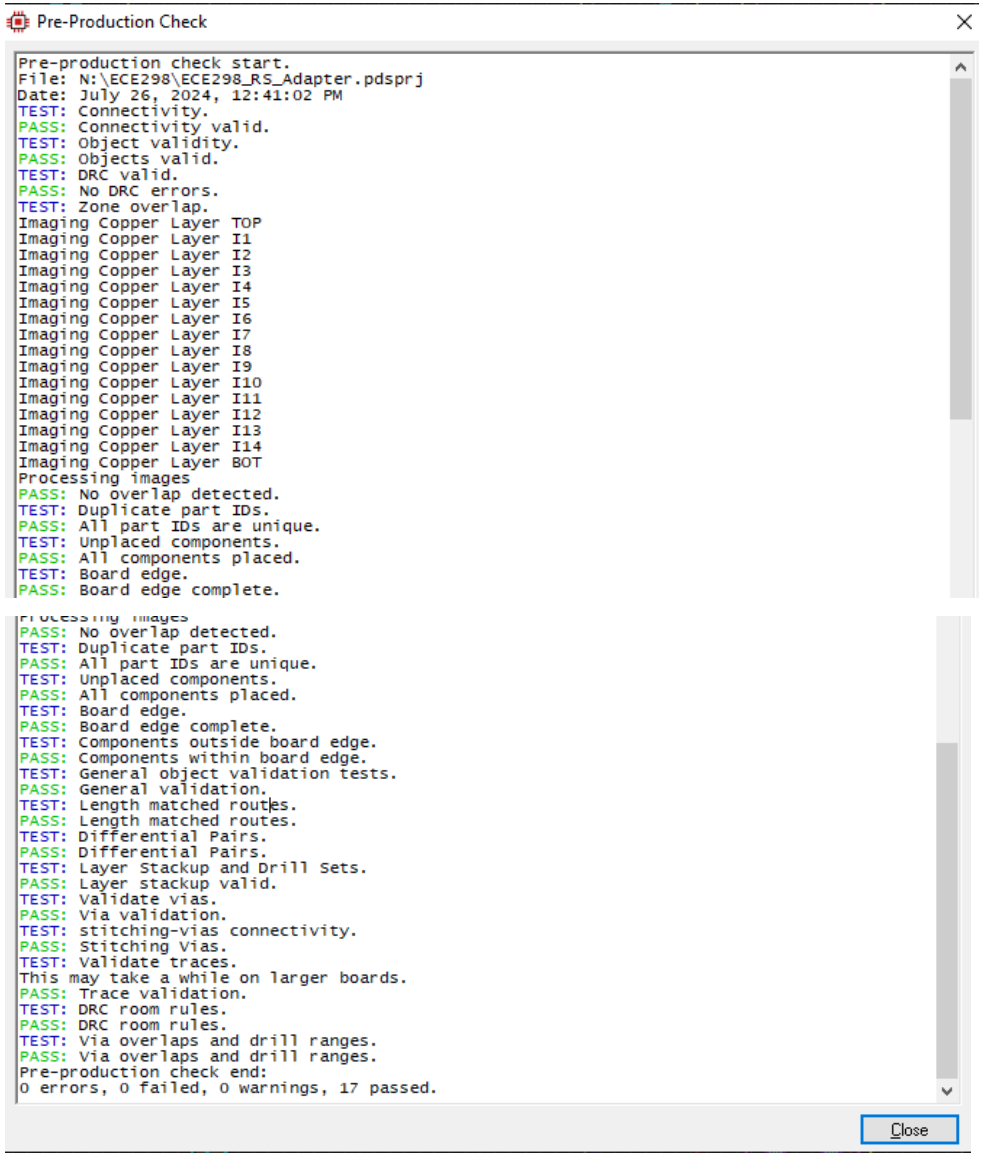
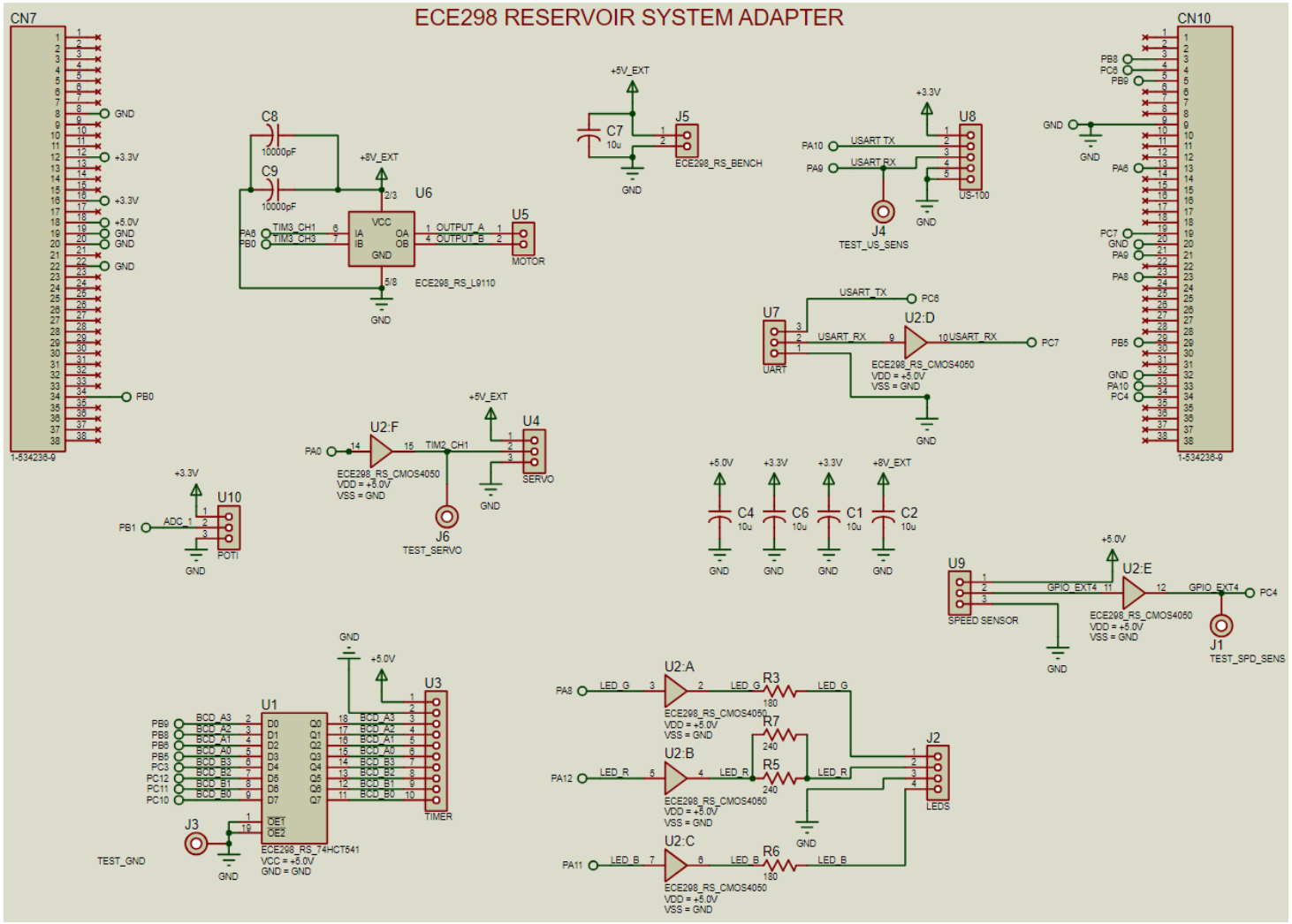
Lab B report

