

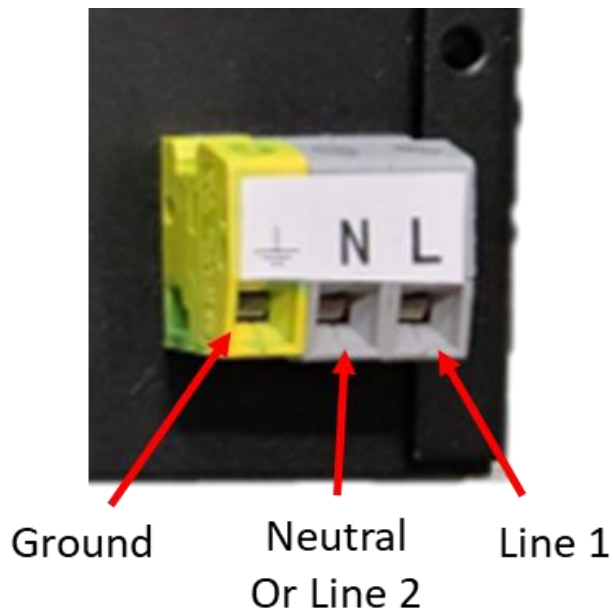
3rd Wave Labs 4 Channel AC Controller



Power IN Connections

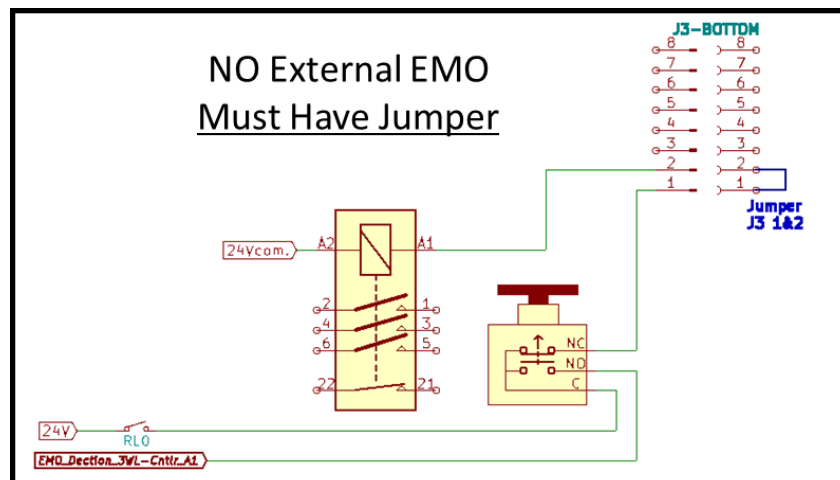
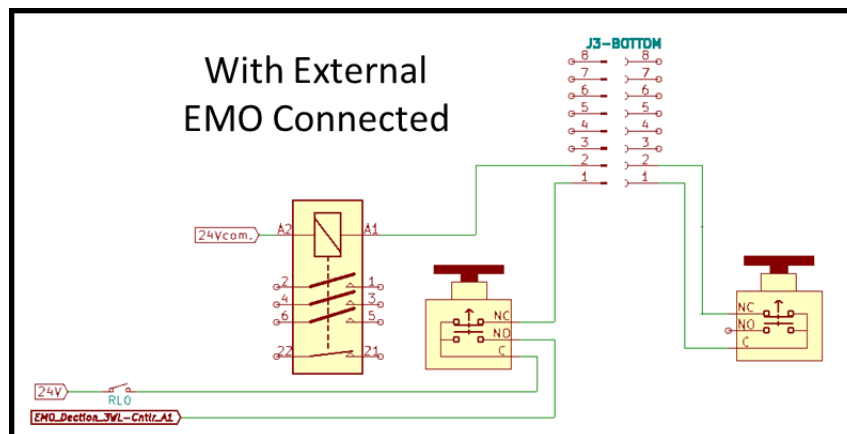
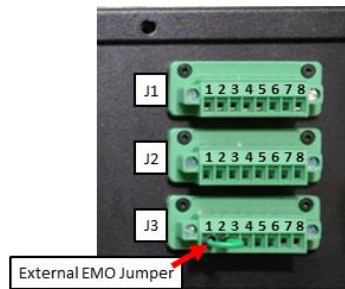
The 4 Channel AC Controller can operate on 120Vac or 240Vac at 30Amps. Please refer to the Tool Placard located on the front of the controller for further information.

It is recommended that the supply circuit be limited to 30Amps to prevent damage to the controller. The ground connection must be connected to earth ground. Failure to connect the ground can pose a safety hazard to the user. Power In terminal screws should be tightened to 0.6-.08Nm.



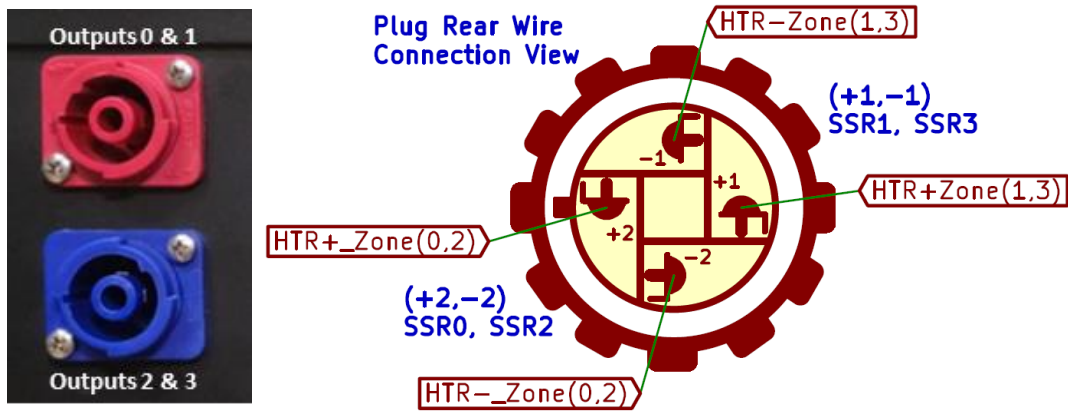
Emergency Stop

The E-Stop is designed to eliminate the output power to the heaters. When the E-Stop is depressed, the contactor will open & the supply voltage to the solid-state relays will be eliminated. Power to the Primary Control circuitry & displays will still be powered on. An External EMO Switch can be added Via Connections J3-1 & J3-2. If no External EMO is to be used, a jumper must be placed across these two points.

