TP solar

INNOVATIVE FURNACE TECHNOLOGIES

Serial Number	2019292
Model Number	CU-610H
Input Service	480 Vac, 3 Wire / Neutral / Ground
Frequency	50 / 60 Hz
Peak Power	46 kW
Peak Current	56 A
Nitrogen Max Input Pressure	75 PSI
Hydrogen Max Input Pressure	65 PSI
Process Exhaust	4 at 10 LPS Each
Cabinet Exhaust	650 LPS
Process Gas - Nitrogen	2800 SCFH
Process Gas - Hydrogen	480 SCFH
Water Input	10 GPM / 65 PSI
Maximum Temperature	1000°C
Manufactured Date	08-2019

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TPSI

Innovative Furnace Technologies

PRODUCT SPECIFICATION

CONTROLLED ATMOSPHERE FURNACE

MODEL: CU 610 H

Specification Number: 201831

Revision: A

Date: 2/8/2019

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FURNACE

This document specifies the performance and configuration of the CU-series hydrogen furnace.

The furnace system is designed for annealing and brazing operations, thick film and other specialty processes that require precise thermal management in a controlled atmosphere. This series is designed for operation with nitrogen only as well as introduction of hydrogen into each of the furnace infrared heating zones. The nitrogen/hydrogen mixing console allows the user to independently control nitrogen and hydrogen flows to each zone. The sophisticated furnace software receives information from combustible gas detectors, oxygen analyzer and pressure switches; and controls ignitors, sample system ports, warmup, processing and shutdown actions for safe, reliable, and repeatable operation.

1. **Furnace Capabilities**

1.1 The furnace can perform thermal processes requiring a control atmosphere with nitrogen. The maximum temperature of the furnace is 1000°C.

1.2 The system operation is left to right as viewed from operator control panel and is clean compatible to class 1000.

1.3 Peak Energy and Gas Consumption

Power: 46 Kw
Process Gas: 2600 SCFH Nitrogen
Process Gas: 400 SCFH Hydrogen

2. **Mechanical Specification**

2.1 Overall Size:

Length: 225 inches
Width: 50 inches
Height: 70 inches
Approximate Weight: TBD

2.2 Transport Specification

Conveyor Width: 10 inches
Conveyor Belt Material: Nichrom V. Compound Balanced Weave
Product Clearance: 4 inch maximum above belt level
Nominal Speed Range: .5 to 10 In/min

3. **Furnace Configuration**

Furnace Section

Load Station	381 mm	15”
Entrance Baffle	762 mm	30”
Heated Length	1524 mm	60”
Transition Tunnel	762 mm	30”
Cooling Length	1524 mm	60”
Exit Baffle	381 mm	15”
Unload Station	381 mm	15”

4. **FURNACE PROCESS SECTIONS:**

4.1 The furnace sections reside in a Stainless chamber shell lined with 2” ceramic insulation top, bottom and side for improved thermal efficiency and reduced cabinet temperatures. To insure very good cross belt uniformity, the heated length of IR Lamps overlaps the belt .5” both ends to leave the belt within the uniform radiation field of the elements.

Process gas is introduced thru the zone dividers (Top / Bottom). The gas then passes through the divider where it is heated and enters the process zones at near zone temperature. The control atmosphere within the furnace system the cover gas is nitrogen with the option of Hydrogen. To prevent particles from contaminating the product we provide three exhaust systems, one at the entrance end, and a second one at the transition tunnel after the last heating zone, and the third at the exit end after the water-cooled section. Most of the gas is exhausted at the entrance end, using a dual eduction system to insure good scavenging of contaminants. A small amount of gas is also drawn out the transition tunnel and exit end via a dual exhaust system to keep the front zones free of firing zone contaminants as well.

4.2 Heating is accomplished by IR Lamps located above and below the belt.

Additionally, the entrance, transition & exit baffle trays are located above the chamber for ease of maintenance.

4.3 Cooling is accomplished by a closed atmosphere water-cooled tunnel.

A water cooled heat exchanger surrounds sides, top and bottom of the product to help remove heat mostly carried by the belt. Water flowing through four independently controllable circuits in the heat exchanger removes heat to customer re-circulating chiller system (by others, recommended) or to facility drain. To enhance the water cooling, flow meter controlled process gas (N2) is injected through gas curtains to create stable forced boundary layer cooling flow across both top and bottom of the product. Process gas used for cooling is collected at the exit end of the cooling section and is exhausted through the exit exhaust stack to facility exhaust duct work (by others).

Water Requirements

Water: 15 - 20°C Inlet water temperature recommended
Flow: 4 GPM
Pressure; 60 psi (maximum)

Cooling length is 60 inches long with 2 heat exchangers, one on top and one bottom, including two water flow meters for final adjustment (cooling rate). For controling the atmosphere for cooling, we provide two flow meters, one top and one for bottom.