Team 1
Lab section 003
Daniel Chen & Antarpreet Khalsa

Pre-production check



Schematic


ECE298 RESERVOIR SYSTEM ADAPTER
CN7
CN10
C8
C9
10000pF
+8V_EXT
U6
ECE298_RS_L9110
U5
MOTOR
+5V_EXT
C7
10u
J5
ECE298_RS_BENCH
U8
US-100
J4
TEST_US_SENS
U7
UART
U2:D
ECE298_RS_CMOS4050
VDD = +5.0V
VSS = GND
U2:F
U4
SERVO
J6
TEST_SERVO
U10
POTI
C4
C6
C1
C2
10u
U9
SPEED SENSOR
U2:E
J1
TEST_SPD_SENS
U1
ECE298_RS_74HCT541
VCC = +5.0V
GND = GND
U3
TIMER
J3
TEST_GND
U2:A
U2:B
U2:C
R3
R5
R6
R7
180
240
J2
LEDS

Netlist

```
ISIS SCHEMATIC DESCRIPTION FORMAT 8.0
=====================================
Design:   ECE298_RS_ADAPTER
Doc. no.: <NONE>
Revision: <NONE>
Author:   <NONE>
Created:  2023-07-07
Modified: 2024-07-26

*PROPERTIES,0

*MODELDEFS,0

*PARTLIST,29
C1,ECE298_RS_CAP_10U,10u,CODE="Digikey PCC2182TR-ND",EID=E,PACKAGE=CAPC2012X100
C2,ECE298_RS_CAP_10U,10u,CODE="Digikey PCC2182TR-ND",EID=F,PACKAGE=CAPC2012X100
C4,ECE298_RS_CAP_10U,10u,CODE="Digikey PCC2182TR-ND",EID=2A,PACKAGE=CAPC2012X100
C6,ECE298_RS_CAP_10U,10u,CODE="Digikey PCC2182TR-ND",EID=10,PACKAGE=CAPC2012X100
C7,ECE298_RS_CAP_10U,10u,CODE="Digikey PCC2182TR-ND",EID=26,PACKAGE=CAPC2012X100
C8,ECE298_RS_CAP_0U1,10000pF,CODE="Digikey PCC103BQDKR-ND",EID=2C,PACKAGE=CAPC1005X55
C9,ECE298_RS_CAP_0U1,10000pF,CODE="Digikey PCC103BQDKR-ND",EID=2D,PACKAGE=CAPC1005X55
CN7,1-534236-9,1-534236-9,CODE=1-534236-9,EID=1,PACKAGE=ECE298_REVTRANS38DIL-1,SUPPLIER=TE_CONNECT
IVITY
CN10,1-534236-9,1-534236-9,CODE=1-534236-9,EID=2,PACKAGE=ECE298_REVTRANS38DIL-1,SUPPLIER=TE_CONNEC
TIVITY
```

```
J1,ECE298_TERMINAL_VIA,TEST_SPD_SENS,EID=3,PACKAGE=PIN
J2,ECE298_RS_4PINREC,LEDS,EID=4,PACKAGE=CONN-SIL4
J3,ECE298_TERMINAL_VIA,TEST_GND,EID=29,PACKAGE=PIN
J4,ECE298_TERMINAL_VIA,TEST_US_SENS,EID=A,PACKAGE=PIN
J5,ECE298_RS_2PINHDR,ECE298_RS_BENCH,EID=25,PACKAGE=SIL-100-02
J6,ECE298_TERMINAL_VIA,TEST_SERVO,EID=B,PACKAGE=PIN
R3,9C04021A1800JLHF3,180,CODE="Digikey 311-180JCT-ND",EID=1D,PACKAGE=RESC1005X40,PRIMTYPE=RESISTOR
R5,9C04021A1800JLHF3,240,CODE="Digikey 311-180JCT-ND",EID=22,PACKAGE=RESC1005X40,PRIMTYPE=RESISTOR
R6,9C04021A1800JLHF3,180,CODE="Digikey 311-180JCT-ND",EID=24,PACKAGE=RESC1005X40,PRIMTYPE=RESISTOR
R7,9C04021A1800JLHF3,240,CODE="Digikey 311-180JCT-ND",EID=28,PACKAGE=RESC1005X40,PRIMTYPE=RESISTOR
U1,ECE298_RS_74HCT541,ECE298_RS_74HCT541,EID=6,GND=GND,PACKAGE=SO20W,PINSWAP="1,19",VCC=+5.0V
U2,ECE298_RS_CMOS4050,ECE298_RS_CMOS4050,EID_A=7,EID_B=8,EID_C=9,EID_D=11,EID_E=15,EID_F=C,ITFMOD=
CMOS,MODFILE=40BUF,PACKAGE=SO16,VDD=+5.0V,VSS=GND
U3,ECE298_RS_10PINREC,TIMER,EID=5,PACKAGE=CONN-SIL10
U4,ECE298_RS_3PINHDR,SERVO,EID=1F,PACKAGE=SIL-100-03
U5,ECE298_RS_2PINHDR,MOTOR,EID=1C,PACKAGE=SIL-100-02
U6,ECE298_RS_L9110,ECE298_RS_L9110,EID=D,ITFMOD=TTL,PACKAGE=SO8
U7,ECE298_RS_3PINHDR,UART,EID=1B,PACKAGE=SIL-100-03
U8,US-100,US-100,EID=2E,PACKAGE=NULL
U9,ECE298_RS_3PINHDR,"SPEED SENSOR",EID=23,PACKAGE=SIL-100-03
U10,ECE298_RS_3PINHDR,POTI,EID=12,PACKAGE=SIL-100-03

*NETLIST,28
OUTPUT_A,3,CLASS=SIGNAL
OUTPUT_A,LBL
U5,PS,1
U6,OP,1
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OUTPUT_B,3,CLASS=SIGNAL
OUTPUT_B,LBL
U5,PS,2
U6,OP,4

PB0,4,CLASS=SIGNAL
PB0,GT
TIM3_CH3,LBL
U6,IP,7
CN7,PS,34

PA6,4,CLASS=SIGNAL
PA6,GT
TIM3_CH1,LBL
U6,IP,6
CN10,PS,13

PC6,4,CLASS=SIGNAL
PC6,GT
USART_TX,LBL
U7,PS,3
CN10,PS,4

PA0,6,CLASS=SIGNAL
TIM2_CH1,LBL
PA0,GT
```

```
U4,PS,2
U2,OP,15
U2,IP,14
J6,PS,1

PA11,7,CLASS=SIGNAL
LED_B,LBL
PA11,GT
R6,PS,1
U2,OP,6
U2,IP,7
J2,PS,4
R6,PS,2

PA8,8,CLASS=SIGNAL
PA8,GT
LED_G,LBL
U2,IP,3
CN10,PS,23
R3,PS,1
U2,OP,2
J2,PS,1
R3,PS,2

PA12,9,CLASS=SIGNAL
PA12,GT
LED_R,LBL
```

```
U2,IP,5
R5,PS,1
U2,OP,4
R7,PS,1
J2,PS,2
R5,PS,2
R7,PS,2

PB6,5,CLASS=SIGNAL
BCD_A1,LBL
PB6,GT
U3,PS,5
U1,TS,16
U1,IP,4

PB5,6,CLASS=SIGNAL
BCD_A0,LBL
PB5,GT
U3,PS,6
U1,TS,15
U1,IP,5
CN10,PS,29

PC3,5,CLASS=SIGNAL
BCD_B3,LBL
PC3,GT
U3,PS,7
```

```
U1,TS,14
U1,IP,6

PC12,5,CLASS=SIGNAL
BCD_B2,LBL
PC12,GT
U3,PS,8
U1,TS,13
U1,IP,7

PC11,5,CLASS=SIGNAL
BCD_B1,LBL
PC11,GT
U3,PS,9
U1,TS,12
U1,IP,8

PC10,5,CLASS=SIGNAL
BCD_B0,LBL
PC10,GT
U3,PS,10
U1,TS,11
U1,IP,9

PC7,6,CLASS=SIGNAL
USART_RX,LBL
PC7,GT
```

```
U2,OP,10
CN10,PS,19
U7,PS,2
U2,IP,9

PA10,4,CLASS=SIGNAL
PA10,GT
USART TX,LBL
CN10,PS,33
U8,PS,2

PB8,6,CLASS=SIGNAL
PB8,GT
BCD_A2,LBL
CN10,PS,3
U3,PS,4
U1,TS,17
U1,IP,3

PB9,6,CLASS=SIGNAL
PB9,GT
BCD_A3,LBL
CN10,PS,5
U3,PS,3
U1,TS,18
U1,IP,2
```