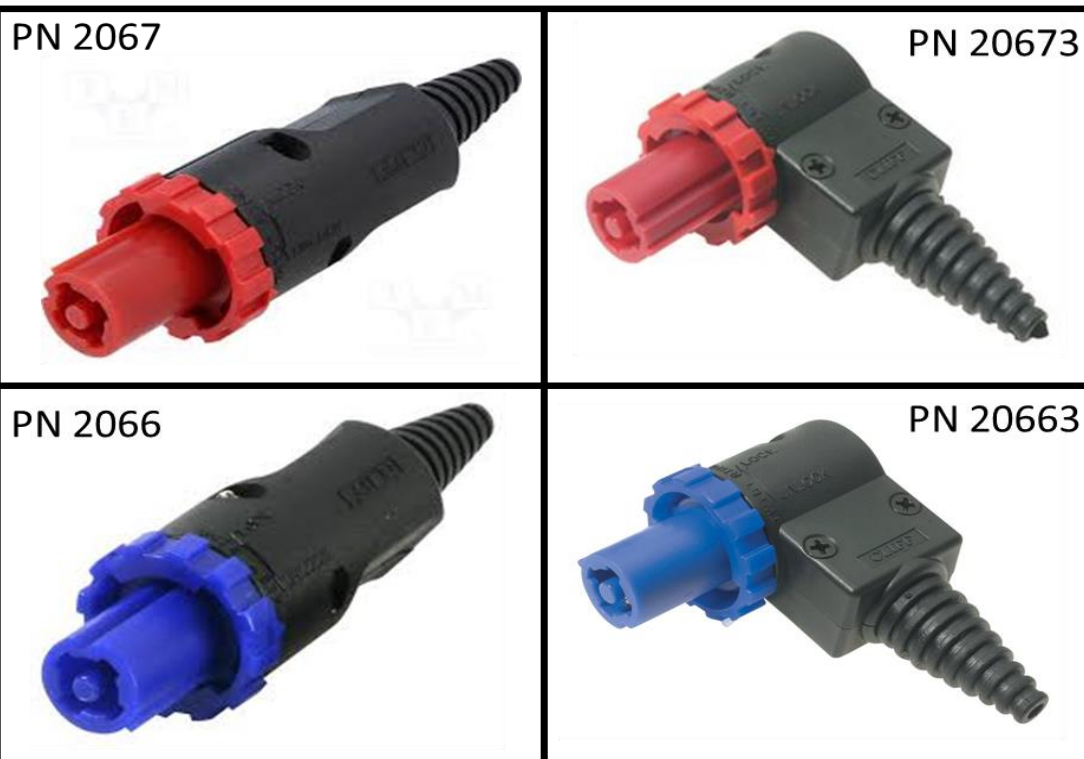


Heater Connections

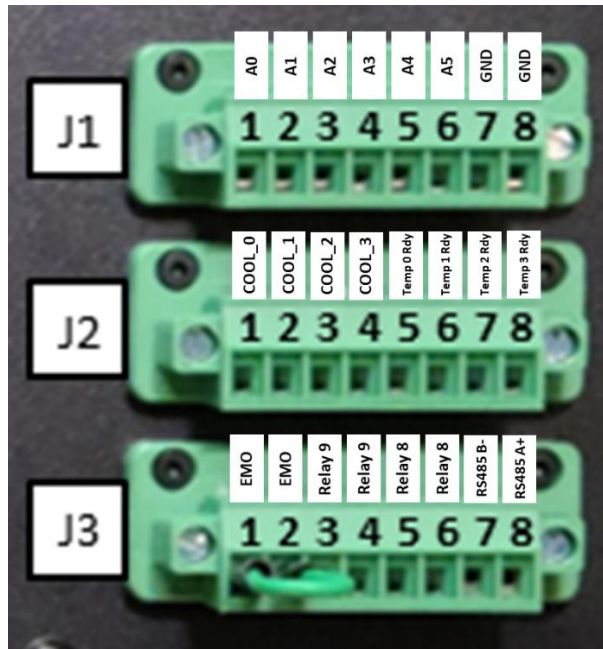
RED & BLUE Connectors have the same connections points.



Available Plug Types & Part Numbers



J1/J2/J3 Connections



J1: Analog Inputs(A0-A5)

- Logic “0” Level: 0V-7.2V
- Logic “1” Level: 18V-26.4V
- Maximum Input Current <3ma

J2: Digital Outputs(D0-D7)

- D0-D3 have been configured as the cooling output for each of the respective heater zones(0-3).
- D4-D7 have been configured to provide “Temp Ready” Signals for each of the respective heater zones(0-3).
- Nominal Load Current is 2A (self-limiting)

J3: EMO/Relays/Communication

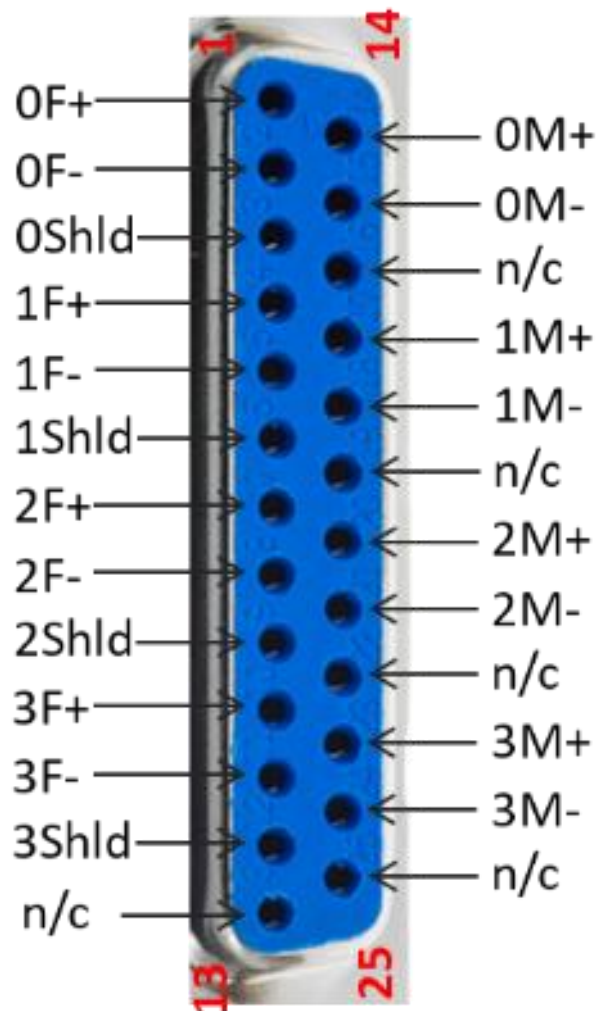
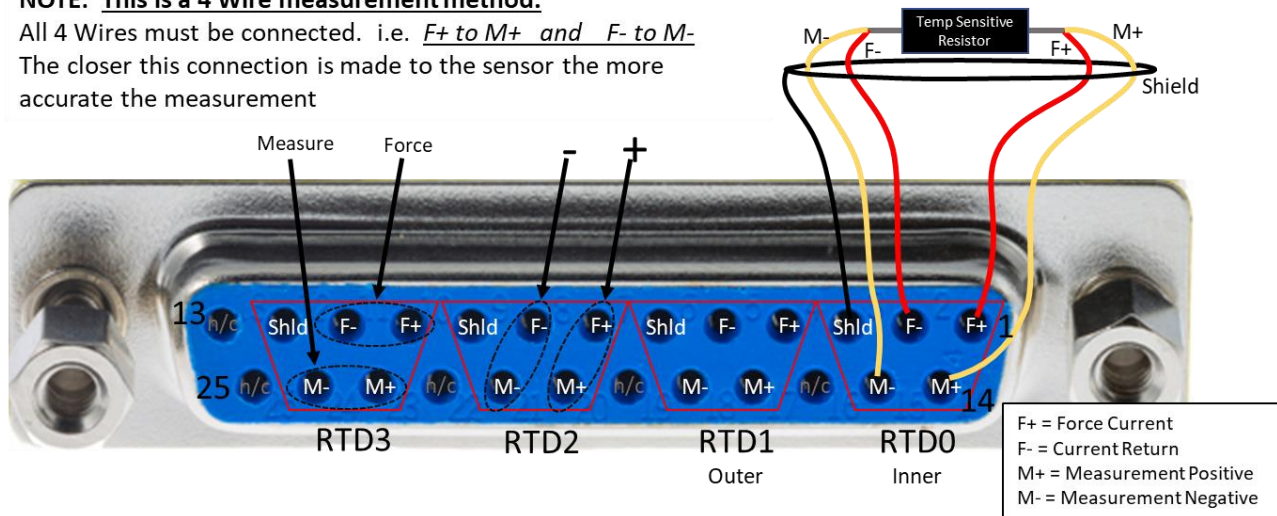
- EMO (pins1 & 2). Provides power to the contactor.
 - Pin1 (24V out)
 - Pin 2 (24V return)
- Relay8 (pins 5&6) & Relay9 (pins 3&4)
 - Resistive Load Max Current: 6A (250Vac/30Vdc)
 - Fuse is recommended

