Chapter 1

FURNACE EQUIPMENT

Description of the CU-610H infrared hydrogen furnace basic thermal process elements, standard and optional hardware and their functions. Refer to section 1.7 for configuration choices and 1.8 for optional equipment description.

1.1 Furnace Description

The CU-610H is a computer controlled near-infrared, conveyor belt furnace for laboratory and production thermal processing in the range of 100-1000 ^{0}C in a controlled hydrogen/nitrogen atmosphere, free of outside contamination. Your furnace is configured for a maximum 1000 ^{0}C temperature operation. Process gas may be clean dry compressed air (CDA), nitrogen (N_2), Forming Gas (FG) and/or another inert gas. Tri-gas and dual gas furnaces may use CDA with N_2 in the furnace process zones; or N_2 and a second gas such as FG (pre-mixed N_2/H_2) or another type non-combustible gas reducing gas injected into the heating chamber.

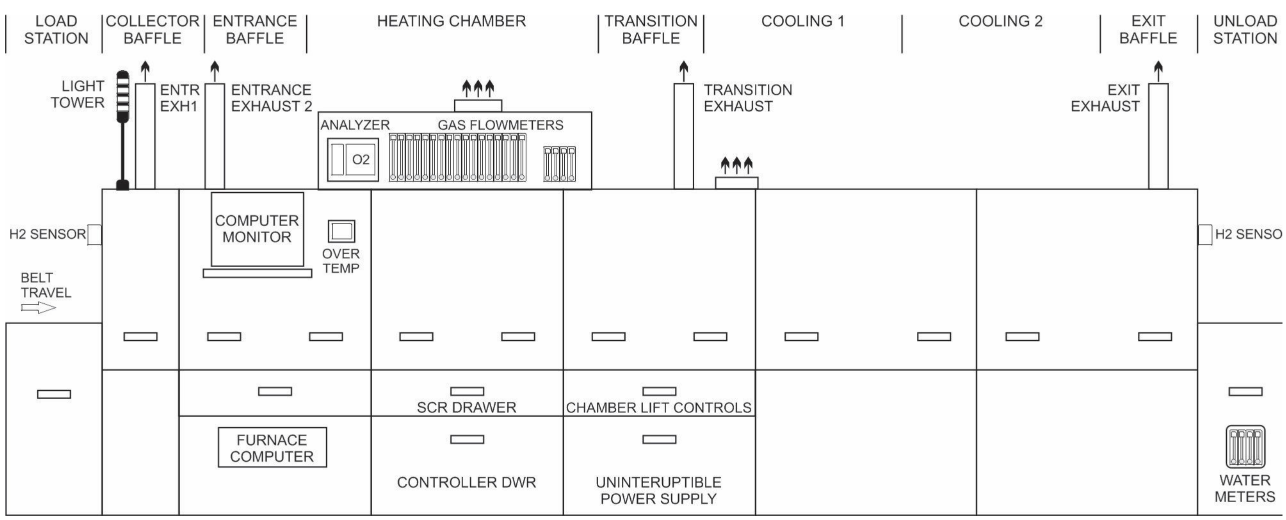


Figure 1-1 Furnace Front

The CU-610H furnace transports product on a 254 mm (10-inch) wide belt. In the standard design the chamber clearance above the belt is 50 mm (2 inches). Optionally the furnace can be ordered with 25 mm (1-inch) or 100 mm (4-inch) vertical clearance above belt. CU-610H furnaces feature a hermetically sealed heating chamber permitting control of the furnace chamber process environment. Baffle sections before and after the heating section contain curtains that hang down to just above the belt to further isolate the furnace chamber from the room atmosphere and from the cooling section.

The CU-610H can process surface mount devices, substrates, wafers, PCBs, metal, ceramic, glass or polycarbonate parts for electronic package sealing, thermo-setting polymer curing, reflow soldering, copper and hybrid/thick film firing, brazing, brazing, tempering and metal sintering applications, or almost any kind of general thermal processing requiring precision temperature control in a controlled atmosphere environment.

The CU-610H can also be used for precise curing of coatings on optical lenses, advanced thin film crystalline silicon, cadmium telluride (CdTe alloys) and certain copper indium diselenide (CIS-alloys) as well as many other production applications.

