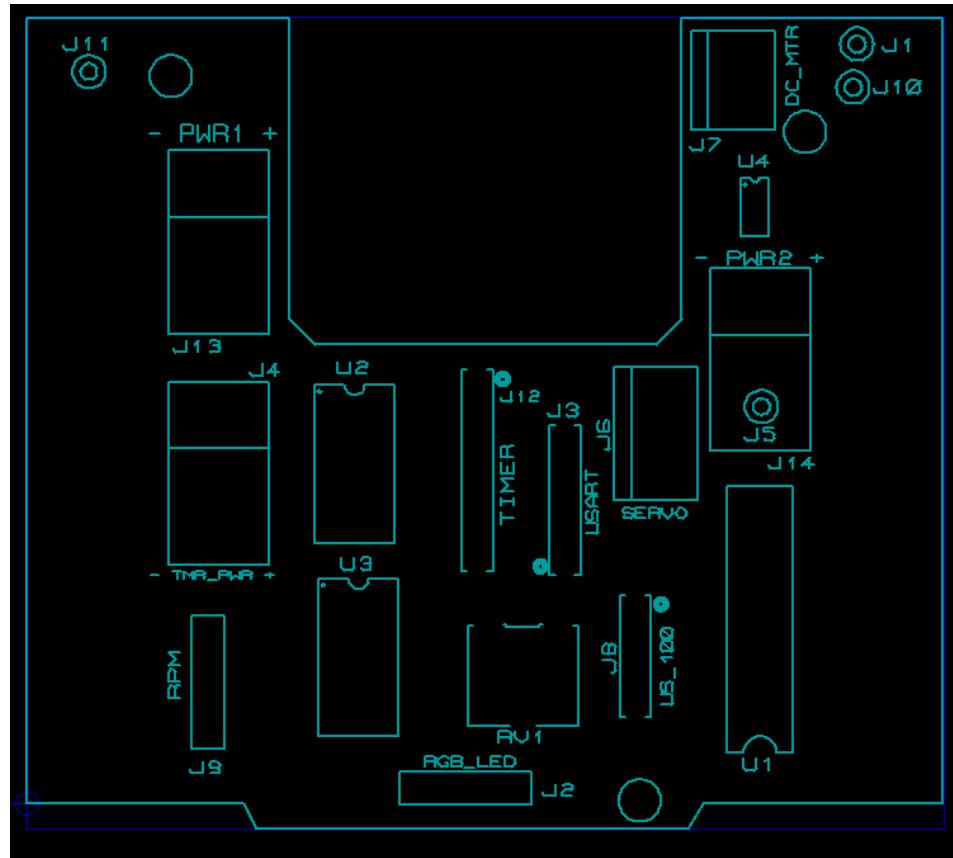


Bottom Copper:

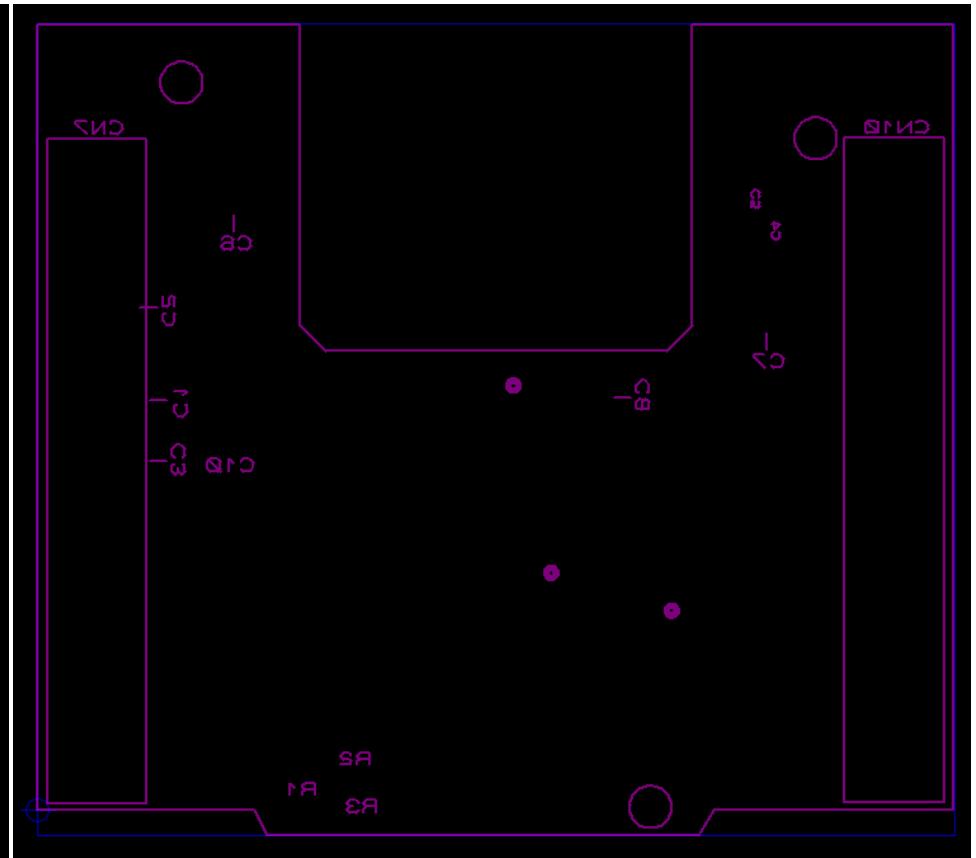


Silk Files:

Top Silk:

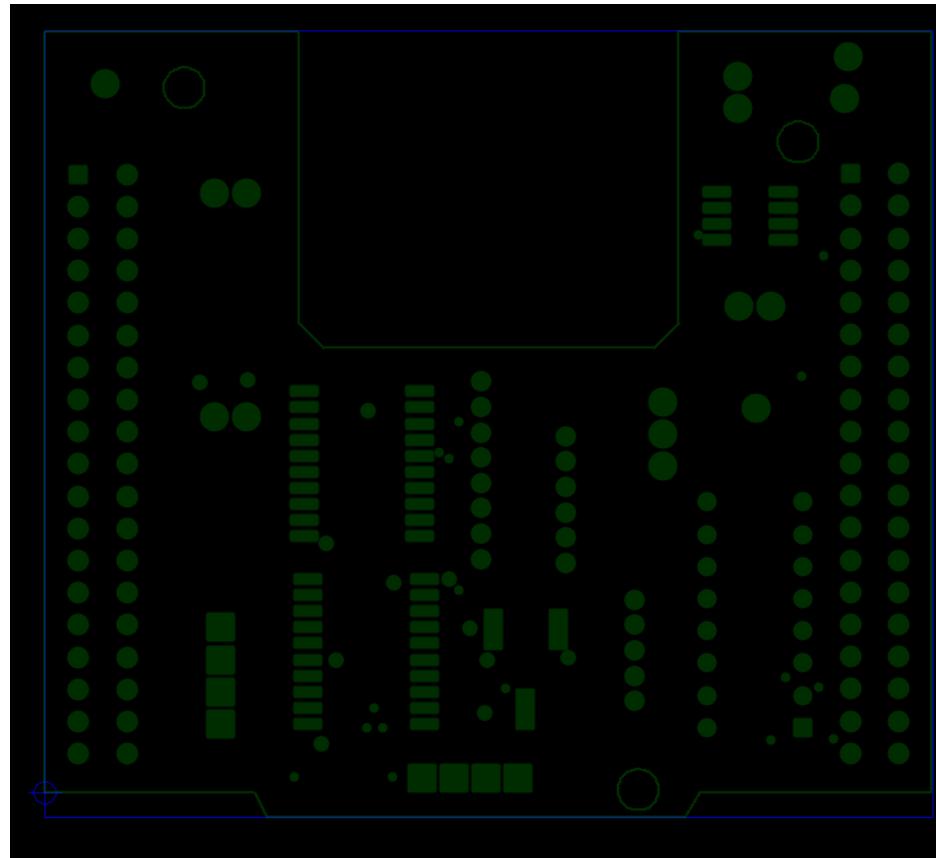


Bottom Silk:

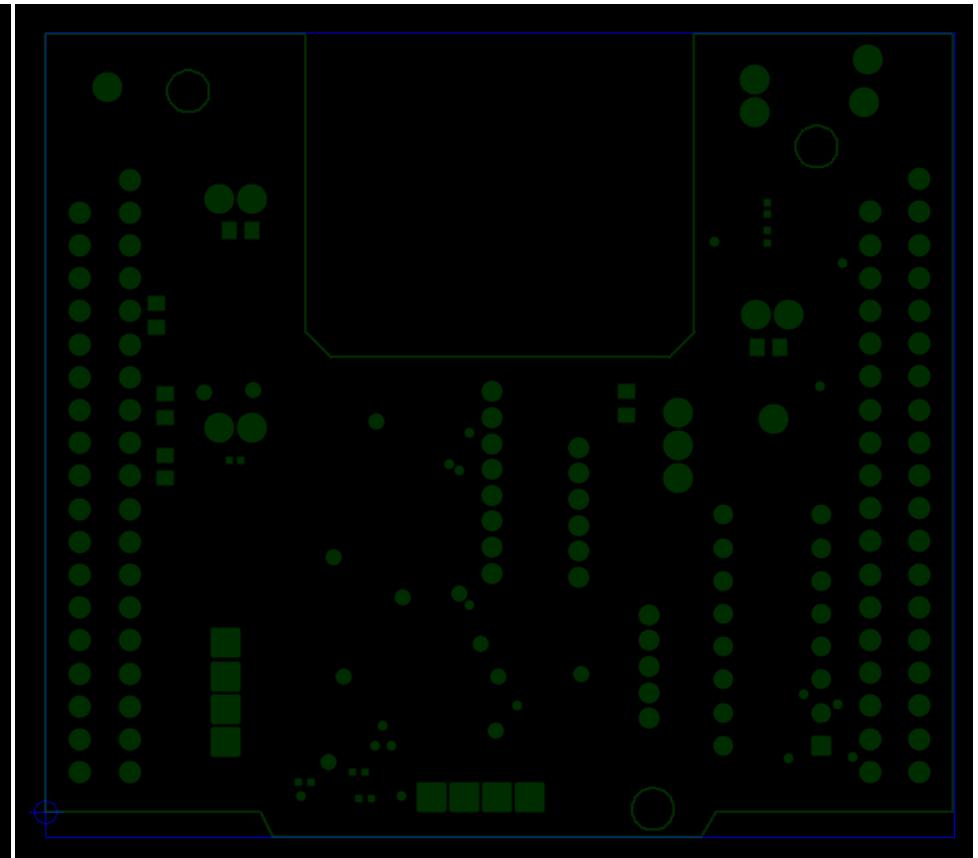


Resist Files:

Top Resist:

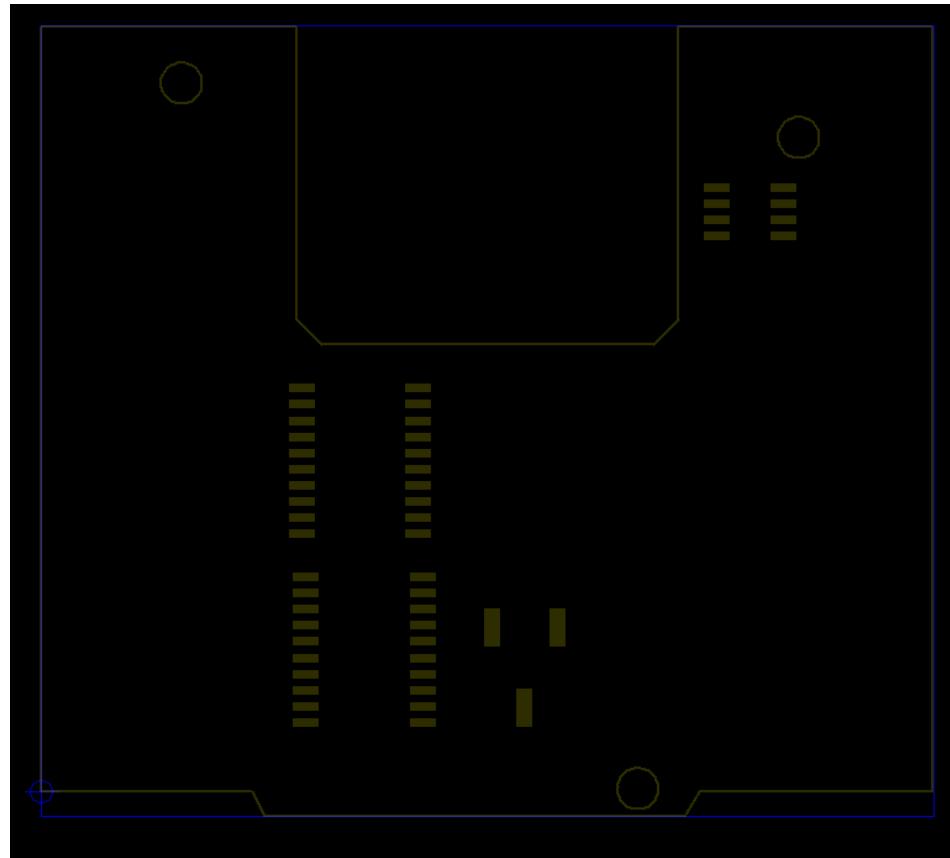


Bottom Resist:

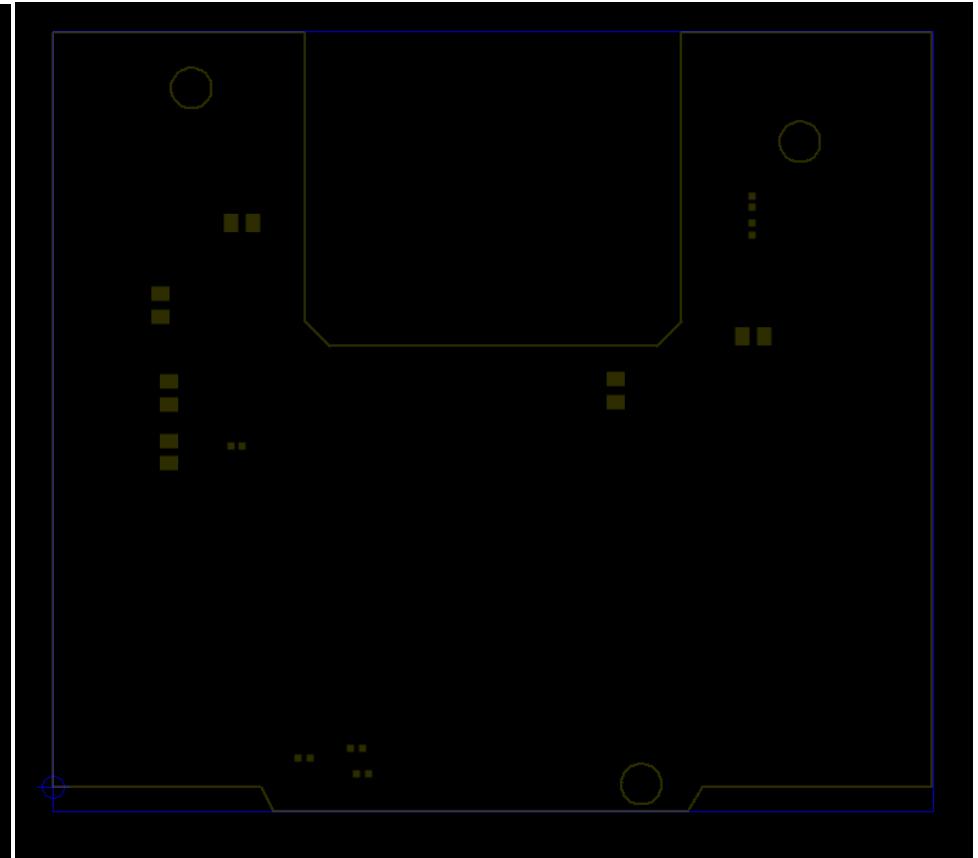


Paste Files:

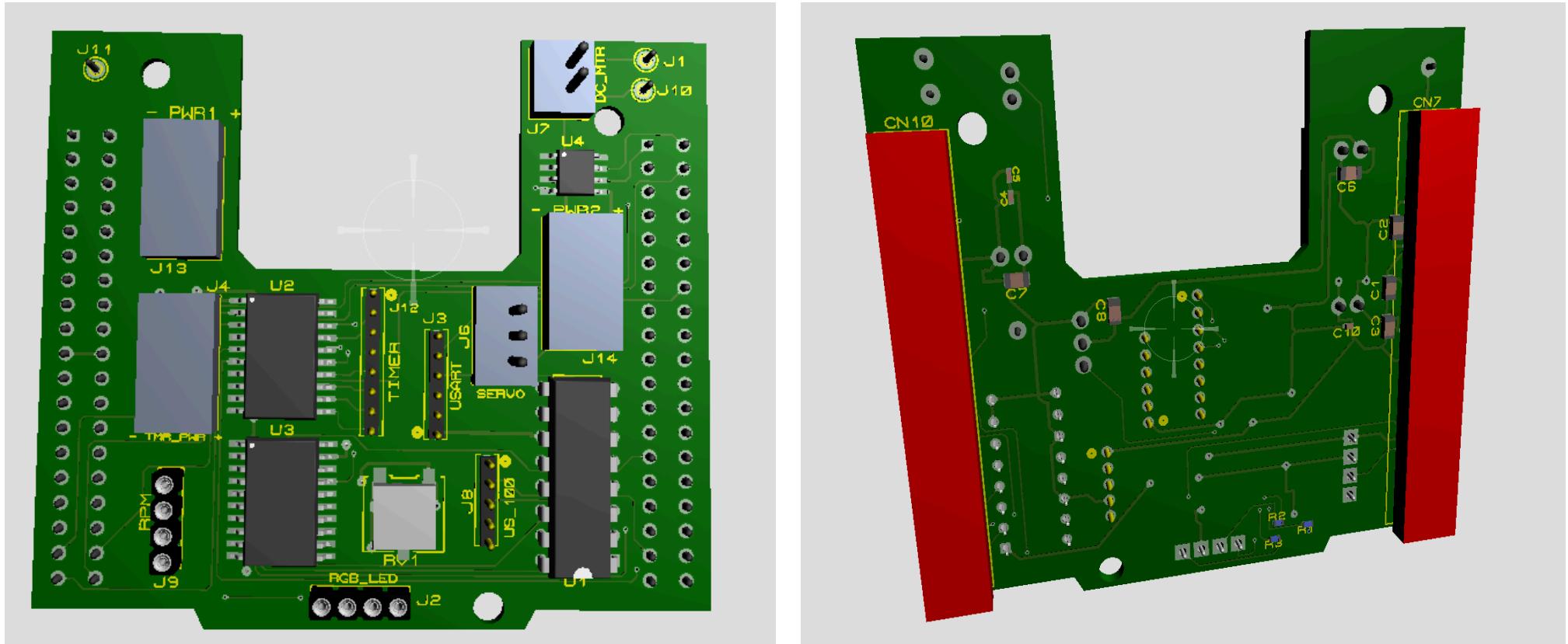
Top Paste:



Bottom Paste:



PCB Assembly 3D View:



Pick and Place File:

A	B	C	D	E	F	G	H
Part ID	Value	Package	Stock Code	Layer	Rotation	X	Y
CN7	1-534236-9	ECE298_REVTRANS38DIL-1	1-534236-9	BOT	0	4.50499	25.9001
CN10	1-534236-9	ECE298_REVTRANS38DIL-1	1-534236-9	BOT	0	65.4649	25.94
J13	BENCH POWER 5V	SIL-100-02R		TOP	180	14.63	47.2999
J14	BENCH POWER 6V	SIL-100-02R		TOP	180	56.0301	38.2999
C6	10u	CAPC2012X100	Digikey PCC2182TR-ND	BOT	180	15	44.8
C7	10u	CAPC2012X100	Digikey PCC2182TR-ND	BOT	180	55.6999	35.8
J4	TIMER POWER	SIL-100-02R		TOP	-180	14.63	29.5999
C10	0.1u	CAPC1005X55	Digikey 311-1047-2-ND	BOT	-180	14.55	27.1
C3	10u	CAPC2012X100	Digikey PCC2182TR-ND	BOT	-90	9.20001	26.5999
C1	10u	CAPC2012X100	Digikey PCC2182TR-ND	BOT	-270	9.20001	31.2999
C2	10u	CAPC2012X100	Digikey PCC2182TR-ND	BOT	-90	8.50001	38.2999
J11	GLOBAL GROUND	PIN		TOP	0	4.69999	55.9001
U2		SO20W		TOP	0	25	25.9001
J12	SIP SOCKET	CON8_1X8_U_2563	NorComp 25630801RP2	TOP	-270	34.4	25.4
J3	USART	CON6_1X6_U_2563	NorComp 25630601RP2	TOP	-90	41.1	23.1
U4	L9110	SO8		TOP	0	55.6001	45.5
J7	BRUSHED MOTOR	SIL-100-02		TOP	90	54.6001	55.23
J1	TEST PIN	PIN		TOP	0	63.3999	57.9999
J10	TEST PIN	PIN		TOP	0	63.0999	54.6999
C4	0.1u	CAPC1005X55	Digikey 311-1047-2-ND	BOT	-90	55.6001	44.3499
C5	0.1u	CAPC1005X55	Digikey 311-1047-2-ND	BOT	90	55.6001	46.5501
J9	RPM SPEED SENSOR	CONN-SIL4		TOP	-90	13.8	9.19
U1	CMOS4050	DIL16		TOP	-270	55.99	13.99
J6	SERVO MOTOR	SIL-100-03		TOP	-270	48.6999	28.24
J8	US-100 SENSOR	CON5_1X5_U_2563	NorComp 25630501RP2	TOP	-270	46.5	11.2
J2	RGB LED	CONN-SIL4		TOP	0	33.51	1.1
U3		SO20W		TOP	0	25.3	11.1
R2	85	RESC1005X40	Digikey 311-180JCT-ND	BOT	0	24.1	3.09999
R3	85	RESC1005X40	Digikey 311-200JCT-ND	BOT	180	24.6	1
R1	150	RESC1005X40	Digikey 311-150JDKR-ND	BOT	180	19.9	2.3
J5	TEST PIN	PIN		TOP	-180	56.1	30.2999
C8	10u	CAPC2012X100	Digikey PCC2182TR-ND	BOT	270	44.6999	31.5001
RV1	10K	TRIM_3361P	Digikey 3361P-103GLFDKR-ND	TOP	-180	37.9001	9.70001