- RS485 Communication (Pin7 B- / Pin8 A+)

RTD Connections

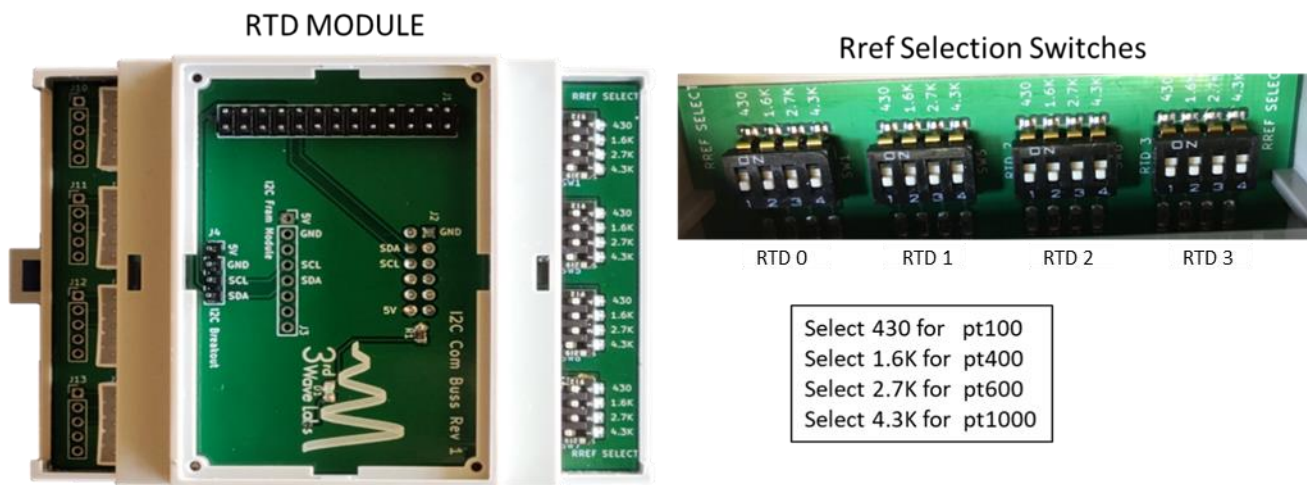
NOTE: This is a 4 Wire measurement method.

All 4 Wires must be connected. i.e. $F+$ to $M+$ and $F-$ to $M-$.
The closer this connection is made to the sensor the more accurate the measurement

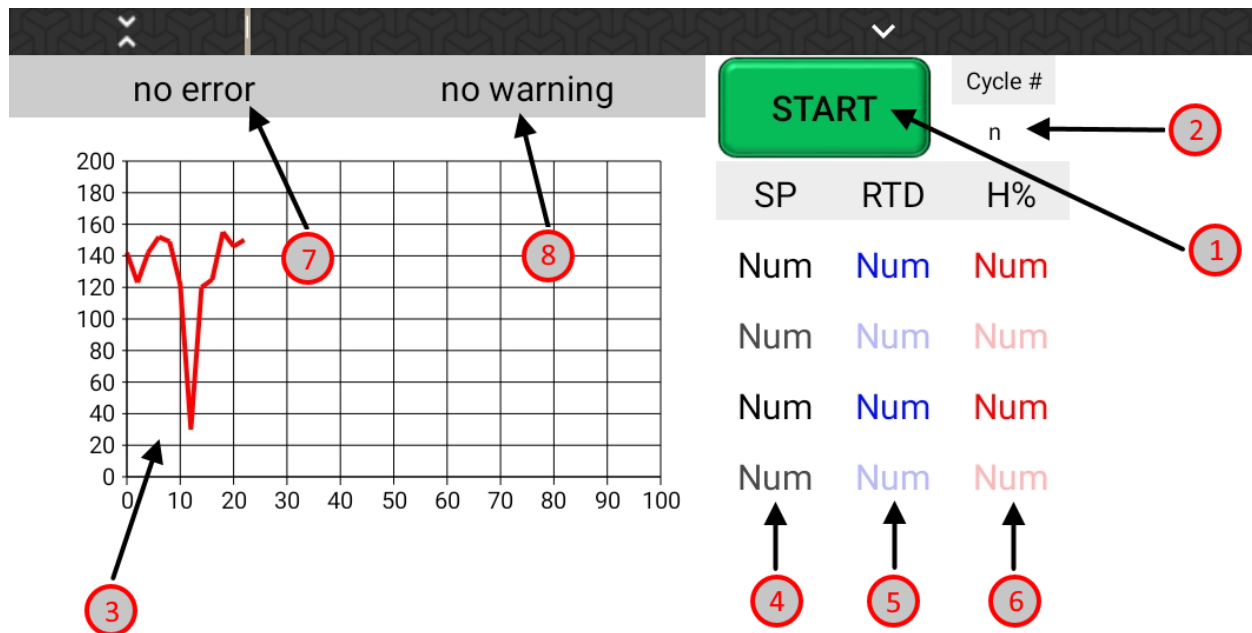


RTD Reference Resistor Selection

- Rref should be set to 2 to 4x the nominal room temp RTD value. Low end for low temp and high end for high temp to balance resolution and range.
 - 4300 is about 4 times 1000 for an RTD resistance of 1000
- Switches may be of different type. Follow the switch position setting for “ON”
- Enable only one Ref Resistor.
- The corresponding value needs to be set in the HMI application as well.