1.2 Furnace Views

Figure 1-2 Furnace Front Elevation

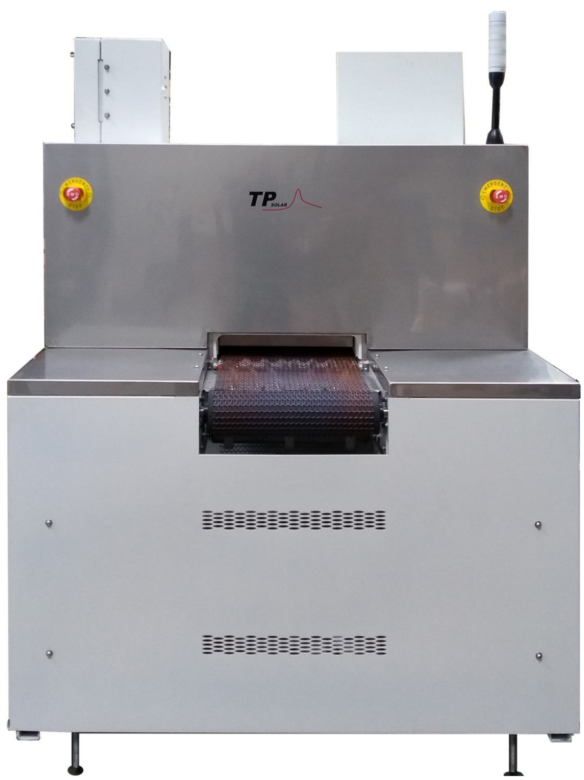


Figure 1-3 Entrance Elevation

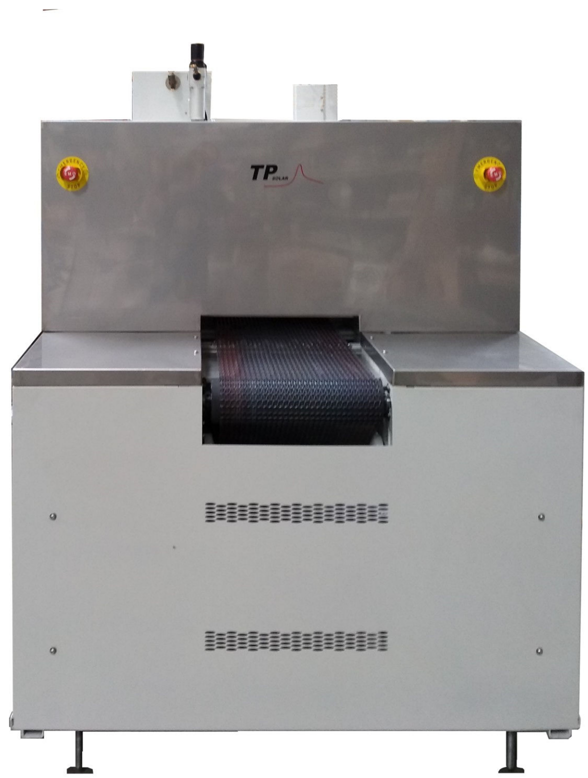


Figure 1-4 Exit Elevation

Figure 1-5 Rear Elevation

Figure 1-6 Front Entrance, Panels Off

1.3 Process Elements

During furnace operation, parts are carried from the load station through the heating and cooling sections of the furnace to the unload station on a 254 mm (10-inch) wide belt driven by an adjustable speed motor. Maximum vertical parts clearance inside the standard furnace is 100 mm (4 inches).