PA9,5,CLASS=SIGNAL
PA9,GT
USART RX,LBL
CN10,PS,21
U8,PS,3
J4,PS,1

PB1,2,CLASS=SIGNAL
ADC_1,LBL
PB1,GT
U10,PS,2

PC4,7,CLASS=SIGNAL
PC4,GT
GPIO_EXT4,LBL
CN10,PS,34
U2,OP,12
J1,PS,1
U9,PS,2
U2,IP,11

{NC},57
CN10,PS,27
CN7,PS,32
CN7,PS,36
CN7,PS,21
CN10,PS,15

CN7,PS,30
CN10,PS,37
CN10,PS,35
CN10,PS,25
CN10,PS,31
CN10,PS,30
CN10,PS,11
CN10,PS,22
U2,PS,13
U2,PS,16
CN10,PS,24
CN10,PS,14
CN10,PS,12
CN7,PS,23
CN7,PS,3
CN7,PS,2
CN7,PS,1
CN10,PS,17
CN10,PS,26
CN10,PS,28
CN10,PS,18
CN10,PS,16
CN10,PS,6
CN10,PS,2
CN10,PS,1
CN7,PS,38
CN7,PS,37

CN7,PS,35
CN7,PS,28
CN7,PS,17
CN7,PS,15
CN7,PS,13
CN7,PS,14
CN10,PS,8
CN10,PS,7
CN10,PS,38
CN10,PS,36
CN10,PS,10
CN7,PS,9
CN7,PS,7
CN7,PS,6
CN7,PS,5
CN7,PS,4
CN7,PS,33
CN7,PS,31
CN7,PS,29
CN7,PS,27
CN7,PS,26
CN7,PS,25
CN7,PS,24
CN7,PS,11
CN7,PS,10

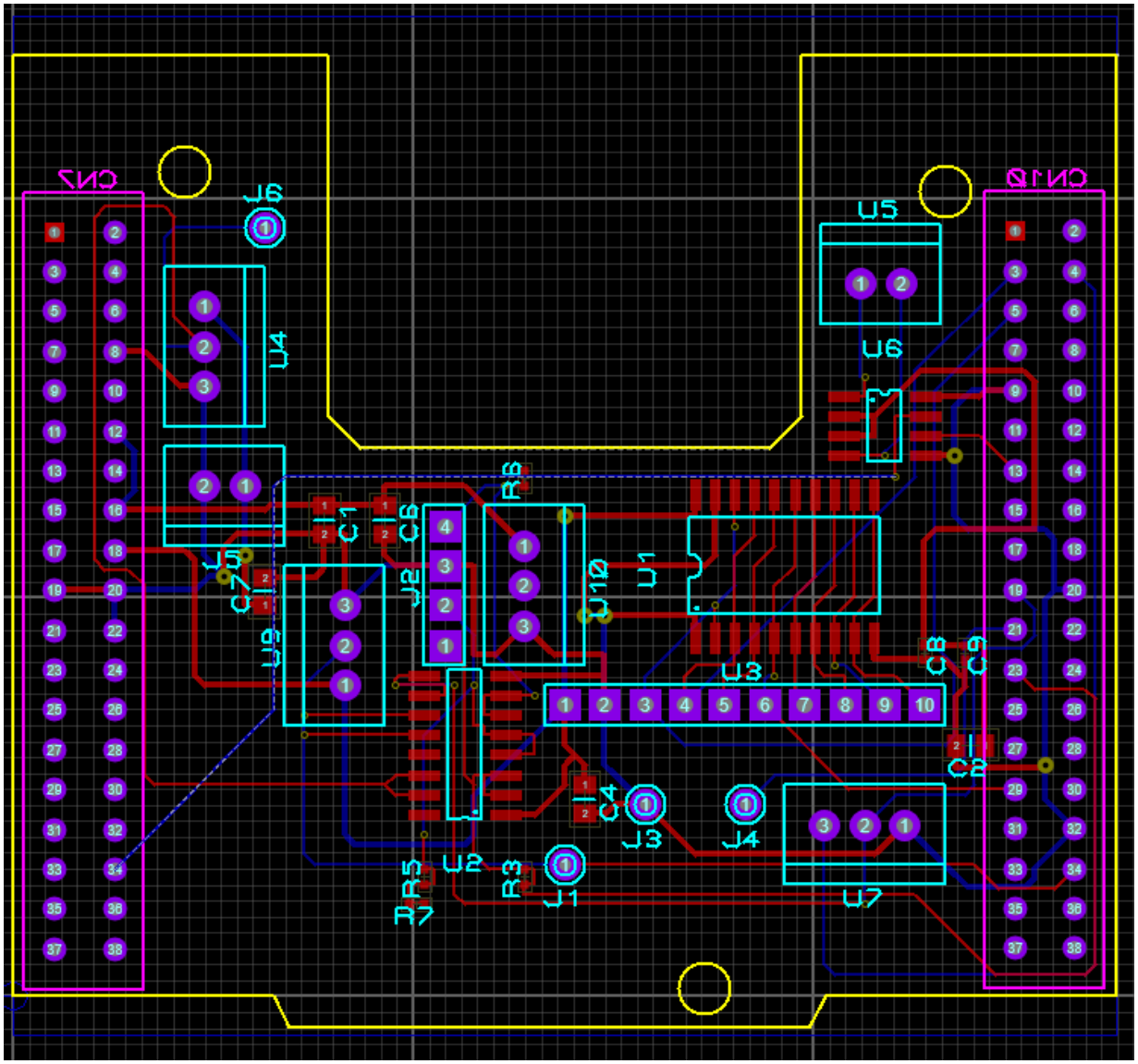
+3.3V,7,CLASS=POWER

```
+3.3V,PR
U10,PS,1
C1,PS,1
U8,PS,1
C6,PS,1
CN7,PS,16
CN7,PS,12

+5.0V,7,CLASS=POWER
+5.0V,PR
U2,PP,1
U1,PP,20
C4,PS,1
U3,PS,1
U9,PS,1
CN7,PS,18

+5V_EXT,4,CLASS=POWER
+5V_EXT,PR
J5,PS,1
C7,PS,1
U4,PS,1

+8V_EXT,6,CLASS=POWER
+8V_EXT,PR
C2,PS,1
U6,PP,2
```