4.4 The Furnace chambers are divided into zones as follows:

Module	Length
Entrance Baffle	30”
Zone 1	10”
Zone 2	20”
Zone 3	20”
Zone 4	10”
Transition Tunnel	30”
Cooling	60”
Exit Baffle	15”

5. **ELECTRICAL SPECIFICATIONS**

5.1 Input Service: 480 Volts, 3 Phases, 60 Hz.

5.2 Peak Instantaneous Power Consumption 46 KW

The electrical system as manufactured by TPS will meet the following U.S Electrical codes:

NFPA 70 – 2008 “The National Electrical Code”
UL-508 “Industrial Control Equipment”
NFPA 79 – 2008 “Electrical Standard for Industrial Machinery”
CE compliance to machinery directive:
Annex 1. 89/392/EEC and Safety of machinery
Electrical Equipment of Machines; Part 1-EN60204-1
SEMI S2-93

6. CONTROL ATMOSPHERE REQUIREMENTS:

Atmosphere control is accomplished with the following flow meters:

FLOW METER	Range	Units
Nitrogen Flow Meters		
Entrance Exhaust	0-100	SCFH
Entrance Baffle	0-200	SCFH
Zone 1	0-200	SCFH
Zone 2	0-200	SCFH
Zones 3	0-200	SCFH
Zones 4	0-200	SCFH
Transition Tunnel	0-400	SCFH
Transition Exhaust	0-100	SCFH
Cooling Top	0-200	SCFH
Cooling Bottom	0-200	SCFH
Plenums	0-200	SCFH
Exit Baffle	0-200	SCFH
Exit Exhaust	0-200	SCFH
Hydrogen Flow Meters		
Zone 1	0-100	SCFH
Zone 2	0-100	SCFH
Zone 3	0-100	SCFH
Zone 4	0-100	SCFH
Water Flow Meters		
Cooling 1 Top	2	GPM
Cooling 2 Bottom	2	GPM

7 The Hydrogen Gas Panel will allow the furnace to run H2, at user's option, by adjusting. H2 and N2 gas in Zones 1 – 4. To operate in this mode, first adjust flow meters (Nitrogen) if necessary to control the atmosphere and balance the furnace zones. Once system is stable (low ppm) the software will allow the hydrogen into the zones, the operator can start adjusting flow rate of Hydrogen into the zones.

7.1 The following safety precautions will be added to the furnace:

a) Sealing clamps will be added to outside of heating chamber to prevent H2 escaping into room during operation. These clamps may be loosened to allow full access to heated furnace interior during maintenance using the Motorized Chamber Lift system.

b) Ignitors shall be installed on all exhaust stacks.

c) Combustible gas detectors shall be installed on all at-risk points.

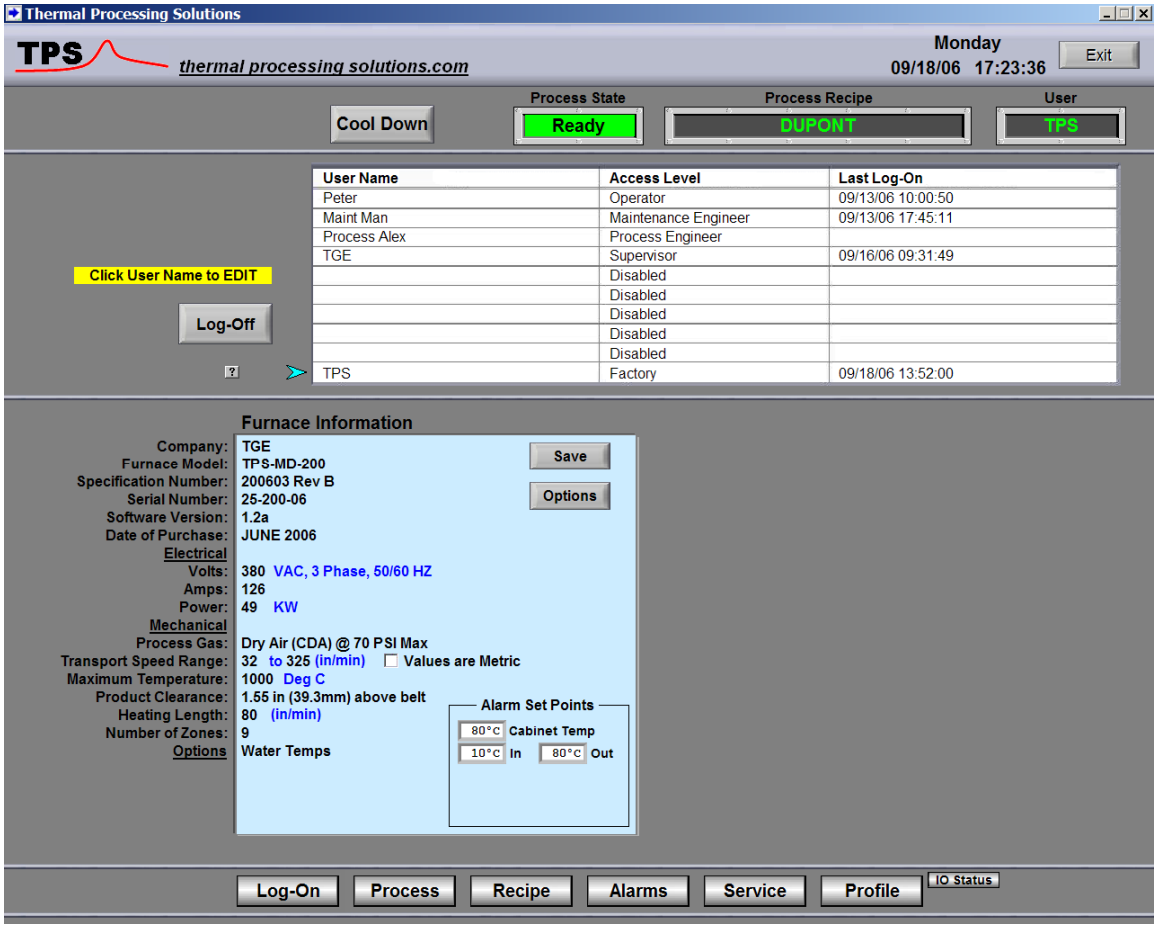
d) A gas collector shall be installed at the entrance opening of the furnace above the belt.