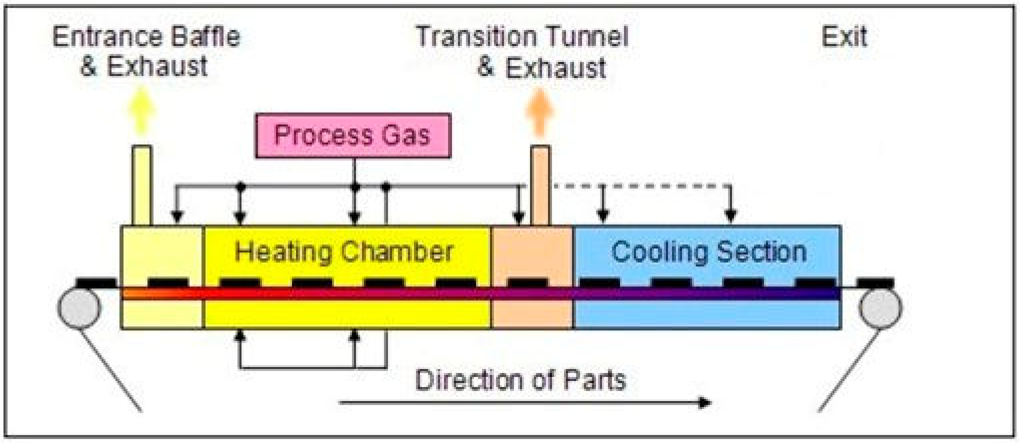


Figure 1-7 Process Sections

Process atmosphere is controlled much like a clean room: pressurized gas is pushed through the heating chamber insulated walls providing pre-heated, laminar flow for a uniform, stable atmosphere.

Zones. The heating chamber is divided into zones separated by insulating dividers so that adjacent zones can maintain different setpoint temperatures, if required. Control starts with K-type thermocouples in each zone quickly sensing changing conditions and feeding these signals to the PLC which communicates with the furnace computer. The furnace software PID loop algorithms control arrays of IR quartz heating lamps inside the heating chamber so as to maintain the desired temperature setpoint in each zone.

Product cooling is by radiant cooling N2 gas convective cooling in an enclosed water jacketed tunnel, with exterior fan heat removal.

1.3.1 Heat Transfer Methods

Transfer of heat in the furnace is by three different methods: Radiation, Convection and Conduction. In order of their contribution to heating the product, these methods are:

A. Radiation

The furnace lamps emit infrared electromagnetic waves which, when striking and absorbed by product on the belt, cause its temperature to rise. “Heat lamps” and microwave ovens work in a similar manner and it is also the way the sun heats the Earth. The infrared radiation does not directly heat the process gas within the furnace.

B. Convection

During operation, lamp radiation heats the chamber top, bottom and side wall insulation. As the process gas enters the furnace through the porous ceramic insulation, it is heated to near the setpoint temperature of the zone. This flow of heated gas transfers heat to the product on the belt. Hair dryers and home forced air heating function in the same fashion.

C. Conduction

Lamp radiation heats the transport belt which becomes a heat source for the product supported on the belt. Electric stoves and hot plates heat in this way.

1.3.2 Controlled Atmosphere

TPS furnaces are equipped with the ability to supply constant streams of a supplied process gas. This feature allows the user to reduce product oxidation or contamination, remove process effluents or reduce other potentially negative effects of ambient air at high temperatures.

A controlled atmosphere also helps establish higher consistency in thermal processes. When a product travels through the process section, slight changes in the atmospheric conditions in a non-controlled atmosphere environment can affect the stability and consistency of the product temperature profile.

A. Flowmeters, Separate Zone Control

Each furnace process area and chamber zone is plumbed with a separate flowmeter for nitrogen. Hydrogen gas flowmeters introduce hydrogen process gas below the belt in the chamber zones.

B. Hermetically Sealed Systems

For most furnace systems, the lamps ends are enclosed in plenums. Gas fed to the plenums keeps the lamps cool and prolongs the life of the lamp and improves lamp IR performance. Balancing the furnace gas inflows and outflows enables the furnace to maintain a hermetic seal. While not air-tight, a hermetic seal resists the mixing of the outside atmosphere with the furnace atmosphere by maintaining a higher pressure inside the furnace chamber. Adjust PLENUM TOP and BOTTOM flowmeters to cool lamp ends and maintain stable furnace atmosphere.

1.4 Furnace Process Sections

The furnace process equipment consists of the furnace chamber including entrance baffles, furnace chamber and transition tunnel followed by jacketed water cooled tunnel configured for 100mm (4-inch) product height (PH2), arranged as shown in Figure 1-8.