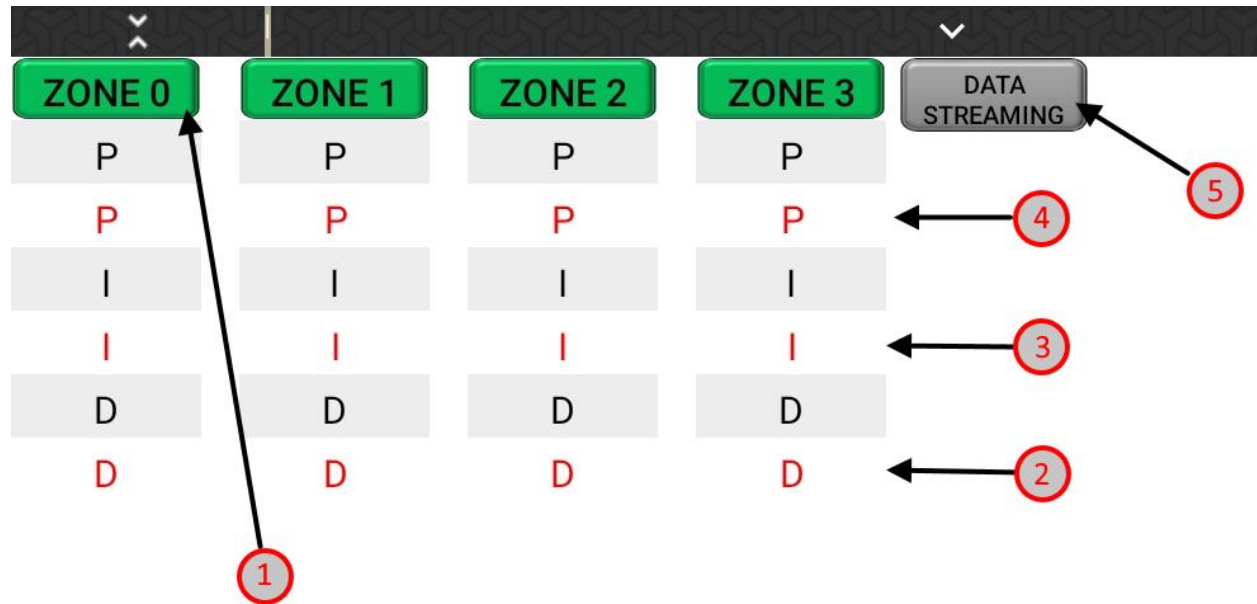


HMI Control Screens

OPERATION

1. Start / Stop Button: when toggled down this sets the controller to heat
2. Cycle Counter: when in profile mode, this indicates the current cycle
3. Temperature Graph: A graph of all 4 Heater zones
4. Setpoints: the current setpoint for each zone in order (0 if disabled)
5. Temperatures: the current temperatures of each zones RTD in order (0 if disabled)
6. Heater %: The drive percent of each zone in order (0 if off or disabled)
7. Error State: The current error state readout from the controller
 1. No Error: the control system is operating normally
 2. Over Temp: temperature has risen over the firmware's set temp limit
 3. Temp rising while off: The heater temperature is rising while idle
 4. EMO Pressed: The front panel EMO switch has been pressed
8. Warning State: Used as a both a conditional warning output and an area to describe necessary actions to take when an error state is set. For example for error state a-d, the warning state will display "RESET NEEDED"
See Misc Config for reset button.

HMI Control Screens Cont.

CONTROL TUNING

1. Zone Disable: The zone disable button, same functionality for zone 1 – 3
2. Differential Gain: Typically untouched, used to smooth nonlinear sources of oscillation
3. Integral Gain: the weight of cumulative error between setpoint and temp on output
4. Proportional Gain: the weight of current error between setpoint and temp on output.
5. Serial Streaming Enable / Disable: for precise data collection of setpoint, output and temperature. Leave off for normal operation

HMI Control Screens Cont.

CALIBRATIONS

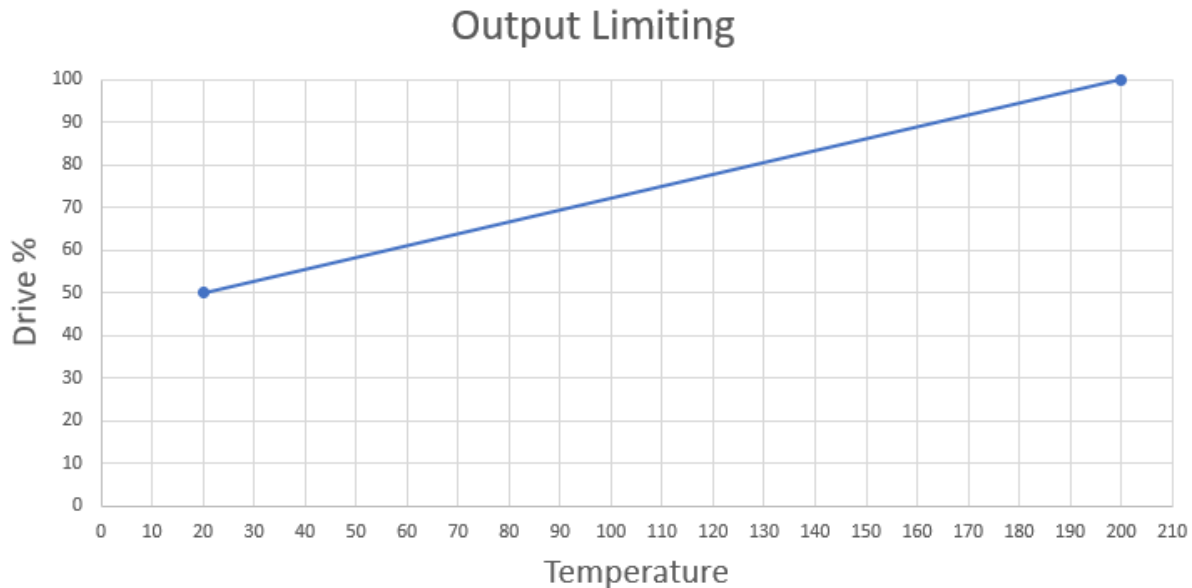
Zone 0	Zone 1	Zone 2	Zone 3	Output Limiting
M	M	M	M	Start Temp
M	M	M	M	n
B	B	B	B	Start %
B	B	B	B	n
RREF	RREF	RREF	RREF	100% Temp
RREF	RREF	RREF	RREF	n

1. M: Resistive heater slope calibration factor for zone n
(Temp = M*Resistance - B)
2. B: Resistive heater intercept calibration factor for zone n
(Temp = M*Resistance - B)
3. RREF: Reference resistance value for 3rd Wave RTD Module for zone n
4. Start Temp: see graphical description below
5. Start %: see graphical description below
6. 100% Temp: see graphical description below

HMI Control Screens Cont.

CALIBRATIONS CONT.

Graphical Description of 4, 5, and 6:



As you can see here, the output is limited to 50% (Start%) at 20°C (Start Temp) and can go to 100% at 210 (100% Temp).

This feature is used in situations where high current through a heater at low temperatures causes damage to the heater.

Normally, default values are set such that the output is 100% at every temperature. For example:

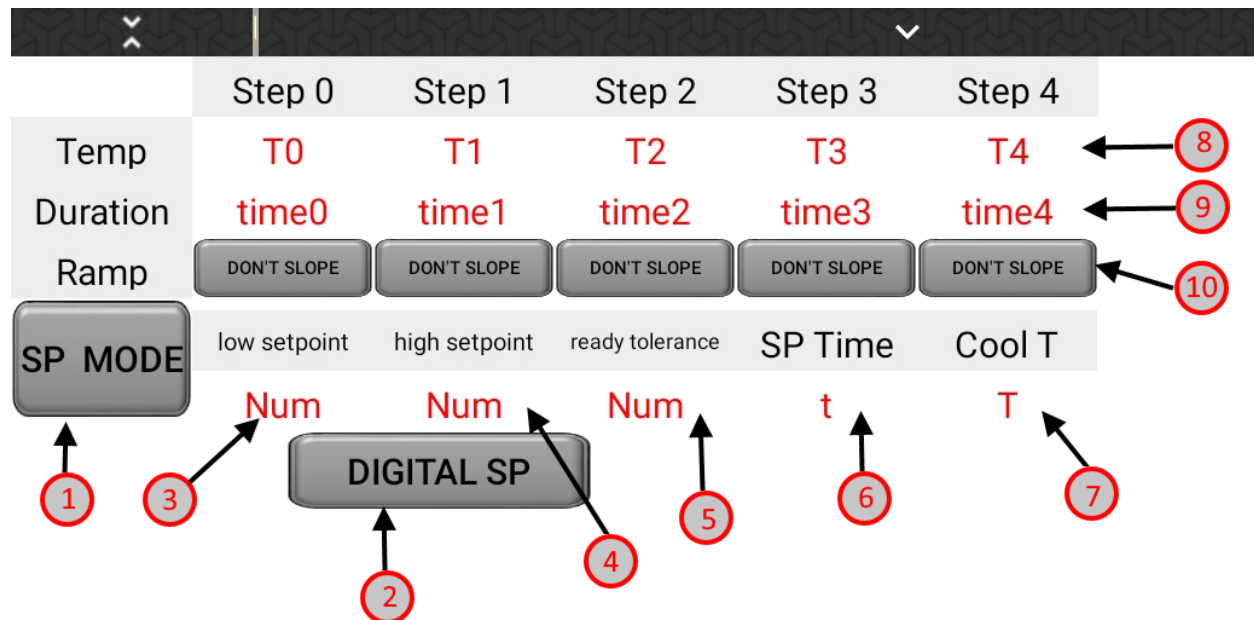
Start Temp = 20

Start % = 100

100% Temp = 100

Warning: if you use this feature, make sure not to set the values in a way that the output limit goes below 0 at any point.

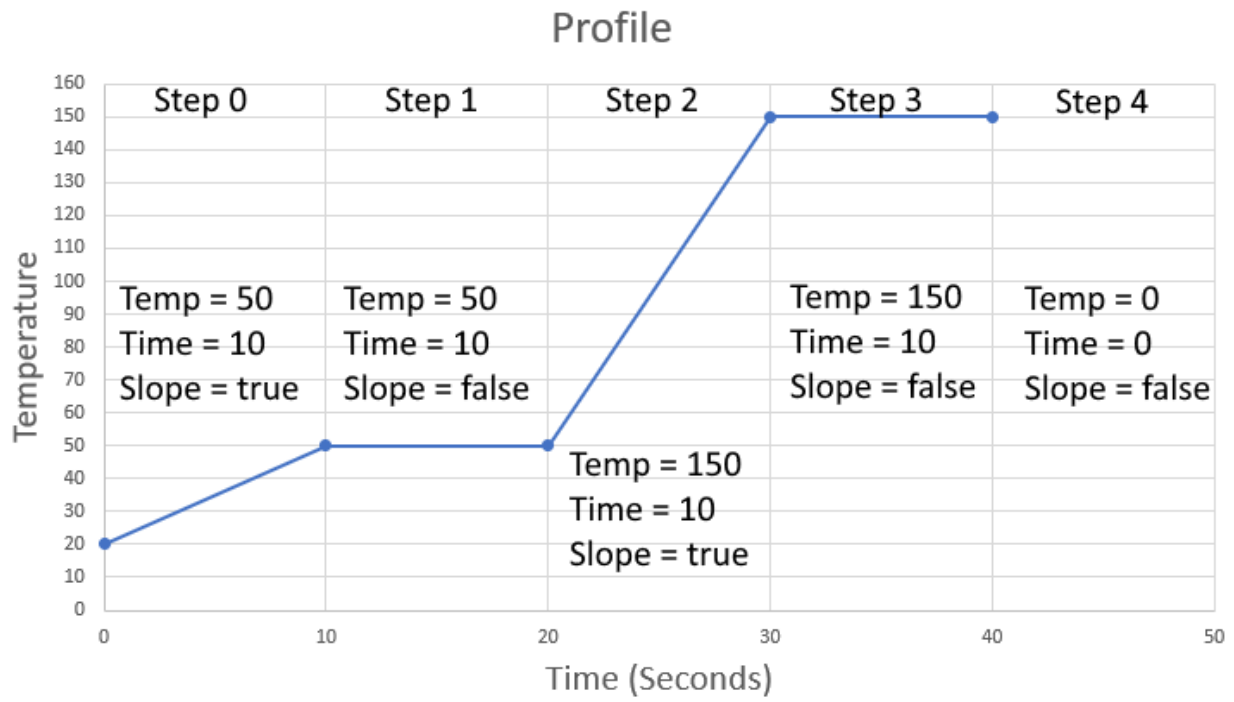
HMI Control Screens Cont.

PROFILES

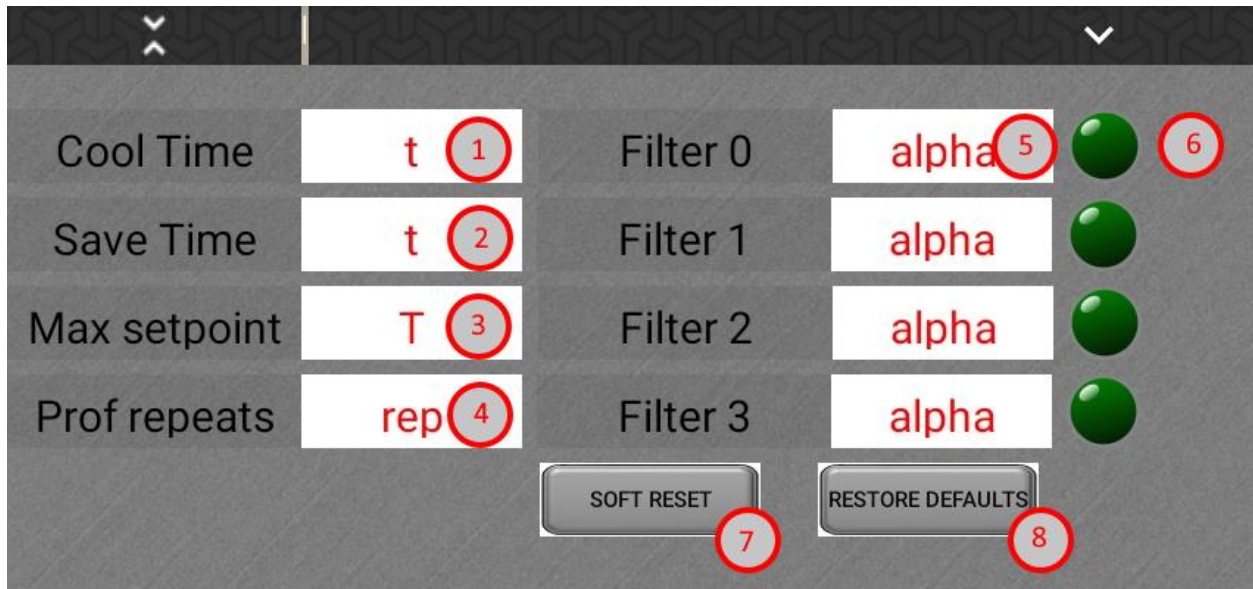
1. Setpoint Mode / Profile Mode Button: Switches control mode between directly controlled setpoint mode, and internal profile mode
2. Digital IO Setpoint / Modbus Setpoint: When in setpoint mode, switches setpoint control between Digital input and Modbus Input.
3. Low Setpoint: When in Digital Setpoint mode, this is the setpoint for a low signal on a digital input thermode zone
4. High Setpoint: When in Digital Setpoint mode, this is the setpoint for a high signal on a digital input for a thermode zone.
5. Ready Tolerance: The temperature region + - the setpoint, that when the temperature is within this region the temp ready digital output will be set high
6. Setpoint Time: The length that setpoint mode will run in seconds. 0 means run until manually stopped
7. Cool Temp: The temperature that cooling will turn off after heating stops
8. Internal Profile Temperatures: See Graphical Description
9. Internal Profile Times: See Graphical Description
10. Slope Control: See Graphical Description

HMI Control Screens Cont.