e) Furnace software limits hydrogen operation until all safety and process provisions are met.

7.2 Oxygen Analyzer**:** An O2 analyzer and on-line 4-port gas sampling system will be provided and integrated with the control system. Using the furnace HMI, user can select a port to allow the O2 analyzer to monitor O2 levels in Zone 1, Zone 3, and Zone 4 & Source. Levels out of tolerance will display visual warning and sound audible alarm on HMI screen of furnace and log warning to the event file on hard drive, so that situation can be remedied.

7. **CONTROLS:**

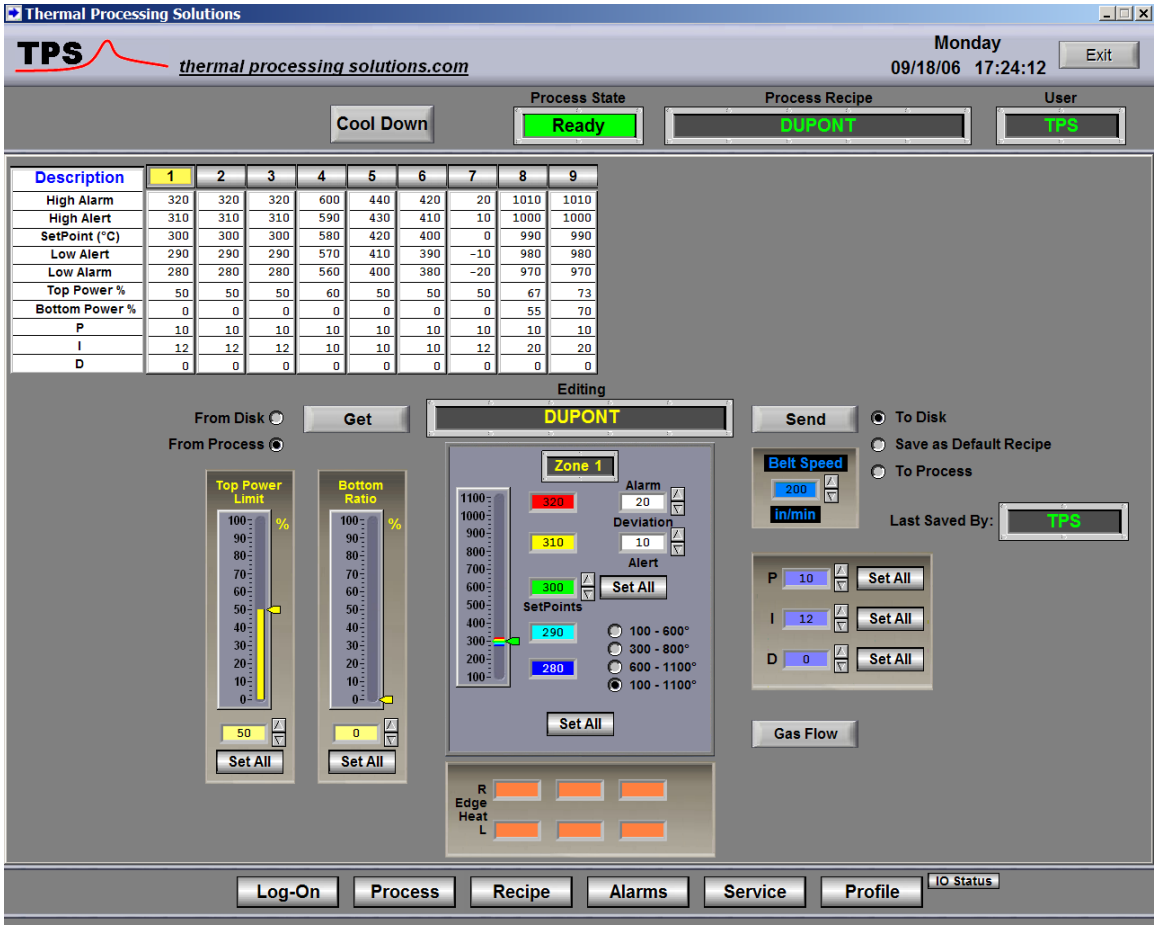
7.1 The TPS furnace is controlled by a 32 bit, industrial controller (PLC) that uses an Industrial rack mount PC for user interface.



