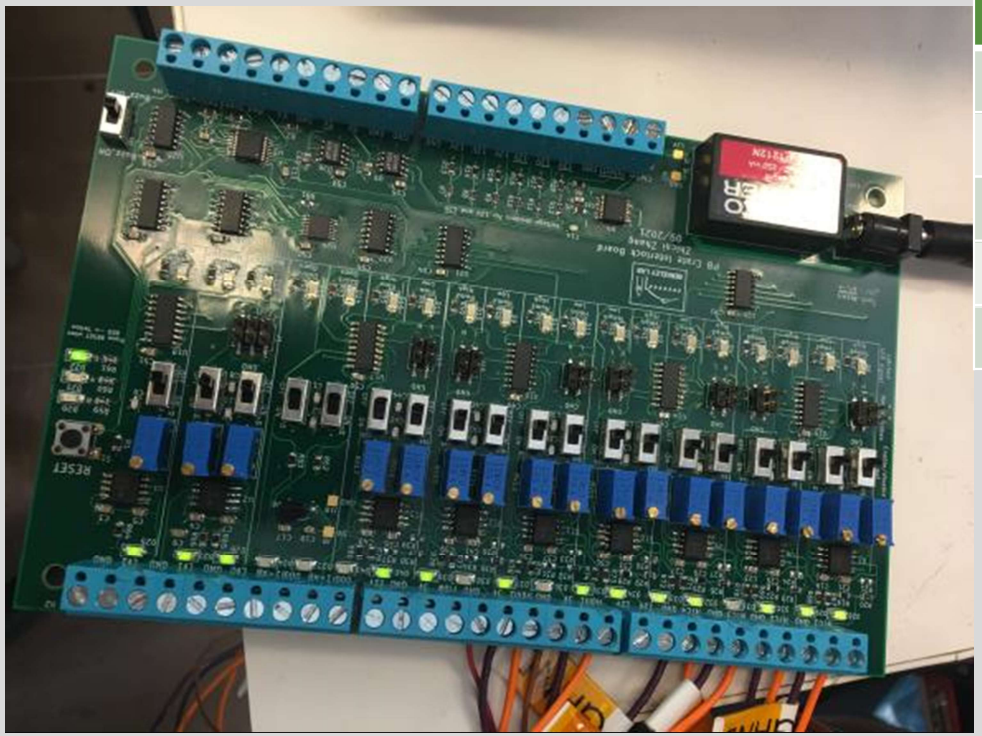
ATLAS UPGRADE PROGRAM URAP PROGRESS

Samantha Kelly (supervised by Zhicai Zhang)

Interlock PCB Introduction

- Generic Interlock PCB presented in September 2021
  - Should be able to monitor resistor type (e.g. NTC) or voltage type signal
  - Can trace source of input failure
  - Should send active low/high interlock signals to device
  - Self-running, no software needed
- Apply to thermal cycle crate
  - Low or high (preset) voltage thresholds trip for Humidity, Temperature, Flow, Door, or LV → board shuts down Chiller, LV, or HV
  - Protects equipment used for the cycle crate and boards inside of it by regulating conditions

MONTH 1



COMPONENT	NUMBER LAUNCHED
0Ω resistor	1
10kΩ resistor	3
50kΩ resistor	3
0.1F capacitor	2
Op amp	1

TOTAL MONEY LOST:

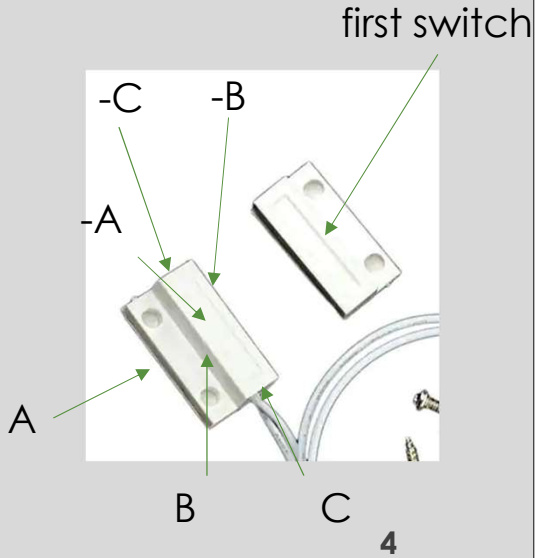
1*$0.12 + 3*$0.10 + 3*$0.10 + 2*$0.10 + 1*$0.94 =