Bill of Materials:

Bill Of Materials for ECE298_RS_ADAPTER

Design Title ECE298_RS_ADAPTER

Author

Document Number

Revision

Design Created July 7, 2023

Design Last Modified December 3, 2024

Total Parts In Design 33

9 Capacitors

<u>Quantity</u>	<u>References</u>	<u>Value</u>
6	C1-C3,C6-C8	10u
3	C4-C5,C10	0.1u

Sub-totals:

3 Resistors

<u>Quantity</u>	<u>References</u>	<u>Value</u>
1	R1	150
2	R2-R3	85

Sub-totals:

4 Integrated Circuits

<u>Quantity</u>	<u>References</u>	<u>Value</u>
1	U1	CMOS4050
2	U2-U3	
1	U4	L9110

Sub-totals:

0 Transistors

<u>Quantity</u>	<u>References</u>	<u>Value</u>
0		

Sub-totals:

0 Diodes

<u>Quantity</u>	<u>References</u>	<u>Value</u>
0		

Sub-totals:

17 Miscellaneous

<u>Quantity</u>	<u>References</u>	<u>Value</u>
2	CN7,CN10	1-534236-9
3	J1,J5,J10	TEST PIN
1	J2	RGB LED
1	J3	USART
1	J4	TIMER POWER
1	J6	SERVO MOTOR
1	J7	BRUSHED MOTOR
1	J8	US-100 SENSOR
1	J9	RPM SPEED SENSOR
1	J11	GLOBAL GROUND
1	J12	SIP SOCKET
1	J13	BENCH POWER 5V
1	J14	BENCH POWER 6V
1	RV1	10K

Sub-totals:

Embedded Project Operating Details:

Energy Rate Plan Chosen: TOU Method

TOU Method									
Pipeline Name	Gallons Transferred	HEAD (ft)	Motor RPM	Pump Power (kW)	Start Time	Stop Time	Total Time (h)	Energy Used (kWh)	(TOU) Energy Cost (\$)
INLET	94000	40	85	225	7:00 PM	4:47 AM	9.79	2202.75	163
ZONE 1	50000	25	70	125	4:47 AM	10:00 AM	5.21	651.25	58.69
ZONE 2	30000	50	85	225	10:00 AM	1:58 PM	3.97	893.25	123.86
ZONE 3	14000	60	95	340	1:58 PM	3:59 PM	2.01	683.4	103.19
							TOTAL:	4430.65	448.74

- TOU method was cheaper than ULO method by **\$18.27**

Time of Use: TOU Method Plan

1. **Inlet:** 7PM - 4:47AM (OFFPEAK)
2. **Zone 1:** 4:47AM - 7:00AM (OFFPEAK), 7:00AM - 10AM (MIDPEAK)
3. **Zone 2:** 10AM - 11AM (MIDPEAK), 11AM - 1:58PM (ONPEAK)
4. **Zone 3:** 1:58PM - 3:59PM (ONPEAK)

Equations Used for Calculations:

Operational Time:

- 1) Total Time (h) = Gallons Transferred ÷ Flow Rate (GPM) ÷ 60
- 2) Total Time (h) = Stop Time (h) - Start Time (h)

Energy Used (kWh):

- 1) Energy Used (kWh) = Total Time (h) * Pump Power (kW)

Energy Cost (\$):

- 1) **Inlet:** $(2202.75 * 0.074) = \$163.00$
- 2) **Zone 1:** $(651.25 * 221/521 * 0.074) + (651.25 * 300/521 * 0.102) = \58.69
- 3) **Zone 2:** $(893.25 * 100/397 * 0.102) + (893.25 * 297/397 * 0.151) = \123.86
- 4) **Zone 3:** $(683.4 * 0.151) = \$103.19$