Log-On Screen

Security is provided by passwords allowing different users levels of access and Control rights. For communication the system uses an Ethernet link between the PC, Controller and I/O points. All inputs and outputs are optically isolated to insure stable, noise free data transfers.
All operational software, recipes and profiles are stored on the hard drive. A removable hard drive is also provided for back up.
For troubleshooting we provided two methods: Via modem and via Internet. We are able to connect to the furnace remotely by one of these protocols for factory diagnostic support.

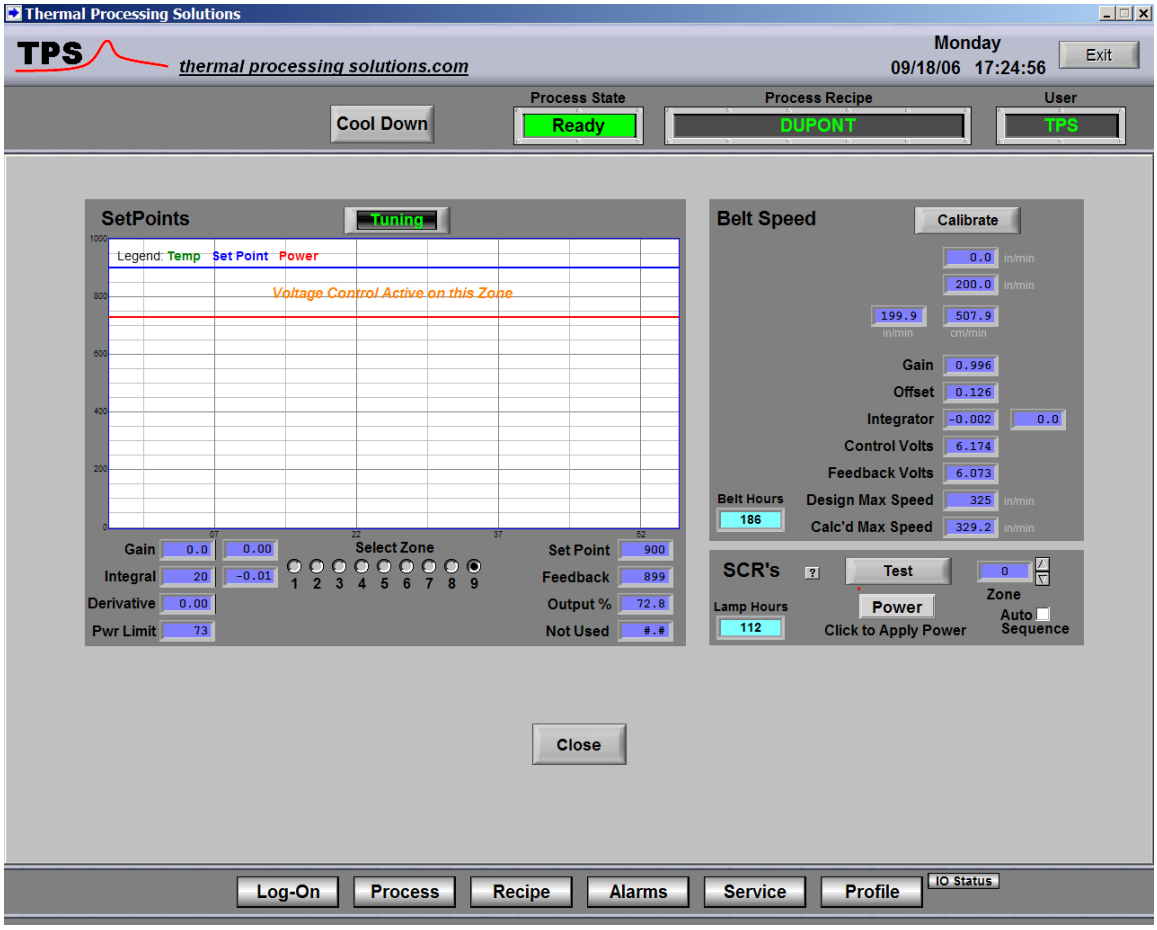
7.2 Conveyor speed is regulated by a closed loop, stand alone motor speed controller which accepts commands from the interface. (PC)