$1.86

0.000000197% of Total Laboratory Costs (as of 2019)

MONTH 2

- Ensured all LEDs on PCB fired at correct times
  - Determined U2 (impacting LV0 and LV1) was dead and replaced component
- Documented magnetic proximity switch range of resistance
  - side with the two holes is Side A
  - long side closest to Side A's holes is Side B
  - the short side to the right of Side B when Side A is placed on a flat surface is Side C
  - all other sides are -Side A, -Side B, and -Side C (as they lie opposite to the original sides)
  - axis of the ruler is The Axis
  - first switch has no wires



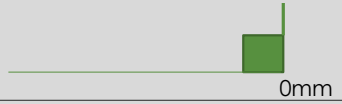
MONTH 2

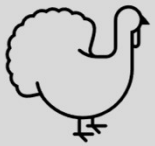
First switch has Side A ⊥ to The Axis and Side A at 0mm	
Side facing first switch	Activation distance
A	0.8mm
B	0.2mm
C	N/A
-A	0.4mm
-B	0.2mm
-C	0.8mm

First switch has Side B ⊥ to The Axis and Side B at 0mm	
Side facing first switch	Activation distance
A	0.15mm
B	N/A
C	N/A
-A	N/A
-B	N/A
-C	N/A

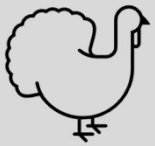
First switch has Side C ⊥ to The Axis and Side C at 0mm	
Side facing first switch	Activation distance
A	0.1mm
B	N/A
C	N/A
-A	0.2mm
-B	0.3mm
-C	0.85mm

Ex: First switch has Side A ⊥ to The Axis and Side A at 0mm





MONTH 2



First switch has Side A ⊥ to The Axis and -Side A at 0mm	
Side facing first switch	Activation distance
A	0.6mm
B	0.1mm
C	0.1mm
-A	1.25mm
-B	1.1mm
-C	0.6mm

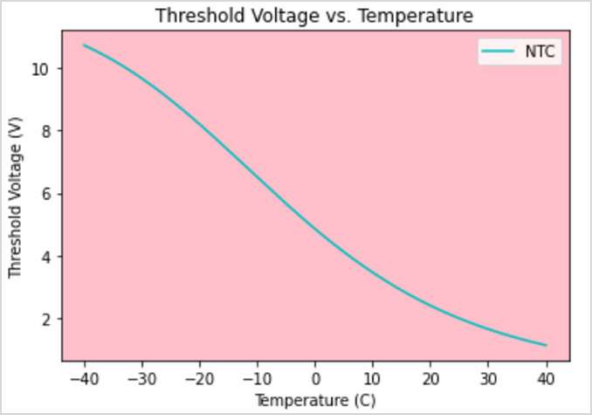
First switch has Side B ⊥ to The Axis and -Side B at 0mm	
Side facing first switch	Activation distance
A	N/A
B	0.1mm
C	0mm
-A	1.3mm
-B	1.2mm
-C	N/A

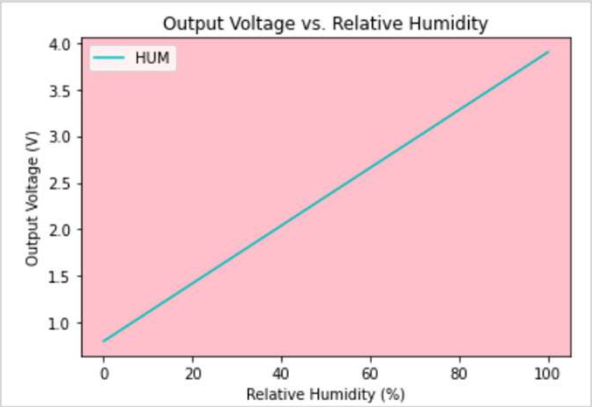
First switch has Side C ⊥ to The Axis and -Side C at 0mm	
Side facing first switch	Activation distance
A	N/A
B	N/A
C	N/A
-A	N/A
-B	N/A
-C	N/A