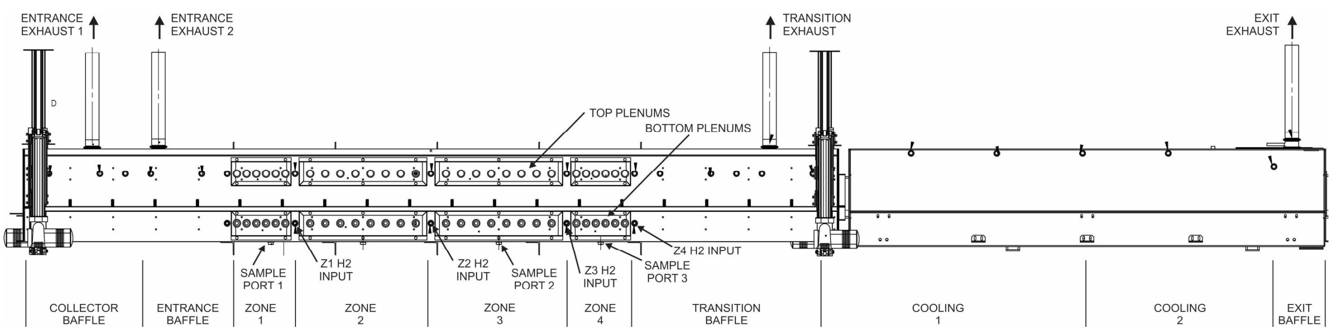


Figure 1-8 Furnace Internals

Together, the individual sections function as a unit to provide a carefully controlled gas atmosphere, precise temperature profile and controlled cooling.

1.4.1 Load Station (LOAD)

Located immediately before the furnace entrance, the Load station consists of two (2) horizontal stainless steel surfaces 390 mm (15 inches) long x 400 mm (15.3 inches) wide positioned on either side of the belt. The Load station provides a convenient area for handling product and for holding profiling equipment.

1.4.2 Furnace Chamber

The furnace chamber comprises the heat processing section consisting of one long chamber divided into three major sections. In the direction of the belt travel, these sections are the Entrance Baffles, Heating Zones and Transition Baffle. The furnace chamber is a welded stainless steel shell lined internally with high temperature ceramic fiber insulation.

The heating chamber is divided horizontally with a remote motorized lift to allow separation of the top and bottom of the furnace chamber for inspection and maintenance when the furnace is down.

A. Collector Baffle & Exhaust Stack1 (CE)

The 381-mm (15-inch) long collector baffle or Entrance Baffle 1 provides the first stage isolation of the heating zones from the ambient air outside the furnace entrance. A process gas curtain with a series of hanging swinging stainless steel baffle plates serves to act as a thermal barrier as well as purge the baffle and help prevent ambient air from entering and process gas from escaping the furnace. As with all baffle sections, Owner can stipulate baffle clearance of 6 mm to 40 mm (0.25 to 1.5 inches) above the belt (or eliminate entirely). Your CU-610H was shipped with 10 mm (0.37") baffle clearance. Adjust gas flow to the ENTRANCE BAFFLE 1 flowmeter to isolate process sections from room atmosphere.

A venturi-assisted exhaust stack, or "eductor," draws furnace gases out of the furnace. Before exhausting via the stack, the process gas passes over an accessible drip tray to collect exhaust condensation and prevent it from falling into the baffle section and contaminating the product. The eductor pulls 15 times its process gas flow from the furnace. Adjust gas flow to the ENTRANCE EXHAUST 1 flowmeter to balance the furnace gas outflow with the gas inflow.

B. Entrance Baffle & Exhaust Stack 2 (BE)

The 381-mm (15-inch) long entrance baffle (Entrance Baffle 2) provides a second stage isolation of the heating zones from the ambient air outside the furnace entrance. A process gas curtain with a series of hanging swinging stainless steel baffle plates serves to act as a thermal barrier as well as purge the baffle and help prevent ambient air from entering the furnace. Adjust gas flow to the ENTRANCE BAFFLE 2 flowmeter to isolate Zone 1 from room atmosphere.