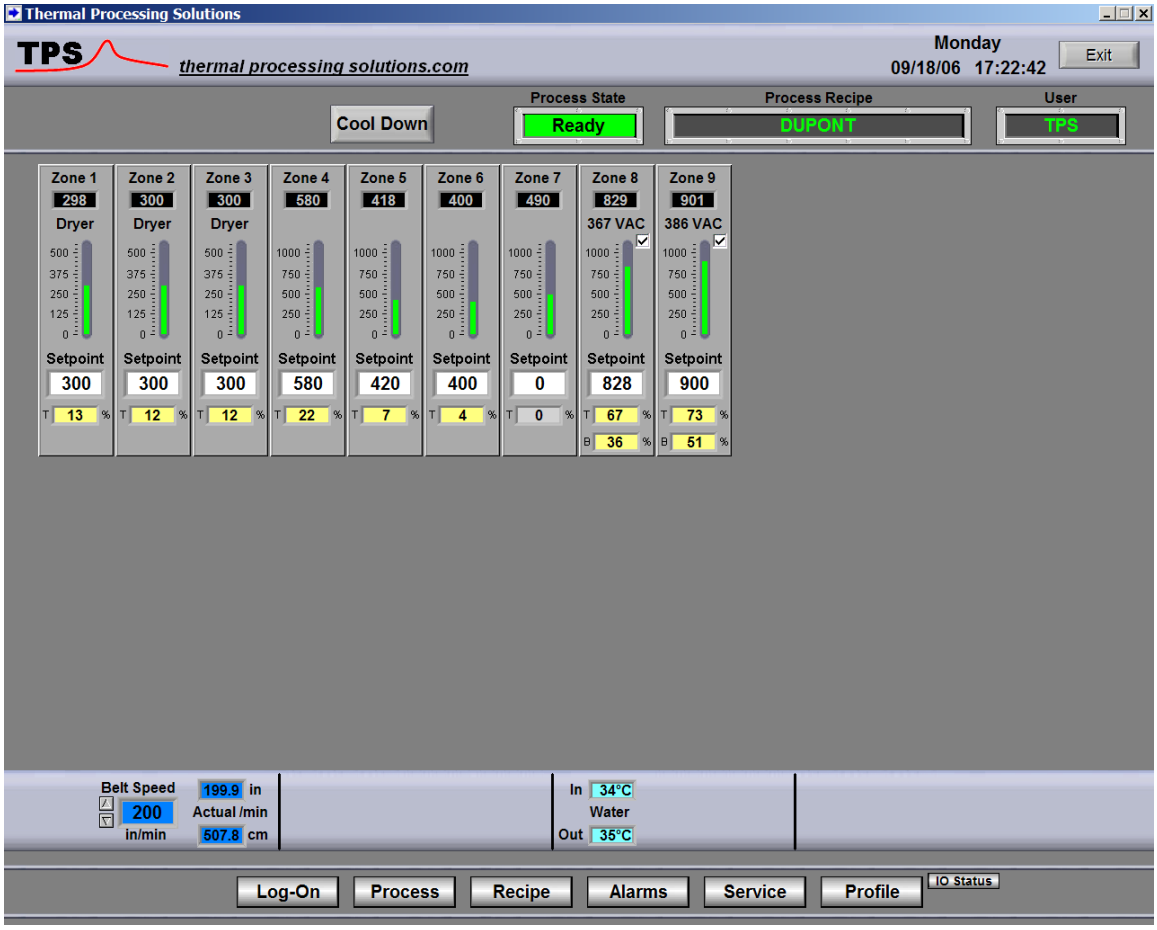
Recipe Screen

7.3 The controller (PLC) accomplishes temperature control via closed loop PID control; Zone temperature set points are established by one of two methods that you have the option to choose as follows:

1) CLOSED LOOP CONTROL BY TEMPERATURE SETTING: User may set temperature, maximum power and PID settings throughout the zones of the furnace.
Type K thermocouples are used to measure the temperature of the zones. Actual power being output to the lamps is displayed on- screen. Lamp power is controlled by SCR single phase firing modules, controlled individually.



Service Screen



Process Screen

8. **DOCUMENTATION:**

TPS shall provide a web-based owner's manual including operating instructions and recommended maintenance procedures.

9. **FINISH**

All exposed parts will be powder coated: Standard color is grey.

10. **ACCEPTANCE CRITERIA**

The furnace, as described in this document, and meeting the requirements herein, will be certified and documented by TPS Quality Assurance before customer acceptance testing begins. A customer acceptance criterion is to be mutually agreed upon and be in writing prior to furnace in-plant acceptance. Upon acceptance of the furnace by TPS, QC, (with or without customer present), TPS will have fulfilled its obligation of in-plant acceptance and will ready the furnace for shipment.

11. **Standard Features & Options**

11.1 **Air Purification System:** Provides an air dryer and filtering system which removes moisture, oil and particulate contamination from air.

11.2 **On Screen Profiling**: Up to five traveling thermocouple outputs can be plotted simultaneously.

11.3 **Over Temperature shut down:** This option provides a secondary scanner to monitor each zone and respond to over temperature conditions. The redundancy in the sensors is designed to provide shutdown of the heat even in the event of multiple component failures.

11.4 **Uninterruptible Power Supply:** This option adds an uninterruptible power supply which keeps the belt, fans and control system operating for at least 20 minutes during a power outage.

11.5 **Dimpled Mesh Belt:** This option provides an alternate conveyor belt that includes one row of low mass inverted "V" stand-offs that are provided to support wafers above the mesh belt. This option provides the ability to achieve the highest heating and cooling rates. (Contact factory for stand-off pattern and dimensions.

11.6 **Scrubber/Water Cooled Condenser System:** Located at entrance exhaust dryer section is ducted to a water cooled condenser unit. The unit traps condensed organic paste material and vents the remaining dryer exhaust to the facility exhaust duct. A drain is also provided at the bottom of the reservoir. The drain may be serviced while the dryer is in operation.