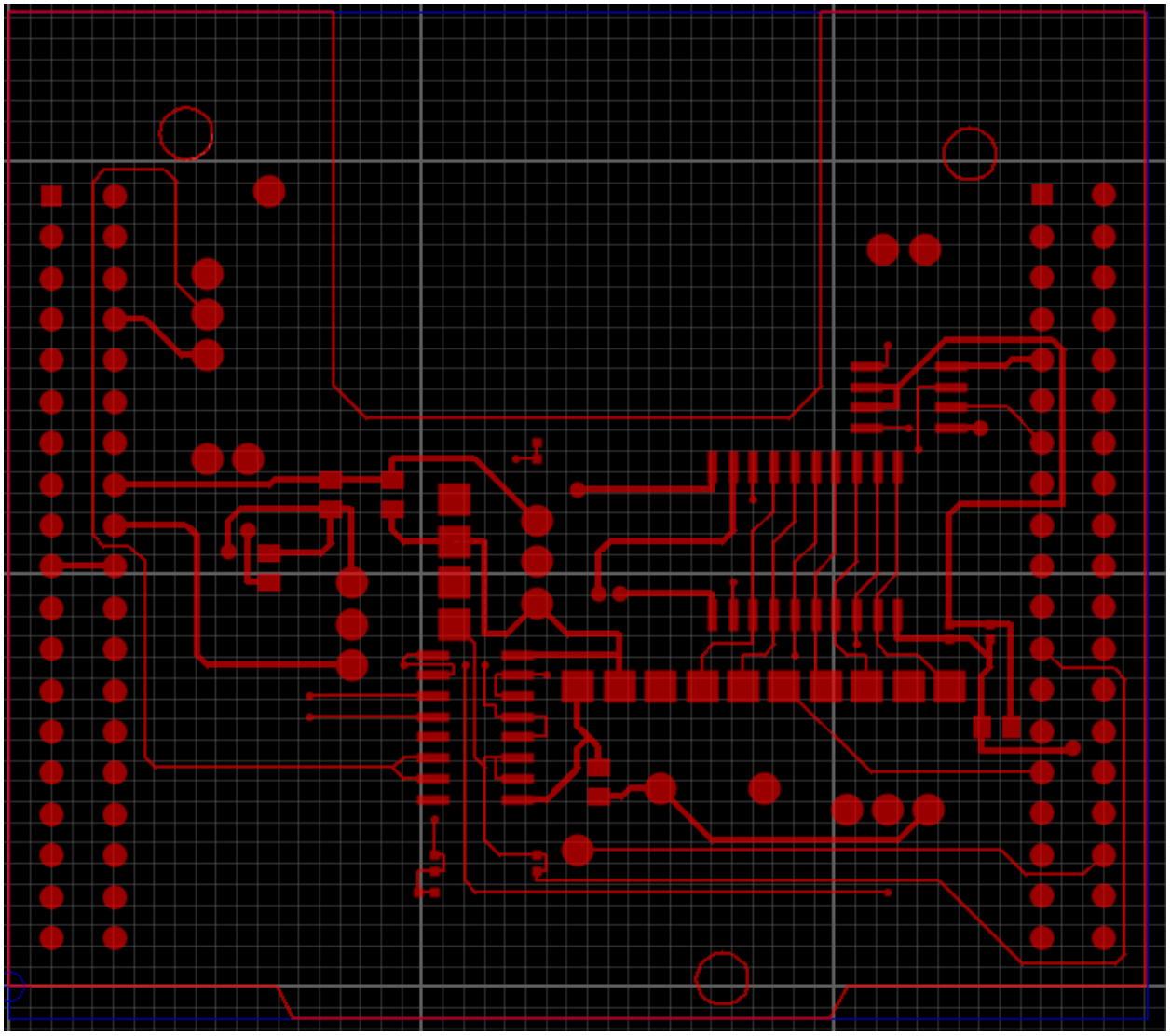
```
U6,PP,3
C8,PS,1
C9,PS,1

GND,31,CLASS=POWER
GND,PR
U2,PP,8
U10,PS,3
U1,PP,10
C2,PS,2
C1,PS,2
J5,PS,2
C7,PS,2
C6,PS,2
C4,PS,2
J3,PS,1
U1,IP,1
U1,IP,19
U9,PS,3
U3,PS,2
U8,PS,4
U8,PS,5
U4,PS,3
U6,PP,5
U6,PP,8
C8,PS,2
C9,PS,2
```

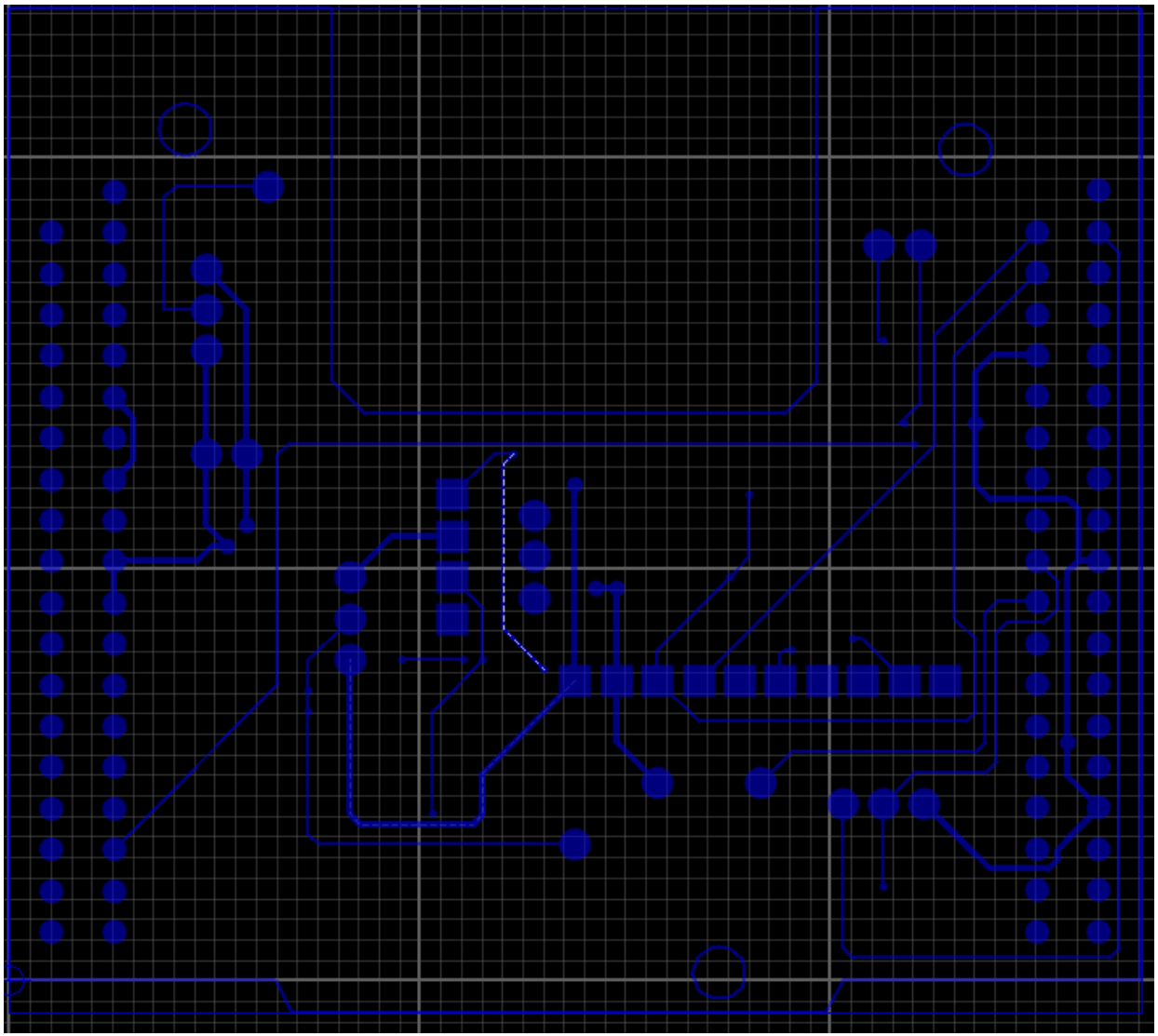
U7,PS,1
J2,PS,3
CN10,PS,9
CN10,PS,32
CN10,PS,20
CN7,PS,8
CN7,PS,22
CN7,PS,20
CN7,PS,19