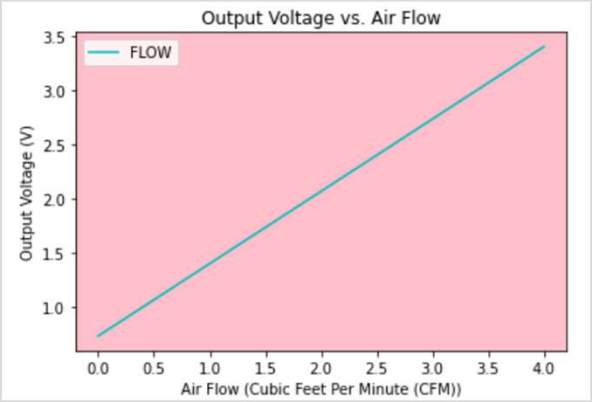
MONTH 3

- Determined NTC3 potentiometers were turning together (vs. independently) when board is powered
  - U9 was not working correctly, and was subsequently replaced
  - Determined U2 (impacting LV0 and LV1) was dead and replaced component
- Created models for NTC, HUM, and FLOW based on datasheets
- Tested all sensors at default room conditions
  - HUM1 and HUM2 were 35.16% and 34.84% respectively
  - NTC1, NTC2, NTC3, and NTC4 were 22.44°C, 22.57°C, 22.81°C, and 22.57°C respectively
- Connected PCB to the thermal cycle crate and collected HUM data

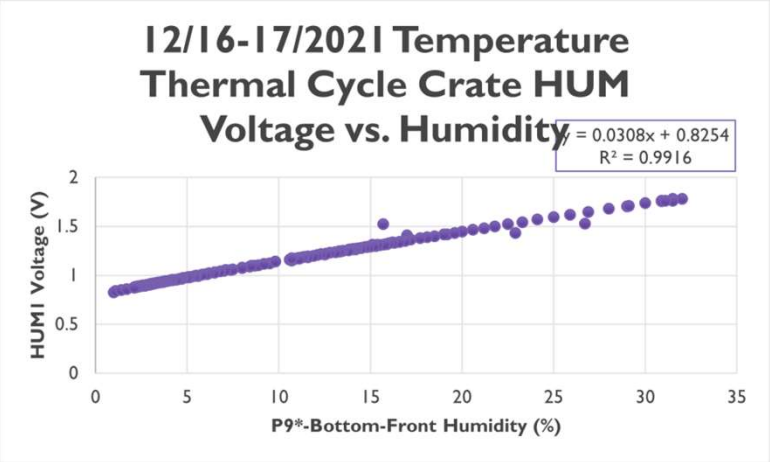
MONTH 3

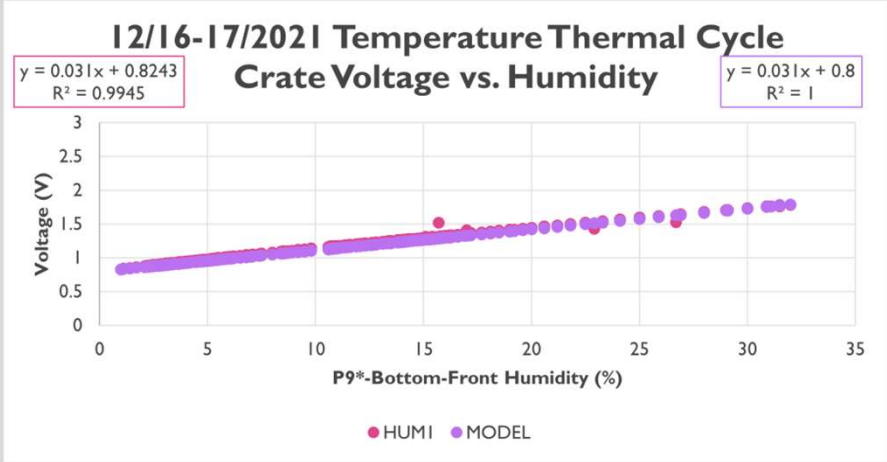

Threshold Voltage vs. Temperature
NTC
Threshold Voltage (V)
Temperature (C)
10
8
6
4
2
−40
−30
−20
−10
0
10
20
30
40


Output Voltage vs. Relative Humidity
HUM
Output Voltage (V)
Relative Humidity (%)
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0
20
40
60
80
100