Graphical Description of 8, 9, 10:



HMI Control Screens Cont.

MISC CONFIG

1. Cool Time: Currently unused, Cool Temp is used instead (see profiles page)
2. Save Time: How often Modbus registers are saved to internal memory
3. Max Setpoint: How high the setpoint is allowed to be set
4. Profile Repeats: When in profile mode, how many times a profile will repeat
5. Alpha Filtering: Used to smooth any external noise on RTD reading for each zone. Smaller alpha values mean heavier smoothing with the consequence of a delay in response when a drastic temperature change occurs.
6. Filtering Enable / Disable: When enabled, the alpha smoothing is applied
7. Soft Reset: Triggers a reset in the controller, used to clear error states
8. Restore Defaults: Sets certain registers to default values. Used only for first time setup purposes

MOD BUS

All Modbus registers:

- have a request type of 16 bit Unsigned Integer
- Use a function code for reading 0x03 Holding Registers
- communicate with PLC ID of 1

For the correctly scaled number in python:

- Scaling factor below: $E0 = 1$, $E1 = 10$, $E2 = 100$, ..., $EN = 10^N$
- Divide by this number after reading i.e. `controller.read_register(N) / 10` #for $E1$
- Multiply by this factor before writing `controller.write_register(N, value * 10)` #for $E1$

MODBUS Registers

Reg Num	Register Name	Scaling Factor	Type	Description
0	profile_T0	E1	Read/Write, Decimal	Temperature for step 0 in the profile (Degrees C)
1	profile_T1	E1	Read/Write, Decimal	Temperature for step 1 in the profile (Degrees C)
2	profile_T2	E1	Read/Write, Decimal	Temperature for step 2 in the profile (Degrees C)
3	profile_T3	E1	Read/Write, Decimal	Temperature for step 3 in the profile (Degrees C)
4	profile_T4	E1	Read/Write, Decimal	Temperature for step 4 in the profile (Degrees C)
5	profile_t0	E1	Read/Write, Decimal	The duration for step 0 in the profile (Seconds)
6	profile_t1	E1	Read/Write, Decimal	The duration for step 1 in the profile (Seconds)
7	profile_t2	E1	Read/Write, Decimal	The duration for step 2 in the profile (Seconds)
8	profile_t3	E1	Read/Write, Decimal	The duration for step 3 in the profile (Seconds)
9	profile_t4	E1	Read/Write, Decimal	The duration for step 4 in the profile (Seconds)

10	slope_T0	E0	Read/Write, Button(1 or 0)	0 = Don't Slope, 1 = Slope (Linearly interpolate between last temp read before start and profile_T0)
11	slope_T1	E0	Read/Write, Button(1 or 0)	1 = Don't Slope, 1 = Slope (Linearly interpolate between profile_T0 and profile_T1)
12	slope_T2	E0	Read/Write, Button(1 or 0)	2 = Don't Slope, 1 = Slope (Linearly interpolate between profile_T1 and profile_T2)
13	slope_T3	E0	Read/Write, Button(1 or 0)	2 = Don't Slope, 1 = Slope (Linearly interpolate between profile_T2 and profile_T3)
14	slope_T4	E0	Read/Write, Button(1 or 0)	3 = Don't Slope, 1 = Slope (Linearly interpolate between profile_T3 and profile_T4)
15	p0	E2	Read/Write, Decimal	Proportional gain for zone 0
16	i0	E2	Read/Write, Decimal	Integral gain for zone 0
17	d0	E2	Read/Write, Decimal	Differential gain for zone 0
18	m0	E3	Read/Write, Decimal	Resistive heater slope calibration factor for zone 0 (Temp = M*Resistance - B)
19	b0	E1	Read/Write, Decimal	Resistive heater intercept calibration factor for zone 0 (Temp = M*Resistance - B)
20	rref0	E0	Read/Write, Integer	Reference resistance value for 3rd Wave RTD Module for zone 0
21	p1	E2	Read/Write, Decimal	Proportional gain for zone 1
22	i1	E2	Read/Write, Decimal	Integral gain for zone 1
23	d1	E2	Read/Write, Decimal	Differential gain for zone 1
24	m1	E3	Read/Write, Decimal	Resistive heater slope calibration factor for zone 1 (Temp = M*Resistance - B)
25	b1	E1	Read/Write, Decimal	Resistive heater intercept calibration factor for zone 1 (Temp = M*Resistance - B)
26	rref1	E0	Read/Write, Integer	Reference resistance value for 3rd Wave RTD Module for zone 1
27	p2	E2	Read/Write, Decimal	Proportional gain for zone 2
28	i2	E2	Read/Write, Decimal	Integral gain for zone 2
29	d2	E2	Read/Write, Decimal	Differential gain for zone 2
30	m2	E3	Read/Write, Decimal	Resistive heater slope calibration factor for zone 2 (Temp = M*Resistance - B)
31	b2	E1	Read/Write, Decimal	Resistive heater intercept calibration factor for zone 2 (Temp = M*Resistance - B)
32	rref2	E0	Read/Write, Integer	Reference resistance value for 3rd Wave RTD Module for zone 2

33	p3	E2	Read/Write, Decimal	Proportional gain for zone 3
34	i3	E2	Read/Write, Decimal	Integral gain for zone 3
35	d3	E2	Read/Write, Decimal	Differential gain for zone 3
36	m3	E3	Read/Write, Decimal	Resistive heater slope calibration factor for zone 3 (Temp = M*Resistance - B)
37	b3	E1	Read/Write, Decimal	Resistive heater intercept calibration factor for zone 3 (Temp = M*Resistance - B)
38	rref3	E0	Read/Write, Integer	Reference resistance value for 3rd Wave RTD Module for zone 3
39	p4	E2	Read/Write, Decimal	Proportional gain for zone 4
40	i4	E2	Read/Write, Decimal	Integral gain for zone 4
41	d4	E2	Read/Write, Decimal	Differential gain for zone 4
42	m4	E3	Read/Write, Decimal	Resistive heater slope calibration factor for zone 4 (Temp = M*Resistance - B)
43	b4	E1	Read/Write, Decimal	Resistive heater intercept calibration factor for zone 4 (Temp = M*Resistance - B)
44	rref4	E0	Read/Write, Integer	Reference resistance value for 3rd Wave RTD Module for zone 4
45	p5	E2	Read/Write, Decimal	Proportional gain for zone 5
46	i5	E2	Read/Write, Decimal	Integral gain for zone 5
47	d5	E2	Read/Write, Decimal	Differential gain for zone 5
48	m5	E3	Read/Write, Decimal	Resistive heater slope calibration factor for zone 5 (Temp = M*Resistance - B)
49	b5	E1	Read/Write, Decimal	Resistive heater intercept calibration factor for zone 5 (Temp = M*Resistance - B)
50	rref5	E0	Read/Write, Integer	Reference resistance value for 3rd Wave RTD Module for zone 5
51	p6	E2	Read/Write, Decimal	Proportional gain for zone 6
52	i6	E2	Read/Write, Decimal	Integral gain for zone 6
53	d6	E2	Read/Write, Decimal	Differential gain for zone 6
54	m6	E3	Read/Write, Decimal	Resistive heater slope calibration factor for zone 6 (Temp = M*Resistance - B)
55	b6	E1	Read/Write, Decimal	Resistive heater intercept calibration factor for zone 6 (Temp = M*Resistance - B)