11.7 **Light Tower:** This option provides a three stage alarm status light tower. The status system has three solid state relay outputs, and activates a three lamps alarm light, located above the upper frame, as follows;
Red Indicator: Alert/Alarm Condition
Yellow Indicator: Process Not Ready, No Alarms / Alerts
Green Indicator: Process Ready, No Alarms

11.8 **Interface Rollers**: This option is designed for integration with automation equipment with conveyor extensions. Load 600mm / Unload 1000mm sections.

12.9 **Process flow Monitor**: This option will add circuitry (flow sensor) and special programming to sense failed flow gas though the process zones. The failure displays on screen, allowing the operator to quickly adjust the minimum required flow before the process is compromised.

11.10 **Exhaust system Monitor**: This option will add circuitry (flow sensor) and special programming to sense failed exhaust flow. The failure displays on screen, allowing the operator to quickly adjust exhaust flow necessary to evacuate organic paste material from the process chamber before the process is compromised.

11.11 **Element Monitor:** This option will add circuitry and special programming to sense failed heating elements, fans thru out the cooling system. The current in each element/fans is monitored continuously and the operator receives audible and visual alerts should a failure occur.

11.12 **Spare Parts:** These options provide two parts kits that may be commonly used within two or four years of operation.

11.13 **Main Breaker**: These options provide main power off switch; this is located at the entrance end of the furnace.

11.14. **WATER REQUIREMENTS (for water-cooled systems only)**

Water: 20°C Inlet water temperature recommended
Flow: 4 gpm (Typical) Clean, PH 6.8-7.2, No organics.
Pressure; 60 psi (maximum)

11.15 **Oxygen Analyzer:** An O2 analyzer and on-line 4-port gas sampling system will be provided and integrated with the control system. Using the furnace HMI, user can select a port to allow the O2 analyzer to monitor O2 levels in one of three zones. Levels out of tolerance will display visual warning and sound audible alarm on HMI screen of furnace and log warning to the event file on hard drive, so that situation can be remedied.

11.16 **Motorized Chamber Lift**: A powered system that raises the top furnace sections above the bottom section for inspection, maintenance and removal of any debris or parts that may be deposited inside the furnace. The system can be powered by local facility 117 V power when 3-phase main power is disconnected from the furnace. Hydrogen furnaces and other specialty equipment may require removal of special clamps before the top and bottom sections can be separated.

LCI Furnaces
DIVISION OF LOCHABER CORNWALL INC

CUSTOMER

CHANNEL ASSIGNMENTS

DOC NBR:	19-001	802-101570	R2
MODEL:	CU-610H	DWN JCLARK	3/25/20
S/N:	2019292	APVL	
SIZE:	A	PRNT 11/23/20	SHT 1 OF 1

Electrical

Power: 480 Vac
Phase: 3
Freq: 60 Hz

Orig FO

Controller Module
OPTO22 PAC-S1 CONTROLLER SNAP-PAC-S1
Opto22 PAC-EB2 Brain SNAP-PAC-EB2