Output Voltage vs. Air Flow
FLOW
Output Voltage (V)
Air Flow (Cubic Feet Per Minute (CFM))
3.5
3.0
2.5
2.0
1.5
1.0
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0

MONTH 3

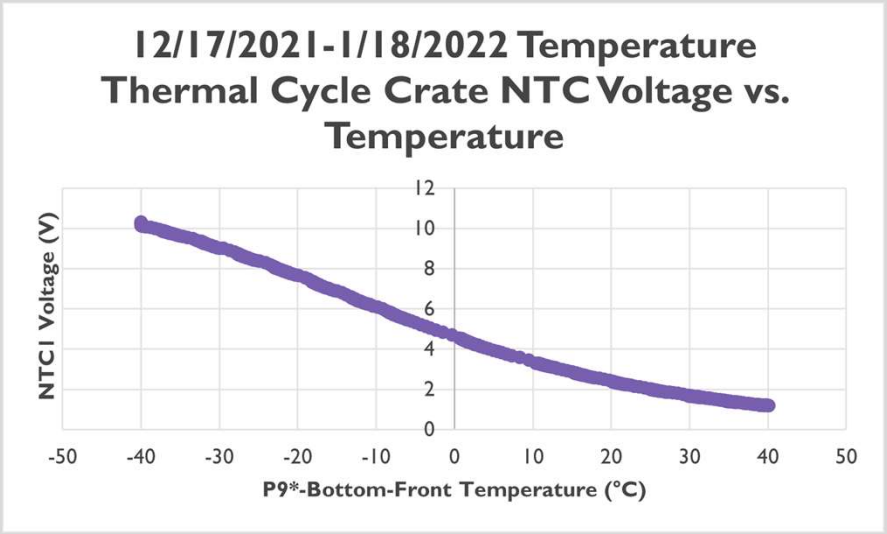

12/16-17/2021 Temperature Thermal Cycle Crate HUM Voltage vs. Humidity
y = 0.0308x + 0.8254
R² = 0.9916
HUM1 Voltage (V)
P9*-Bottom-Front Humidity (%)

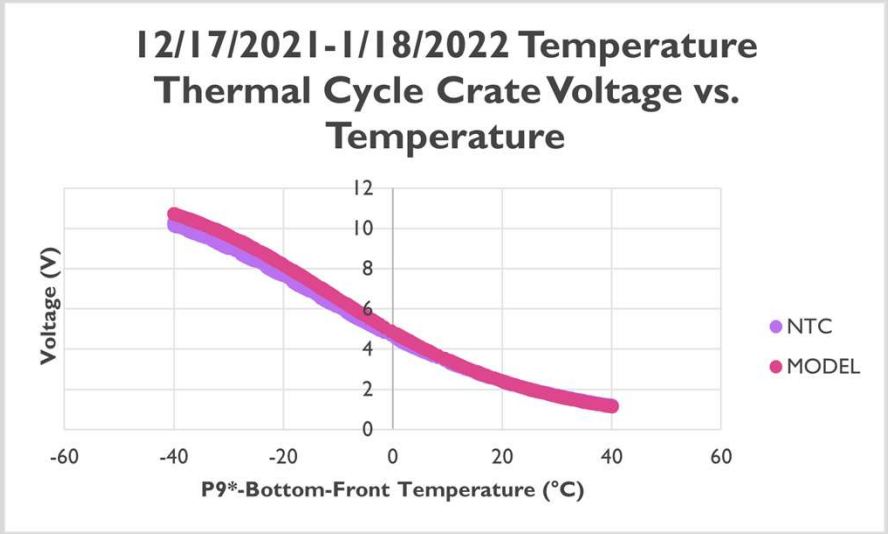

12/16-17/2021 Temperature Thermal Cycle Crate Voltage vs. Humidity
y = 0.031x + 0.8243
R² = 0.9945
y = 0.031x + 0.8
R² = 1
Voltage (V)
P9*-Bottom-Front Humidity (%)
HUM1
MODEL

MONTH 4

- Collected NTC and FLOW data
- Constructed power supply connections for the PCB
  - LV is not shutting off when board is red (i.e. threshold tripped)
    - Testing connections to troubleshoot
- Began troubleshooting how to connect PCB to chiller control
  - Necessary parts determined
- Will itemize components for the three other boards planned for after this PCB is tested