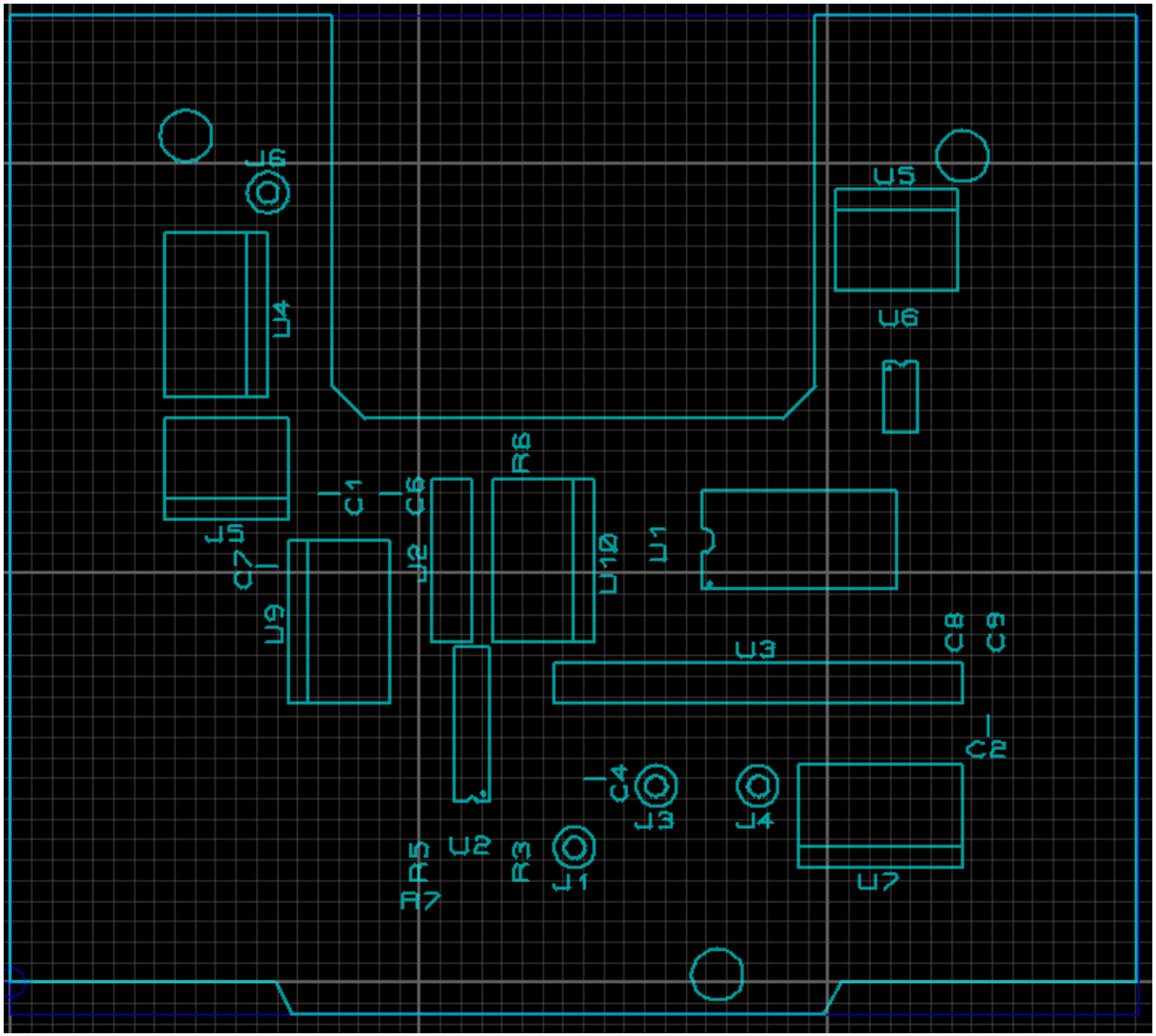
PCB layout

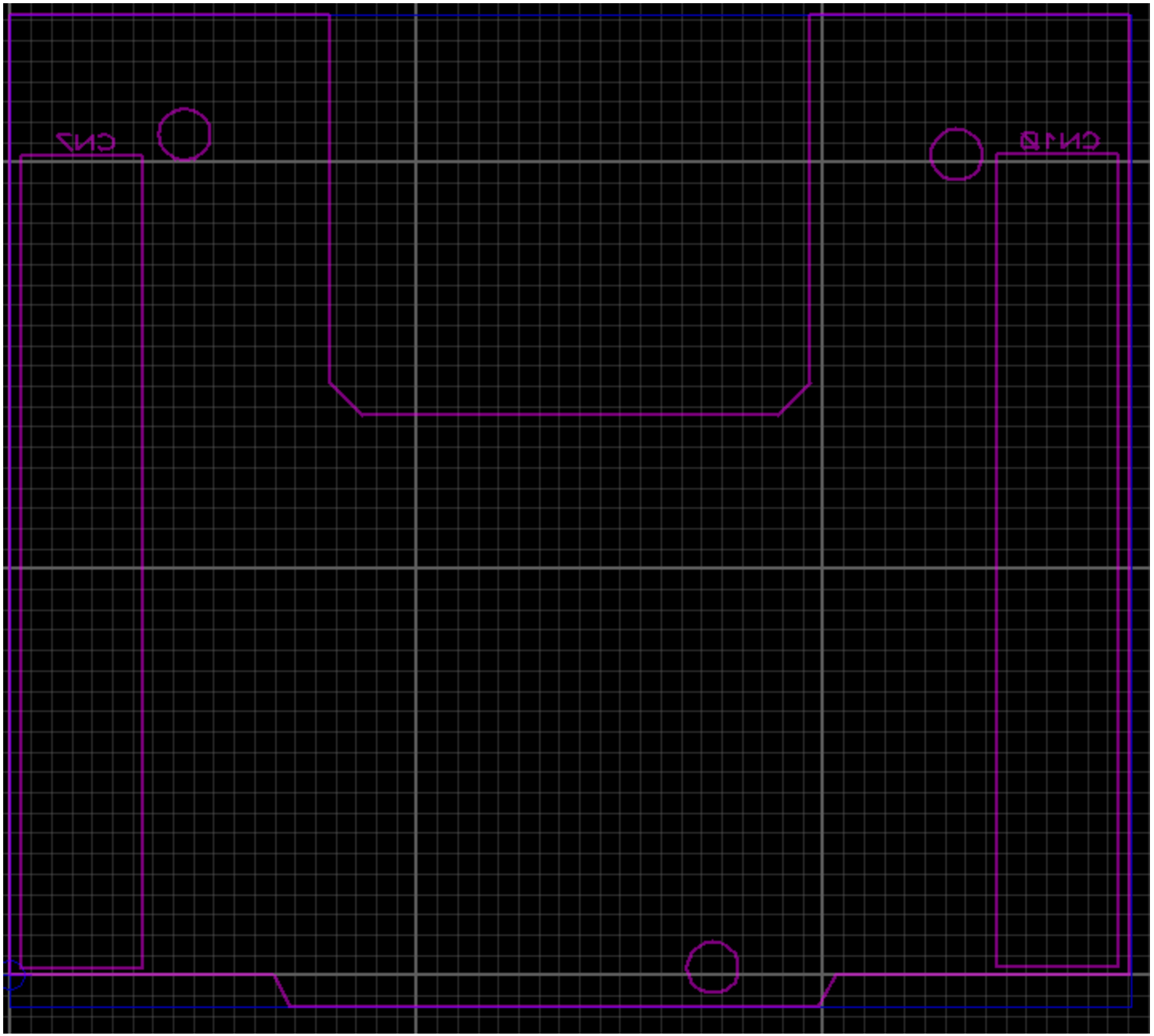

CN2
CN19
J6
U4
U5
U6
R6
C1
C6
U2
C7
U9
U10
U1
U3
C8
C9
C2
C4
J3
J4
U2
R5
R7
R3
J1
U7

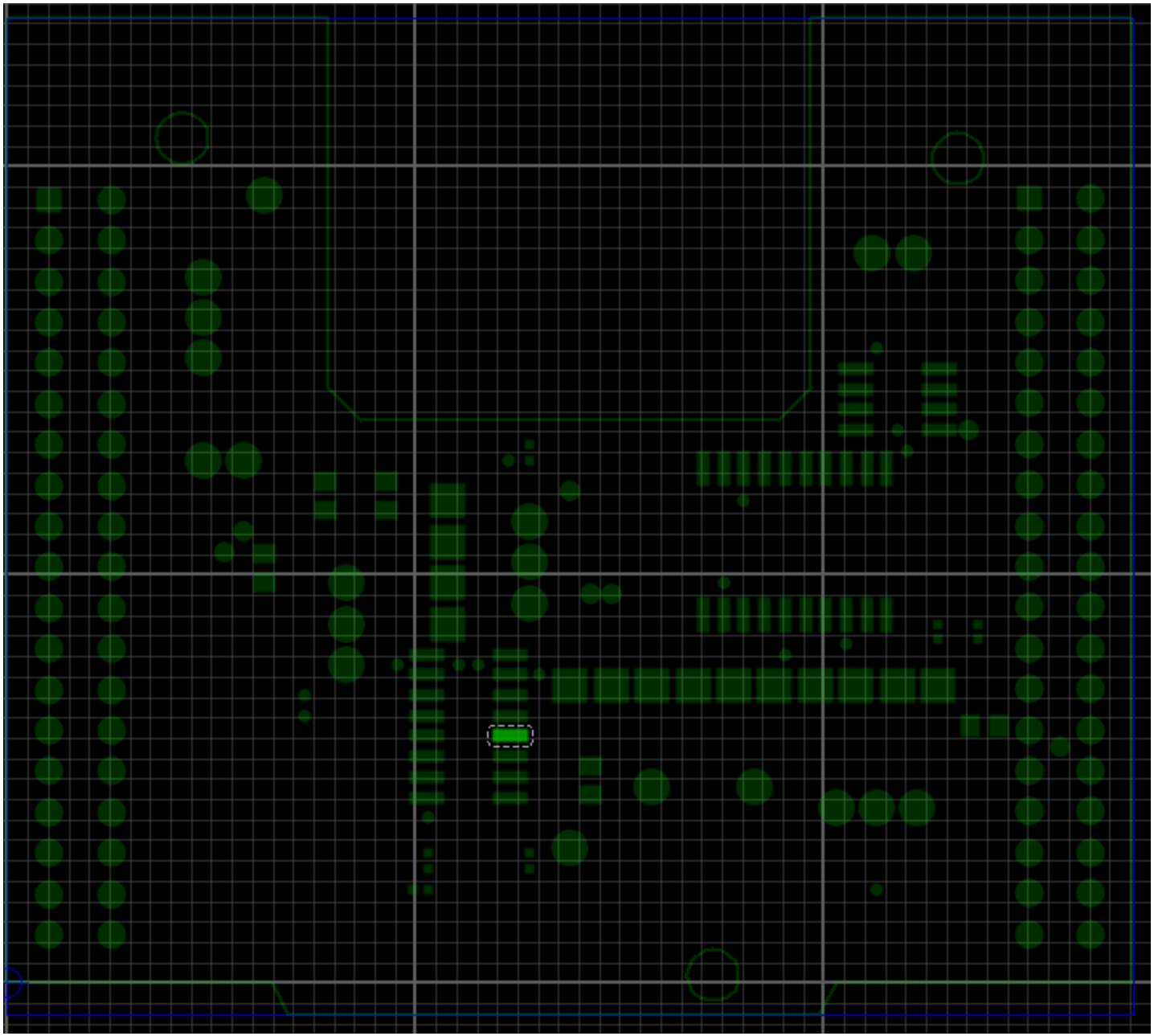
Gerber layers

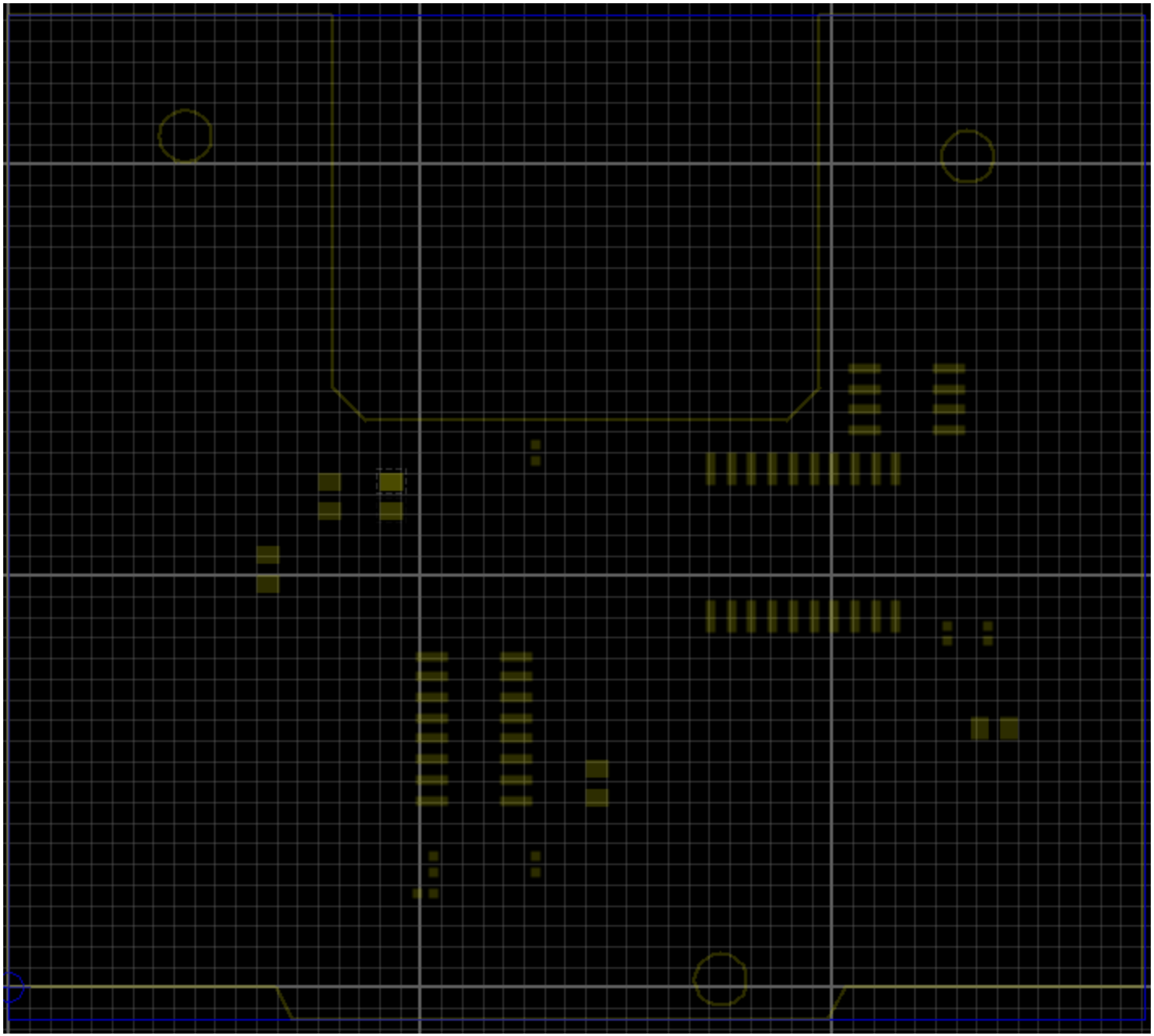





J6
U4
U5
U6
C1
C6
R6
U10
U1
U2
U5
U3
C8
C9
C2
C4
J3
J4
U2
R5
R7
R3
J1
U7

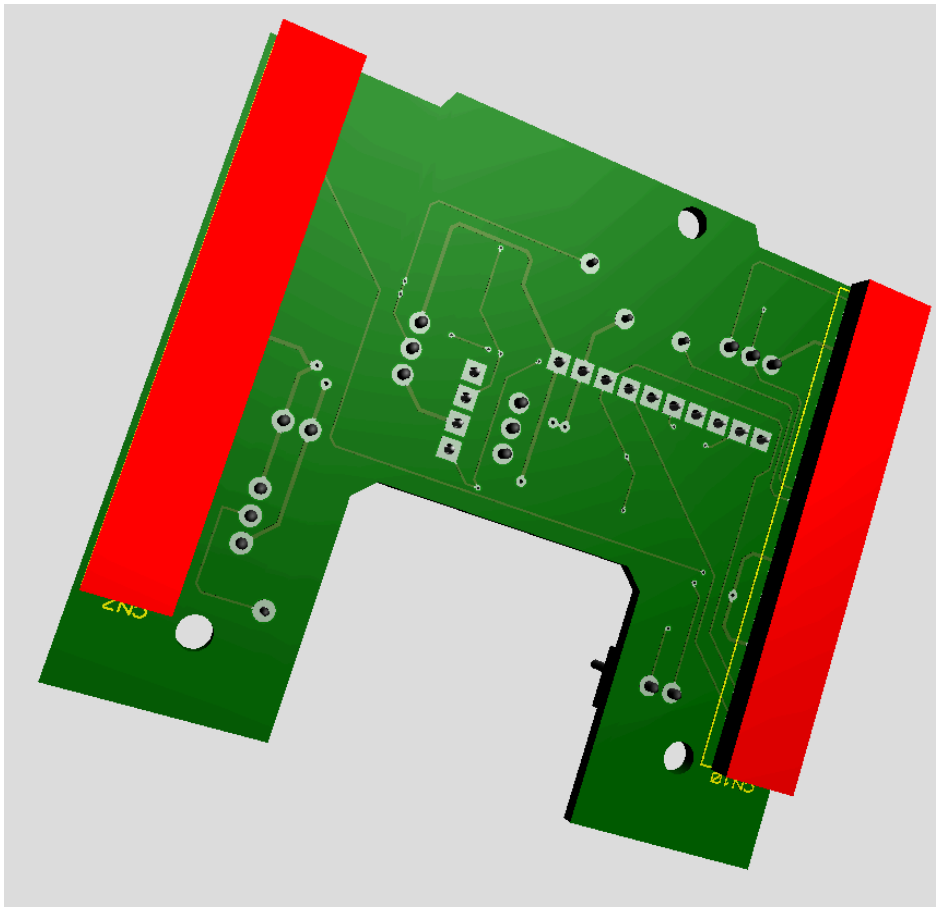

CN2
CN1

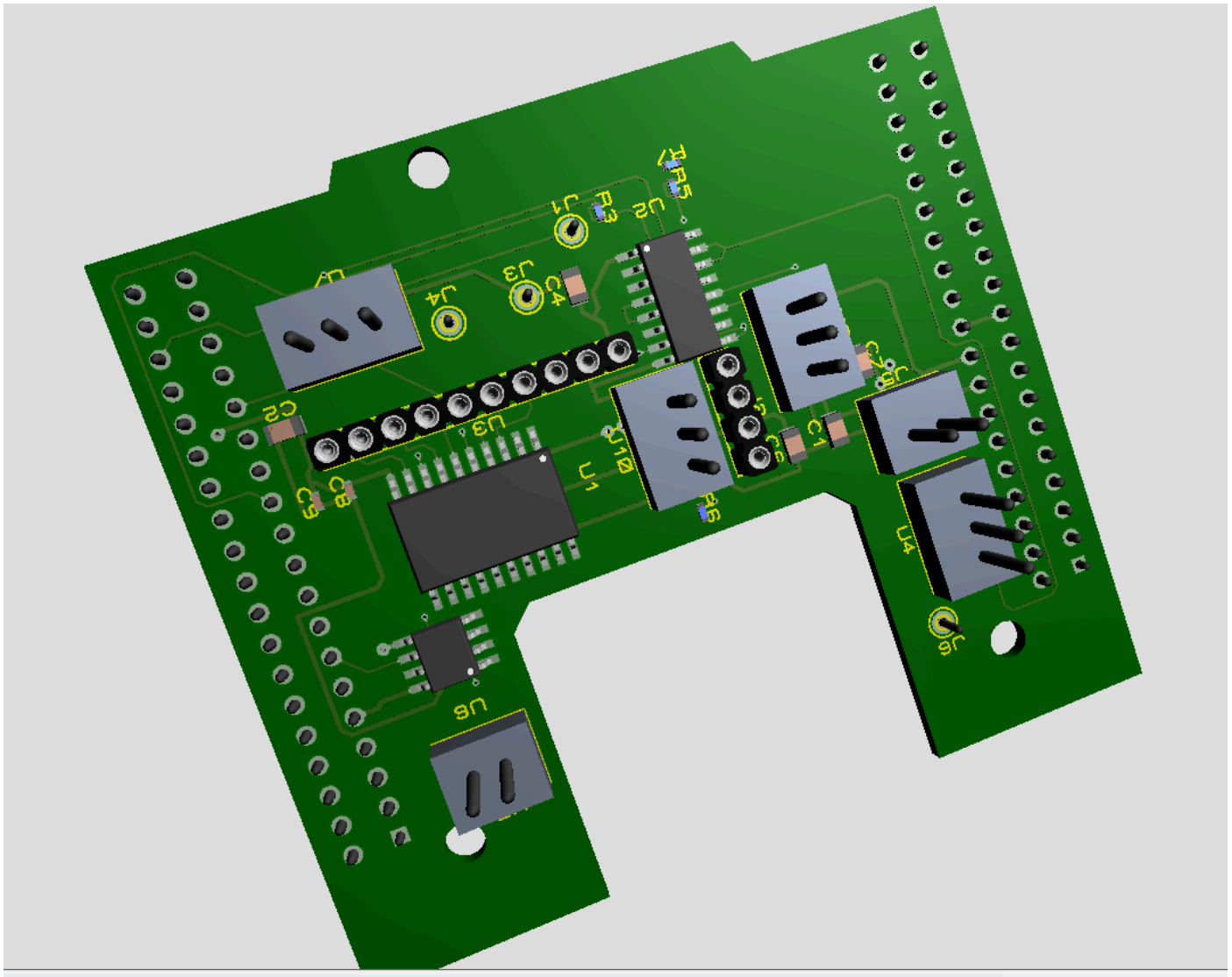




Bottom paste

3D visualisation




J1
R3
J2
R5
J3
C4
J4
C2
U3
C3
C8
U1
U10
C6
C1
C5
R6
U4
J5
U6

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 July 26, 2024
Total Parts In Design 29

7 Capacitors

Quantity	References	Value
5	C1-C2,C4,C6-C7	10u
2	C8-C9	10000pF

Sub-totals:

4 Resistors

Quantity	References	Value
2	R3,R6	180
2	R5,R7	240

Sub-totals:

10 Integrated Circuits

Quantity	References	Value
1	U1	ECE298_RS_74HCT541
1	U2	ECE298_RS_CMOS4050
1	U3	TIMER
1	U4	SERVO
1	U5	MOTOR
1	U6	ECE298_RS_L9110