Address: 0 SNAP-PAC-EB2 PAC Ethernet Brain

Channel		Signal	Module	Type	RANGE	Location	Description	Ref
00	0	TEMPERATURE_ZONE_1	SNAP-AITM-4i	AI	4 ch AI Type K -150 to 1372 C	KA103	Thermocouple input TC1	-04 I/O ANALOG CONTROL
	1	TEMPERATURE_ZONE_2		AI		KA203	Thermocouple input TC2	-04 I/O ANALOG CONTROL
	2	TEMPERATURE_ZONE_3		AI		KA303	Thermocouple input TC3	-04 I/O ANALOG CONTROL
	3	TEMPERATURE_ZONE_4		AI		KA103	Thermocouple input TC4	-04 I/O ANALOG CONTROL
01	0	Water_In	SNAP-AITM-4i	AI	4 ch AI Type K -150 to 1372 C	KA1303	Inlet Water Temperature input	-04 I/O ANALOG CONTROL
	1	Water_Out		AI		KA1303	Outlet Water Temperature input	-04 I/O ANALOG CONTROL
	2	spare						
	3	spare						
02	0	ZONE_1_TOP	SNAP-AOVA-8	AO	8 ch AO 0-10 Vdc (2.44 mV)	KA100	Top SCR Signal Control	-05 ELEMENT WIRING
	1	ZONE_1_BTM		AO		KA101	Bot SCR Signal Control	-05 ELEMENT WIRING
	2	ZONE_2_TOP		AO		KA200	Top SCR Signal Control	-05 ELEMENT WIRING
	3	ZONE_2_BTM		AO		KA201	Bot SCR Signal Control	-05 ELEMENT WIRING
	4	ZONE_3_TOP		AO		KA300	Top SCR Signal Control	-05 ELEMENT WIRING
	5	ZONE_3_BTM		AO		KA301	Bot SCR Signal Control	-05 ELEMENT WIRING
	6	ZONE_4_TOP		AO		KA400	Top SCR Signal Control	-05 ELEMENT WIRING
	7	ZONE_4_BTM		AO		KA401	Bot SCR Signal Control	-05 ELEMENT WIRING
03	0	Edgeheat1_Left	SNAP-AOV-25	AO	2 ch AO 0-10 Vdc	KA112	Edge Heat 1 Left SCR Signal Control	-05 ELEMENT WIRING
	1	Edgeheat1_Right				KA111	Edge Heat 1 Right SCR Signal Contr	-05 ELEMENT WIRING
04	0	Belt_Speed	SNAP-AOV-25	AO	2 ch AO 0-10 Vdc	K2	Motor Speed Control Signal	-03 FRAME WIRING
	1	spare						
05	0	Belt_Speed_Feedback	SNAP-AIV-4	AI	4 ch AO -10 to +10 Vdc	K11	Transport Motor Analog Feedback	-03 FRAME WIRING
	1	O2_Input		AI		KA4	O2 sensor reading	-04 I/O ANALOG CONTROL
	2	spare						
	3	spare						
06	0	Water_Flow	SNAP-IDC5	DI	4 ch DI 10-32 Vdc/12-32 Vac, 5-15 ms	K90	Water Flow Sensor input	-04 I/O ANALOG CONTROL
	1	Air_Flow		DI		K90	Gas Sensor input	802-90806
	2	TransportMotion		DI		K8	Transport Motion Sensor	-04 I/O ANALOG CONTROL
	3	Hydrogen_Pressure		DI		K53	H2/NHM Pressure Sensor SW2	802-101776
07	0	Main_Power	SNAP-ODC5SNK	DO	4 ch DO 5-60 Vdc Sink	K4	Delay Power OFF	-04 I/O ANALOG CONTROL
	1	LAMP_POWER_CTRL		DO		K7	Process Power On	802-101770
	2	Alarm		DO		K14	Alarm Horn	-04 I/O ANALOG CONTROL
	3	Light_Tower_Green		DO		K17	Light Tower Control	-04 I/O ANALOG CONTROL
08	0	Light_Tower_Yellow	SNAP-ODC5SNK	DO	4 ch DO 5-60 Vdc Sink	K16	Light Tower Control	-04 I/O ANALOG CONTROL
	1	Light_Tower_Red		DO		K15	Light Tower Control	-04 I/O ANALOG CONTROL
	2	Light_Tower_Blue		DO		K17	Light Tower Control	-04 I/O ANALOG CONTROL
	3	O2_Power		DO		K24	MA/O2 Power On/Off	-04 I/O ANALOG CONTROL
09	0	O2_Source	SNAP-ODC5SNK	DO	4 ch DO 5-60 Vdc Sink	K20	MA/O2 Source Control	-04 I/O ANALOG CONTROL
	1	O2_Sample_1				K21	MA/O2 Sample Control SV1	-04 I/O ANALOG CONTROL
	2	O2_Sample_2				K22	MA/O2 Sample Control SV2	-04 I/O ANALOG CONTROL
	3	O2_Sample_3		DO		K23	MA/O2 Sample Control SV3	-04 I/O ANALOG CONTROL
10	0	N2ValveForH2	SNAP-ODC5SNKF	DO	4 ch DO 5-60 Vdc Sink (Fact Mutual)	K30	H2/NHM N2 Solenoid Valve	802-101776
	1	H2Valve		DO		K31	H2/NHM H2 Solenoid Valve	802-101776
	2	PrePurgeProcess		DO			Pre-Purge Valve	-04 I/O ANALOG CONTROL
	3	IgnitionPower		DO		K58	H2/NHM Igniter Driver	-04 I/O ANALOG CONTROL
11	0	Ignitor_1	SNAP-IDC-HT-16	DI	16 ch DI 15-48 Vdc/Vac, 2-30 ms	K44	Igniter 1 Top OK	-04 I/O ANALOG CONTROL
	1	Ignitor_11		DI		K44	Igniter 1 Bottom OK	-04 I/O ANALOG CONTROL
	2	Ignitor_2		DI		K44	Igniter 2 Top OK	-04 I/O ANALOG CONTROL
	3	Ignitor_22		DI		K44	Igniter 2 Bottom OK	-04 I/O ANALOG CONTROL
	4	Ignitor_3		DI		K44	Igniter 3 Top OK	-04 I/O ANALOG CONTROL
	5	Ignitor_33		DI		K44	Igniter 3 Bottom OK	-04 I/O ANALOG CONTROL
	6	Ignitor_4		DI		K44	Igniter 4 Top OK	-04 I/O ANALOG CONTROL
	7	Ignitor_44		DI		K44	Igniter 4 Bottom OK	-04 I/O ANALOG CONTROL
	8	Ent.Exhaust1		DI		K54	Eductor Flow Sw	-04 I/O ANALOG CONTROL
	9	Ent.Exhaust2		DI		K55	Eductor Flow Sw	-04 I/O ANALOG CONTROL
	10	Transition_Exhaust		DI		K57	Eductor Flow Sw	-04 I/O ANALOG CONTROL
	11	Exit_Exhaust		DI		K56	Eductor Flow Sw	-04 I/O ANALOG CONTROL
	12	Ent.Baffle1		DI		K54	Baffle Flow Sw	-04 I/O ANALOG CONTROL
	13	Ent.Baffle2		DI		K55	Baffle Flow Sw	-04 I/O ANALOG CONTROL
	14	Transition_Baffle		DI		K57	Baffle Flow Sw	-04 I/O ANALOG CONTROL
	15	Exit_Baffle		DI		K56	Baffle Flow Sw	-04 I/O ANALOG CONTROL
12	0	Plenum_Top	SNAP-IDC5	DI	4 ch DI 10-32 Vdc/12-32 Vac, 5-15 ms	K40	Plenum Top Flow Sw	-04 I/O ANALOG CONTROL
	1	Plenum_Bottom		DI		K41	Plenum Bot Flow Sw	-04 I/O ANALOG CONTROL
	2	N2PresSW		DI		K52	N2 Pressure Sensor SW1	-04 I/O ANALOG CONTROL
	3	spare						
13	0	Auto_Shut_Off	SNAP-ODC5SNK	DO	4 ch DO 5-60 Vdc Sink	K	Master	-04 I/O ANALOG CONTROL
	1	spare						
14	0	Entrance_End	SNAP-AIMA-4	AI	4 ch AI -20+20mA	KA6	H2 Sensor 1	-04 I/O ANALOG CONTROL
	1	Plumbing_Box		AI		KA7	H2/NHM Sensor 2	-04 I/O ANALOG CONTROL
	2	Exit_End		AI		KA8	H2 Sensor 3	-04 I/O ANALOG CONTROL
	3	spare						
Total		31 Data Points	9 Modules					