A venturi-assisted exhaust stack, or "eductor," draws furnace gases out of the furnace. Before exhausting via the stack, the process gas passes over an accessible drip tray to collect exhaust condensation and prevent it from falling into the baffle section and contaminating the product. The eductor pulls 15 times its process gas flow from the furnace. Adjust gas flow to the ENTRANCE EXHAUST 2 flowmeter to balance the furnace gas outflow with the gas inflow.

C. Heating Zones

The heating zones follow the entrance baffles in a 762-mm (60-inch) long section of the furnace chamber divided into furnace zones that are hermetically sealed with plenum covers over the lamp ends. Inside this section, arrays of tungsten filament quartz heating lamp tubes located above and below the belt, generate intense near-wave (sometimes called "short-wave") infrared light with a color temperature of 2500 K (peak wave length of 1.16 µm). These lamps are very efficient heaters with very fast response times, producing up to 1000 watts per lamp at full power and capable of heating the furnace chamber to a state of equilibrium within minutes.

Lamp Arrangement. The lamps are arranged symmetrically above and below the belt. The top and bottom lamps may be used independently or together to configure the best possible heat transfer mode for each individual process. **Table 1-1 Furnace Arrangement** shows the distribution of lamps and available power in each zone. See 802-101501 Power and Current datasheet in Section 5 for more information of the distribution of lamps and available power in each zone.

Table 1-1 Furnace Arrangement

Zone	Zone Length (mm)	Zone Length (inches)	Number of Lamps Top / Btm	T/B Available Zone Power (W) 480 Vac	Max. Available Zone Power (W) 480 Vac
1	254	10	6 / 6	1200	7600
2	508	20	8 / 8	1600	6500
3	508	20	8 / 8	1600	6500
4	254	10	6 / 6	1600	7600

Power Configuration. The CU-610H furnace is wired half power in all zones to facilitate smooth and consistent delivery of heat energy. Zones 1 and 4 are each wired with two (2) strings of lamps, each string consisting of three (3) lamps in series. Zones 2 and 3 are each wired with two (2) strings of lamps, each string consisting of four (4) lamps in series. This arrangement has been tested and will perform well throughout the design temperature range of the furnace (100-1000 ^{0}C). Lamps within the furnace are arranged as shown in Table 1-2.

Table 1-2 Furnace Lamp Wiring Configuration

Chamber	Zone	Standard Configuration		Total Number of Lamps
		Strings Top/Btm	Lamps per String Top/Btm	
1	1	2/2	3/3	12
	2	2/2	4/4	16
	3	2/2	4/4	16
	4	2/2	3/3	12

Control Zones. The furnace heating chamber is partitioned into 4 separate temperature control zones using ceramic fiber dividers. The dividers are designed with the smallest possible opening consistent with the parts clearance specifications. This partitioning assures very high thermal isolation between zones. Although the heating profile across the belt is extremely uniform, heat losses through the furnace side walls and at the belt edge supports produce a temperature drop near the edges of the transport belt. Away from the extreme edges of the belt, overall temperature uniformity across the belt is normally better than ±3 ^{0}C.

Edge Heaters. The Edge heaters are resistance wire heaters that run parallel to the belt and provide a user-adjustable level of heat at the chamber sides. In critical applications, especially in furnaces greater than 14 inches wide, properly adjusted edge heaters can enable greater use of the furnace width because they make possible a flatter temperature profile across the width of the furnace often improving across the belt variation to ±1 ^{0}C.

Use the furnace software to add edge heat power (0-100%) in small increments to improve across the belt performance.

Caution: because the edge heaters are controlled with a feedforward signal, addition of large amounts of edge heat power relative to lamp power can contribute to an instable operating condition.

Temperature Measurement. Inside the furnace chamber, at the top center of each zone a type K thermocouple measures the temperature in that zone and provides feedback to each respective zone PID controller to determine the amount of power necessary to maintain setpoint temperatures. However useful these thermocouples are for controlling the temperature in each zone, the actual part is exposed to three heat transfer methods. As with any furnace, the most accurate way to determine what temperature product on the belt actually sees from these three methods of heating is to profile the furnace with a thermocouple placed directly on the product surface.