1	U7	UART
1	U8	US-100
1	U9	SPEED SENSOR
1	U10	POTI

Sub-totals:

8 Miscellaneous

Quantity	References	Value
2	CN7,CN10	1-534236-9
1	J1	TEST_SPD_SENS
1	J2	LEDS
1	J3	TEST_GND
1	J4	TEST_US_SENS
1	J5	ECE298_RS_BENCH
1	J6	TEST_SERVO

Sub-totals:

Totals:

July 26, 2024 12:47:17 PM

Pick and place file

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
U1	ECE298_RS_74HCT541	SO20W		TOP	90	48.9699	27.4599
U3	TIMER	CONN-SIL10		TOP	0	46.4299	18.57
U7	UART	SIL-100-03		TOP	180	54.0499	10.95
U9	SPEED SENSOR	SIL-100-03		TOP	90	21.03	22.38
U4	SERVO	SIL-100-03		TOP	270	12.14	41.4299
J5	ECE298_RS_BENCH	SIL-100-02		TOP	180	13.41	32.5399
U10	POTI	SIL-100-03		TOP	270	32.4599	26.1899
J1	TEST_SPD_SENS	PIN		TOP	180	34.9999	8.40999
J3	TEST_GND	PIN		TOP	180	40.0799	12.22
J4	TEST_US_SENS	PIN		TOP	180	46.4299	12.22
J6	TEST_SERVO	PIN		TOP	0	15.95	49.0499
U2	ECE298_RS_CMOS4050	SO16		TOP	180	28.6499	16.03
J2	LEDS	CONN-SIL4		TOP	90	27.3799	26.1899