REV		DESCRIPTION	DATE	APPROVED
2				
1			3/23/2020	JCLARK

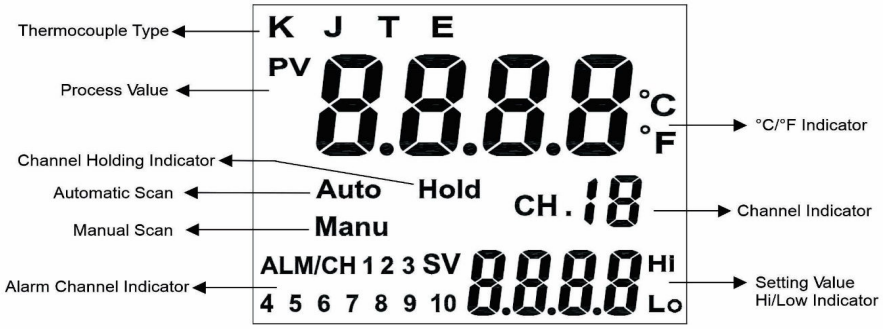
LCI Furnaces DIVISION OF LOCHABER CORNWALL INC	SPECIFICATION OT Scanner	DOC NBR: STD 802-101422 R 0	
CUSTOMER ALL		MODEL: ALL	APVL JCLARK 9/9/14
		S/N: 202xxxx	PM JCLARK 1/28/19
		SIZE: A PRNT 05/29/20	SHT 1 of 1

Pt Nbr	Qty	Description
OT	1	Omega DP10001AM 10-channel Temperature Scanner

Specifications

Type	Automatic Temperature Scanner			
Power	9 Vdc, 200 mA			
Display	Large LCD with backlight displays PV and SV value			
Alarms	Each channel has individual independent programmable alarm setpoint and indicator			
Range	Type	Fahrenheit	Celcius	
	K	-58 - 2498	-50 - 1370	
	J	-58 - 1832	-50 - 1000	
Output	Resolution	0.1 (<1000)	1 (>1000)	
	Accuracy	greater of 0.15% of Reading, +/-1.0 °C or 1.8 °F		
	Channels (max)		10	
	RS232		Yes	
	Relay		Hi/Low	
	Scan Rate		2 - 60 Sec	

LCD DISPLAY

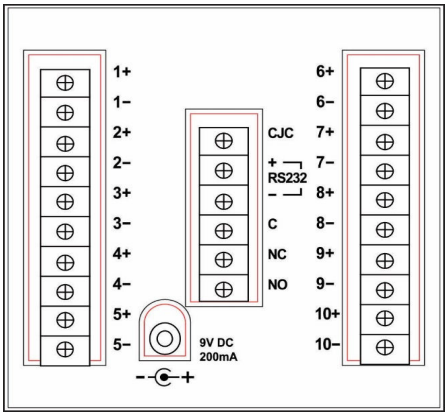


KEY FUNCTIONS

SET A	1. Press to turn on or off the power. 2. Press and hold to enter Basic Setting.
HOLD SET B	1. Press to keep monitoring the value of a certain channel under automatically scan mode. 2. Press and hold to enter Hi/Low Setting.
▲ ▼	1. Switch channels under manually scan mode. 2. Adjust values in Basic and Hi/Low Setting.
RESET	1. Press to turn on the backlight for 10 minutes under backlight-off mode. 2. Press and hold to reset the alarm of each channel.

REAR VIEW CONNECTIONS

1. Channels are labeled 1 through 10. Each active channel requires a positive and negative wire.
2. RS232 Port. For computer connection.
3. Relay connections:
   C - Common
   NC - Normally Closed
   NO - Normally Open



REVISION	DESCRIPTION	BY	DATE
0	ORIGINAL RELEASE	JCLARK	29May20