4 CHANNEL AC CONTROLLER

56	rref6	E0	Read/Write, Integer	Reference resistance value for 3rd Wave RTD Module for zone 6
57	p7	E2	Read/Write, Decimal	Proportional gain for zone 7
58	i7	E2	Read/Write, Decimal	Integral gain for zone 7
59	d7	E2	Read/Write, Decimal	Differential gain for zone 7
60	m7	E3	Read/Write, Decimal	Resistive heater slope calibration factor for zone 7 (Temp = M*Resistance - B)
61	b7	E1	Read/Write, Decimal	Resistive heater intercept calibration factor for zone 7 (Temp = M*Resistance - B)
62	rref7	E0	Read/Write, Integer	Reference resistance value for 3rd Wave RTD Module for zone 7
63	setpoint0	E1	Read/Write, Decimal	The desired temperature to reach when heating ("heat" register 75 is 1) for zone 0
64	setpoint1	E1	Read/Write, Decimal	The desired temperature to reach when heating ("heat" register 75 is 1) for zone 1
65	setpoint2	E1	Read/Write, Decimal	The desired temperature to reach when heating ("heat" register 75 is 1) for zone 2
66	setpoint3	E1	Read/Write, Decimal	The desired temperature to reach when heating ("heat" register 75 is 1) for zone 3
67	setpoint4	E1	Read/Write, Decimal	The desired temperature to reach when heating ("heat" register 75 is 1) for zone 4
68	setpoint5	E1	Read/Write, Decimal	The desired temperature to reach when heating ("heat" register 75 is 1) for zone 5
69	setpoint6	E1	Read/Write, Decimal	The desired temperature to reach when heating ("heat" register 75 is 1) for zone 6
70	setpoint7	E1	Read/Write, Decimal	The desired temperature to reach when heating ("heat" register 75 is 1) for zone 7
71	setpoint_heat_time	E1	Read/Write, Decimal	Time in seconds that setpoint mode lasts before it shuts itself off (0 for no limit)
72	[Unused]	-	-	-
73	save_time	E1	Read/Write, Decimal	How often Modbus register values are saved to controller memory module (seconds)
74	max_setpoint	E1	Read/Write, Decimal	Setpoint data entry limit. Any setpoint entered above this value will be reset to this value
75	heat	E0	Read/Write, Button(1 or 0)	0 = idle, 1 = start heating
76	mode	E0	Read/Write, Button(1 or 0)	0 = setpoint mode (individual setpoints or externally defined profile), 1 = internal profile mode
77	input0	E1	Read Only, Decimal	The current read temperature of zone 0
78	input1	E1	Read Only, Decimal	The current read temperature of zone 1

4 CHANNEL AC CONTROLLER

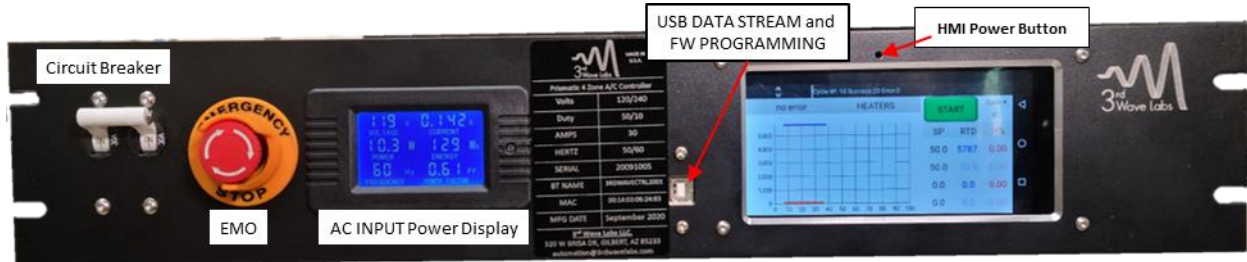
79	input2	E1	Read Only, Decimal	The current read temperature of zone 2
80	input3	E1	Read Only, Decimal	The current read temperature of zone 3
81	input4	E1	Read Only, Decimal	The current read temperature of zone 4
82	input5	E1	Read Only, Decimal	The current read temperature of zone 5
83	input6	E1	Read Only, Decimal	The current read temperature of zone 6
84	input7	E1	Read Only, Decimal	The current read temperature of zone 7
85	output0	E1	Read Only, Decimal	The drive percent being written to the SSR's for zone 0
86	output1	E1	Read Only, Decimal	The drive percent being written to the SSR's for zone 1
87	output2	E1	Read Only, Decimal	The drive percent being written to the SSR's for zone 2
88	output3	E1	Read Only, Decimal	The drive percent being written to the SSR's for zone 3
89	output4	E1	Read Only, Decimal	The drive percent being written to the SSR's for zone 4
90	output5	E1	Read Only, Decimal	The drive percent being written to the SSR's for zone 5
91	output6	E1	Read Only, Decimal	The drive percent being written to the SSR's for zone 6
92	output7	E1	Read Only, Decimal	The drive percent being written to the SSR's for zone 7
93	[Unused]	-	-	-
94	error_codes	E0	Read Only, Integer	Code corresponding to a specific error, See error table
95	warning_codes	E0	Read Only, Integer	Warning corresponding to action taken on a specific error code
96	start_percent	E0	Read/Write, Integer	The percent that output is limited to at room_temp. Integer of percent values 0 -> 100
97	room_temp	E1	Read/Write, Decimal	The temperature (C) at which output is limited by start_percent
98	max_temp	E1	Read/Write, Decimal	The temperature (C) at which output is not limited (100 %)
99	serial_streaming	E0	Read/Write, Button(1 or 0)	0 = Serial data stream on USB disabled, 1 = Serial data stream on USB enabled.
100	[Unused]	-	-	-
101	[Unused]	-	-	-
102	disable0	E0	Read/Write, Button(1 or 0)	0 = Zone 0 enabled, 1 = Zone 0 disabled