U5	MOTOR	SIL-100-02		TOP	0	55.0649	45.4431
C1	10u	CAPC2012X100	Digikey PCC2182TR-ND	TOP	270	19.76	30.37
C4	10u	CAPC2012X100	Digikey PCC2182TR-ND	TOP	270	36.2699	12.59
C6	10u	CAPC2012X100	Digikey PCC2182TR-ND	TOP	270	23.57	30.37
C7	10u	CAPC2012X100	Digikey PCC2182TR-ND	TOP	90	15.95	25.8201
R3	180	RESC1005X40	Digikey 311-180JCT-ND	TOP	90	32.4599	7.63999
R5	240	RESC1005X40	Digikey 311-180JCT-ND	TOP	90	26.1099	7.63999
R6	180	RESC1005X40	Digikey 311-180JCT-ND	TOP	90	32.4599	33.0401
R7	240	RESC1005X40	Digikey 311-180JCT-ND	TOP	180	25.6101	5.86999
U6	ECE298_RS_L9110	SO8		TOP	0	55.3199	36.3499
C2	10u	CAPC2012X100	Digikey PCC2182TR-ND	TOP	180	60.77	16.03
C8	10000pF	CAPC1005X55	Digikey PCC103BQDKR-ND	TOP	270	57.8599	21.93
C9	10000pF	CAPC1005X55	Digikey PCC103BQDKR-ND	TOP	270	60.3999	21.93

Operating details

We use the ULO plan during weekends (2.4c/kWh from 23:00-07:00, 7.4c/kWh otherwise)

Pipeline name	Start time	Stop time	Motor RPM	Water transferred (gallons)	Power rate (kW)	Energy used (kWh)	Energy rate (S/kWh)	Cost ($)