Chamber Process Gas. Process gas (N_2, H_2 FG or other gas) is preheated before reaching the furnace interior by allowing it to permeate through the hot porous ceramic fiber insulation. This method of gas distribution minimally affects the temperature profile and helps keep the furnace interior clean.

Adjust flowmeters for ZONE 1 through 6 to establish stable furnace operation and desired controlled processing atmosphere.

D. Transition Baffle (TT)

The Transition Baffle is similar to the entrance baffles and consists of a 760-mm (30-inch) long transition tunnel with swinging baffle plates that separate the furnace heating section from the cooling sections. It is housed in a welded stainless steel shell lined with ceramic fiber insulation. An N_2 gas curtain with a series of hanging stainless steel baffle plates serves to act as a thermal barrier as well as purge the baffle and help prevent ambient air from entering the furnace.

Adjust TRANSITION BAFFLE flowmeter to control product initial temperature drop and to isolate the furnace atmosphere from the cooling section.

A venturi-assisted exhaust stack, or "eductor" draws furnace gases out of the furnace. Before exhausting via the stack, the process gas passes over an accessible drip tray to collect exhaust condensation and prevent it from falling into the baffle section and contaminating the product. Each eductor pulls 15 times its process gas flow from the furnace. Adjust gas flow to the TRANSITION EXHAUST flowmeter to rapidly evacuate heat and process atmosphere from the furnace as well as balance the furnace gas outflow with the gas inflow.

1.4.3 Water Cooled Section (CAWC)

The Closed Atmosphere Water Cooled section is an enclosed section with process gas air rakes for rapid cooling. Air rakes are mounted above the belt to improve transfer of heat to the water inside of the cooling jackets above and below the belt. This heat must then be extracted by an external chiller.

Water or other liquid coolant should be circulating through the CAWC jacket before the furnace is started. Adjust coolant flow rates at water flowmeters near furnace exit, Figure 1-9.

Adjust process gas flow rate by adjusting flowmeters for COOLING 1 and COOLING 2. Clockwise adjustment decreases gas flow to the air rakes, counterclockwise increases gas flow speed (Figure 1-9).

Figure 1-9 Water Flowmeters

1.4.4 Exit Baffle (BX)

The Transition Baffle is similar to the entrance baffle and consists of a 304-mm (12-inch) long exit tunnel with swinging baffle plates that separate the furnace heating section from the cooling sections. It is housed in a welded stainless steel shell lined with ceramic fiber insulation. An N_2 gas curtain with a series of hanging stainless steel baffle plates serves to act as a thermal barrier as well as purge the baffle and help prevent ambient air from entering the furnace.

Adjust EXIT BAFFLE flowmeter to control product initial temperature drop and to isolate the furnace atmosphere from the cooling section.

A venturi-assisted exhaust stack, or "eductor" draws furnace gases out of the furnace. Before exhausting via each stack, the process gas passes over an accessible drip tray to collect exhaust condensation and prevent it from falling into the baffle section and contaminating the product. Each eductor pulls 15 times its process gas flow from the furnace. Adjust gas flow to the EXIT EXHAUST flowmeter to rapidly evacuate heat and process atmosphere from the furnace as well as balance the furnace gas outflow with the gas inflow

1.4.5 Unload Station (UNLOAD)

Located immediately after the final cooling stage exit, the Unload station consists of two (2) horizontal stainless steel surfaces 390 mm (15 inches) long x 400 mm (15.3 inches) wide positioned on either side of the belt. The Load station provides a convenient area for handling and removing product exiting the furnace.

1.5 Control System

This control system is comprised of a programmable logic controller (PLC) and computer interface (HMI).

1.5.1 Computer Interface (HMI)

The furnace control system uses a high quality industrial computer to manage user interface with the furnace controller and to store recipes. The furnace computer can also be used for profiling and other tasks.

The furnace computer is located in the 1st bottom drawer under the Control Console.

Figure 1-10 Furnace Computer

1.5.2 PLC

The furnace controller is a programmable logic controller consisting of a SNAP-PAC controller connected to a SNAP PAC-EB2 Brain and analog and digital analog input and output modules mounted on a rack.

