WORK FLOW FOR TEST MACHINE
TO TEST AND CALIBRATE A HEATING UNIT

0. START AND MOVE TO ZERO POSITION
1. MOVE INTO THE UNIT TO PUSH THE MEASUREMENT TUBE INSIDE IT
2. TURN ON THE HEATING UNIT
3. WAIT 6 SECONDS FOR UNIT TO HEAT UP
4. ACTIVATE VACUUM PUMP
5. WAIT 7 SECONDS FOR STABLE AIR MEASUREMENT
6. LOOK FOR THE POINT TO MEASURE HIGHEST TEMPERATURE IN UNIT
7. SAVE THE MEASUREMENT DATA TO FLASH RAM AND TURN OFF THE PUMP
8. MOVE BACK AND GET OUT OF UNIT TAKING CARE OF O-RINGS
9. MAKE THE TEST MACHINE READY FOR THE NEXT UNIT TO BE INSERTED
10. DISPLAY THE RESULT

PERIPHERAL	CONNECTION	DIRECTION
color LCD	I2C port	Input / Output
MCP9600 Thermocouple module	I2C port	Input / Output
Motor 1 DRV8825 driver	P2.2 DIR P2.0 STEP P3.2 nSLEEP P2.1 nENABLE P3.3 nRESET	Output
Motor 2 DRV8825 driver	P2.4 DIR P3.4 STEP P2.5 nSLEEP P2.3 nENABLE P3.5 nRESET	Output
Motor 3 DRV8825 driver	P2.7 DIR P3.6 STEP P2.6 nSLEEP P3.7 nENABLE P1.0 nRESETP	Output
Start Button	P1.3	Input
Limit Switch (to check Zero Position)	P1.4	Input
Solenoid (to push a physical button)	P3.1	Output
Relay (to activate vacuum pump)	P3.0	Output

MOTOR PROPERTIES:

Motor 1	**Motor 2**	**Motor 3**
Has 200 steps per revolution with 1/16 step size in driver.	Has 400 steps per revolution with 1/16 step size in driver.	Has 200 steps per revolution with 1/16 step size in driver.
Attached to the lead screw which moves 2mm per revolution.	Attached to the measurement tube assembly.	Attached to the potentiometer.
Responsible for moving the machine forward and backward.	Responsible for rotating the measurement probe.	Responsible for connecting to the adjustment dial, and rotates the potentiometer inside the unit.
Each revolution results in 2mm of displacement. Max. displacement is 100mm.	Limited to rotating max. 360 degrees in each direction. Attention needed for o-rings and wires.	Limited to rotating max. 120 degrees in each direction from middle position.
Anti-CW rotation means forward movement. Forward movement should be max. 100 mm (50 revolutions)	Should work in conjunction with Motor-1 during forward&backward movements of machine.	Should always be at the middle position of the shaft before and after operation.
CW rotation means backward movement. Backward movement should be stopped by Limit Switch.		Middle position is manually adjusted by human operator before turning on the machine.
Heavy to move by hand.		

SOLENOID PROPERTIES:

Used to mechanically push the physical button on the unit to be tested.
0.1 seconds of active-pulse is enough to make a good button-pressing.
0.1 seconds of waiting is enough for unit to recognize multiple presses.
Unit is turned on by 3 presses with max. 0.3 seconds between each press.
Unit is turned off by 3 presses with max. 0.3 seconds between each press.

DETAILED SUBSTEPS OF OPERATION:

0. START AND MOVE TO ZERO POSITION Init peripherals: Init MCU (itself) Init LCD (I2C colored display) Init MCP9600 (thermocouple) Init 3xDRV8825 (three motor drivers) Init Solenoid (Key presser) Init Zero Position Switch (normally Low, internal pull up) Init Relay (vacuum turn on/off) Print on LCD: “Start OK” Move Motor-1 to Zero Position (Rotate Motor1 CW until Limit Switch is High) Print on LCD: “ZeroPos OK” Wait for START button press for next step.
1. MOVE INTO THE UNIT TO PUSH THE MEASUREMENT TUBE INSIDE IT Move Motor-1 forward to push the measurement tube inside the unit to be tested. (Rotate Motor-1 anti-CW 50 full revolutions) Motor-2 should rotate in conjunction with motor-1 to prevent any damage on measurement tube.
2. TURN ON THE HEATING UNIT Activate solenoid and wait for 0.1 secs, then deactivate solenoid and wait for 0.1 secs Activate solenoid and wait for 0.1 secs, then deactivate solenoid and wait for 0.1 secs Activate solenoid and wait for 0.1 secs, then deactivate solenoid and wait for 0.1 secs
3. WAIT 6 SECONDS FOR UNIT TO HEAT UP
4. ACTIVATE VACUUM PUMP Activate relay to turn on the vacuum pump
5. WAIT 7 SECONDS FOR STABLE AIR MEASUREMENT Wait 7 secs. Read temperature if value is below 60 degrees celcius, then set NOPOWER flag and jump to STEP-7

6. LOOK FOR THE POINT TO MEASURE HIGHEST TEMPERATURE INSIDE THE UNIT

Repeat for each angle-stops per 22.5 degrees. (360/22.5 = 16 angle-stops)
{ Move motor-2 to next angle-pos.
Wait 3 secs.
Read temperature
repeat until value is below 180-4 or above 180+4
{ if the value is below 180-4 degrees celcius then move motor-1 forward a bit.
Else if the value is above 180+4 degrees celcius then move motor-1 backward a bit.
Wait 3 secs.
Read temperature again.
If value is still out of range then, call [dial_problem] function here.
Read temperature again.
Wait 3 seconds.
If value is still below, then set TOOLOW flag and jump to STEP-7
If value is still above, then set TOOHIGH flag and jump to STEP-7
}
save value to the values array.
}
Find maximum value in the values array.

[dial_problem] function: print on LCD: “dial problem?”
move motor-3 to mid-pos.
wait for human op. START button press.

7. SAVE THE MEASUREMENT DATA TO FLASH RAM AND TURN OFF THE PUMP

If NOPOWER or TOOLOW or TOOHIGH flags are set then skip storing and calibration ops.
Store the value and other necessary data to Flash ram.
Save the calibration to the unit:
Activate solenoid and wait for 0.1 secs, then deactivate solenoid and wait for 2 secs
Turn heating unit off:
Activate solenoid and wait for 0.1 secs, then deactivate solenoid and wait for 0.1 secs
Activate solenoid and wait for 0.1 secs, then deactivate solenoid and wait for 0.1 secs
Activate solenoid and wait for 0.1 secs, then deactivate solenoid and wait for 0.1 secs
Deactivate relay to turn off the vacuum pump

8. MOVE BACK AND GET OUT OF UNIT TAKING CARE OF O-RINGS

Move motor-1 backwards until limit switch.
Move motor-2 in conjunction with motor to prevent any damage to o-rings

9. MAKE THE TEST MACHINE READY FOR THE NEXT UNIT TO BE INSERTED

Move motor-3 position to its initial position (middle position)
Move motor-2 back start position.

10. DISPLAY THE RESULT

if HEATINGFAIL flag is not set then, Print on LCD: “Successful” and set background green.
If HEATINGFAIL flag is set then, Print on LCD: “No Power”, and set background red.
If TOOLOW flag is set then, Print on LCD: “temp too lo”, and set background red.
If TOOHIGH flag is set then, Print on LCD: “temp too hi”, and set background red.