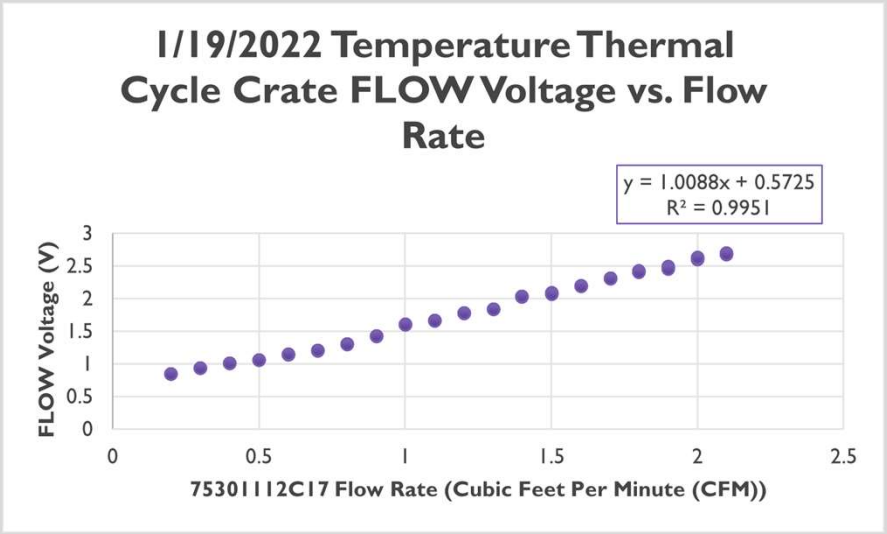
MONTH 4

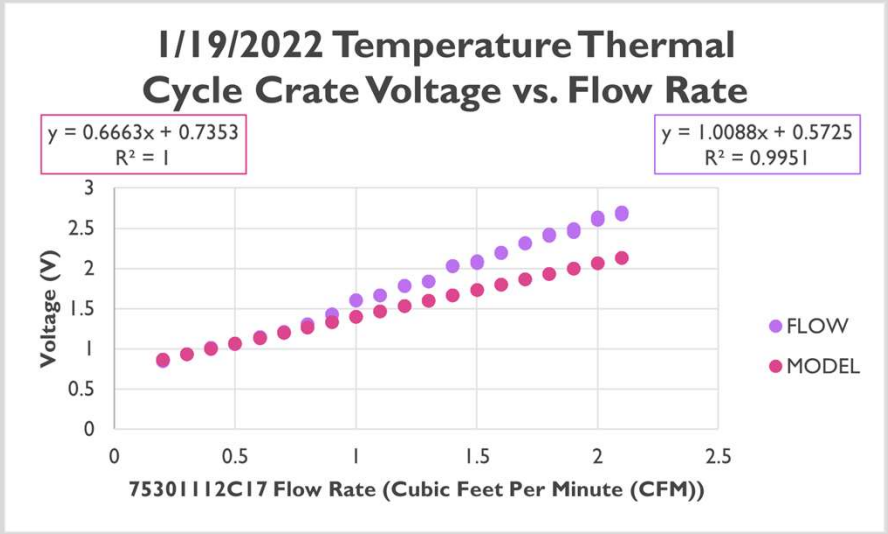




	FIT	ACTUAL	%ERROR
R0 (Ω)	9356.944	10000	7.993316
B (K)	3665.546	3984	6.43056

MONTH 4


1/19/2022 Temperature Thermal Cycle Crate FLOW Voltage vs. Flow Rate
y = 1.0088x + 0.5725
R² = 0.9951
FLOW Voltage (V)
0
0.5
1
1.5
2
2.5
3
0
0.5
1
1.5
2
2.5
75301112C17 Flow Rate (Cubic Feet Per Minute (CFM))


1/19/2022 Temperature Thermal Cycle Crate Voltage vs. Flow Rate
y = 0.6663x + 0.7353
R² = 1
y = 1.0088x + 0.5725
R² = 0.9951
Voltage (V)
0
0.5
1
1.5
2
2.5
3
0
0.5
1
1.5
2
2.5
75301112C17 Flow Rate (Cubic Feet Per Minute (CFM))
FLOW
MODEL