Inlet	04:30	07:00 (2 h 30 min)	100	25500	375	937.5	0.024	22.5
Inlet	07:00	09:33 (2 h 33 min)	85	24500	225	573.25	0.074	42.46
Zone 1	09:33	14:45 (5 h 12 min)	70	50000	125	650	0.074	48.10
Inlet	14:45	19:20 (4 h 35 min)	85	44000	225	1031.25	0.074	76.26
Zone 3	23:00	00:57 (117 min)	100	14000	375	731.25	0.024	17.5
Zone 2	00:57	04:30 (3 h 30 min)	100	30000	375	1312.5	0.024	32.13

Total energy consumed: 5235.75 kWh

Total cost: $238.95

Costs per zone: 2542 kWh / $141.22 inlet, 650 kWh / $48.10 zone 1, 1312.5 kWh / $32.13 zone 2, 731.25 kWh / $17.5 zone 3

Zone	Min RPM	Max RPM	Min GPM	Max GPM
Inlet	85	100	160 (9600 gph)	170 (10200 gph)
Zone 1	70	100	160 (9600 gph)	193 (11580 gph)
Zone 2	85	100	125 (7500 gph)	140 (8400 gph)
Zone 3	95	100	115 (6900 gph)	120 (7200 gph)

Reservoir can hold 94000 gallons
Zone 1 needs 50 000 gallons
Zone 2 needs 30 000 gallons
Zone 3 needs 14 000 gallons