103	disable1	E0	Read/Write, Button(1 or 0)	0 = Zone 1 enabled, 1 = Zone 1 disabled
104	disable2	E0	Read/Write, Button(1 or 0)	1 = Zone 2 enabled, 1 = Zone 2 disabled
105	disable3	E0	Read/Write, Button(1 or 0)	1 = Zone 3 enabled, 1 = Zone 3 disabled
106	disable4	E0	Read/Write, Button(1 or 0)	2 = Zone 4 enabled, 1 = Zone 4 disabled
107	disable5	E0	Read/Write, Button(1 or 0)	2 = Zone 5 enabled, 1 = Zone 5 disabled
108	disable6	E0	Read/Write, Button(1 or 0)	3 = Zone 6 enabled, 1 = Zone 6 disabled
109	disable7	E0	Read/Write, Button(1 or 0)	3 = Zone 7 enabled, 1 = Zone 7 disabled
110	cool_temp	E1	Read/Write, Decimal	The temperature threshold for cooling, cooling will stop after temp is below this value
111	filtering0	E0	Read/Write, Button(1 or 0)	0 = Disable filtering, 1 = Enable filtering for zone 0
112	filtering1	E0	Read/Write, Button(1 or 0)	0 = Disable filtering, 1 = Enable filtering for zone 1
113	filtering2	E0	Read/Write, Button(1 or 0)	0 = Disable filtering, 1 = Enable filtering for zone 2
114	filtering3	E0	Read/Write, Button(1 or 0)	0 = Disable filtering, 1 = Enable filtering for zone 3
115	filtering4	E0	Read/Write, Button(1 or 0)	0 = Disable filtering, 1 = Enable filtering for zone 4
116	filtering5	E0	Read/Write, Button(1 or 0)	0 = Disable filtering, 1 = Enable filtering for zone 5
117	filtering6	E0	Read/Write, Button(1 or 0)	0 = Disable filtering, 1 = Enable filtering for zone 6
118	filtering7	E0	Read/Write, Button(1 or 0)	0 = Disable filtering, 1 = Enable filtering for zone 7
119	alpha0	E3	Read/Write, Decimal	Weighted smoothing factor for zone 0 (Alpha is the complementary percent applied to each new data sample)
120	alpha1	E3	Read/Write, Decimal	Weighted smoothing factor for zone 1
121	alpha2	E3	Read/Write, Decimal	Weighted smoothing factor for zone 2
122	alpha3	E3	Read/Write, Decimal	Weighted smoothing factor for zone 3
123	alpha4	E3	Read/Write, Decimal	Weighted smoothing factor for zone 4
124	alpha5	E3	Read/Write, Decimal	Weighted smoothing factor for zone 5
125	alpha6	E3	Read/Write, Decimal	Weighted smoothing factor for zone 6

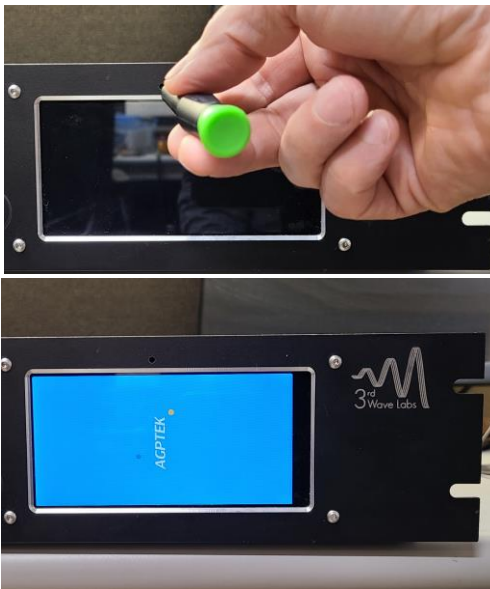
126	alpha7	E3	Read/Write, Decimal	Weighted smoothing factor for zone 7
127	link_filter	E0	Read/Write, Button(1 or 0)	All filtering registers will follow the filter enable and alpha register 0 (alpha0 also writes to alpha1-alpha7, filtering0 to filtering0-filtering7)
128	[Unused]	-	-	-
129	num_profile_repeats	E0	Read/Write, Integer	When in profile mode, the profile will repeat after cooling this many times, 0 is no repeat, 1 is one repeat...
130	profileRepeatCount	E0	Read Only, Integer	The current cycle count when profile repeat is > 0
131	soft_reset	E0	Read/Write, Button(1 or 0)	Setting this to 1 restarts the controller, automatically sets self back to 0 after write
132	restore_defaults	E0	Read/Write, Button(1 or 0)	Setting this to 1 sets certain important registers to default values, automatically sets self back to 0 after write. Used only for first time setup by 3rd Wave labs
133	modbus_control	E0	Read/Write, Button(1 or 0)	0 = Digital I/O control of setpoint, 1 = Modbus control of setpoint
134	high_setpoint	E1	Read/Write, Decimal	When modbus_control is 0, setpointN will be set to this temperature when Digital input Thermode_Temp_N is high (1)
135	low_setpoint	E1	Read/Write, Decimal	When modbus_control is 0, setpointN will be set to this temperature when Digital input Thermode_Temp_N is low (0)
136	temp_ready_tolerance	E1	Read/Write, Decimal	When inputN is within this value + or - setpointN, digital output Temp_N_Ready will be set high

Initial Power on Sequence

Front Panel



1. Ensure that mains external power is connected and on
2. Emergency stop button (EMO) should be depressed
3. Toggle the front panel circuit breaker to the on position (
4. Use 2.5mm key (or similar small diameter screw driver) inserted and then apply a downward press and wait ~15 seconds. The power splash screen will appear and the boot sound.



5. Apply a right to left swipe to the touchscreen for login (upward with respect to screen rotation).
6. Note screen may take an additional 15 seconds to sense orientation and rotate to the horizontal view
7. Tap the Green HMI modbus viewer icon to start the HMI loader and select "load last project".



Rear Panel Exterior



Connector Pin List

4 CHANNEL AC CONTROLLER

Connector	Label	Pin #	Description
AC Power In	L1	~	Line In
	N	~	Nuetral or L2
	GND	~	Ground
General Purpose Inputs	J1	1	Controller A0
		2	Controller A2
		3	Controller A3
		4	Controller A4
		5	Controller A5
		6	Controller A6
		7	Gnd
		8	Gnd
General Purpose Outputs (2Amps @250Vac/30Vdc) Limited by supply Current	J2	1	D0 (Cooling 0)
		2	D1 (Cooling 1)
		3	D2 (Cooling 2)
		4	D3 (Cooling 3)
		5	D4 (Temp 0 Ready)
		6	D5 (Temp 1 Ready)
		7	D6 (Temp 2 Ready)
		8	D7 (Temp 3 Ready)
EMO Relay (2) RS485	J3	1	EMO Out
		2	EMO Ret
		3	Relay 9 (6Amps @250Vac/30Vdc)
		4	
		5	Relay 8 (6Amps @250Vac/30Vdc)
		6	
		7	RS485-
		8	RS485+
OUTPUTS 0 & 1 (Top, Red)	HTR	1+	Zone 1 Heater +
		1-	Zone 1 Heater -
		2+	Zone 0 Heater +
		2-	Zone 0 Heater -
OUTPUTS 2 & 3 (Bottom, Blue)	HTR	1+	Zone 3 Heater +
		1-	Zone 3 Heater -
		2+	Zone 2 Heater +
		2-	Zone 2 Heater -
RTD Connector	RTD	1	0_F+ Zone 0 RTD Force +
		2	0_F- Zone 0 RTD Force -
		3	0_Shld Zone 0 RTD Shield
		14	0_M+ Zone 0 RTD Measure +
		15	0_M- Zone 0 RTD Measure -
		4	1_F+ Zone 1 RTD Force +
		5	1_F- Zone 1 RTD Force -
		6	1_Shld Zone 1 RTD Shield
		17	1_M+ Zone 1 RTD Measure +
		18	1_M- Zone 1 RTD Measure -
		7	2_F+ Zone 2 RTD Force +
		8	2_F- Zone 2 RTD Force -
		9	2_Shld Zone 2 RTD Shield
		20	2_M+ Zone 2 RTD Measure +
		21	2_M- Zone 2 RTD Measure -
		10	3_F+ Zone 3 RTD Force +
		11	3_F- Zone 3 RTD Force -
		12	3_Shld Zone 3 RTD Shield
		23	3_M+ Zone 3 RTD Measure +
		24	3_M- Zone 3 RTD Measure -
		13	N/C
		16	N/C
		19	N/C
		22	N/C
		25	N/C