The controller operates the furnace and connects via Ethernet to the furnace computer to receive instructions and to send information regarding the furnace operations and status.

The PLC controller is located in the 2nd bottom drawer from entrance, next to the furnace computer (Figure 1-12Figure 1-12).

Figure 1-11 PLC Rack

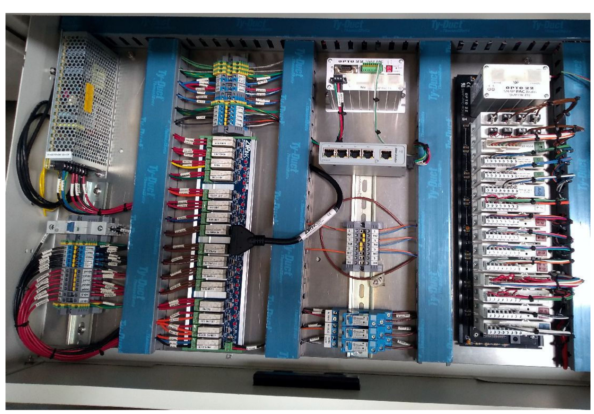


Figure 1-12 PLC Drawer

1.5.3 Controller

The SNAP PAC S1 programmable automation controller provides powerful, real-time control and communication to meet the furnace industrial control, monitoring, and data acquisition needs. The SNAP-PAC-S2 is a compact, industrially hardened controller that can handle multiple control, automation, and data acquisition tasks involving digital and analog control, serial string handling, PID, and enterprise connectivity. Connecting to Opto 22 serial and Ethernet-based I/O systems, the SNAP PAC S1 controller runs the furnace control programs written in Opto 22's PAC Control™ software to monitor and control all critical furnace functions.

The furnace controller continues to manage all aspects of furnace operation even if communication with the furnace computer is lost.

Figure 1-13 PAC-S1 Controller

1.5.4 I/O (Input / Output)

The SNAP-PAC-EB2 brain is an I/O and communications processor for the furnace control system. The SNAP-PAC-EB2 provides local intelligence that frees the PAC-S1 controller for supervisory tasks.

As an I/O processor, the SNAP PAC EB2 brain independently handles functions such as latching, thermocouple linearization, watchdog timers, and PID loop control. These functions continue to work in the brain even if communication with the SNAP PAC controller is lost.

Figure 1-14 PAC-EB2 I/O Brain

1.5.5 Ethernet Switch

The furnace computer, SNAP PAC S1 controller and SNAP PAC brains and I/O communicate over standard 10/100 Mbps Ethernet networks and can be attached to existing wired or wireless Ethernet networks. The system includes an industrial Ethernet switch which provides connection to local intelligence and to digital and analog sensors and actuators as well as serial devices.

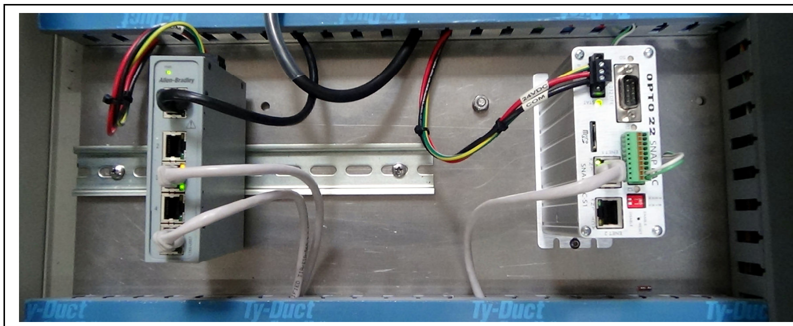


Figure 1-15 Ethernet Switch (R) & Controller (L)

Each of the devices and independent Ethernet ports have separate IP addresses. See Figure 1-16Figure 1-16 Furnace network for typical furnace network configuration

1.5.6 Furnace Ethernet Network

The furnace network consists of the furnace computer, a SNAP PAC S1 controller and one or more SNAP PAC brains and I/O racks which communicate over standard 10/100 Mbps Ethernet networks and can be attached to existing wired or wireless Ethernet networks. A typical furnace network map is shown in Figure 1-16.

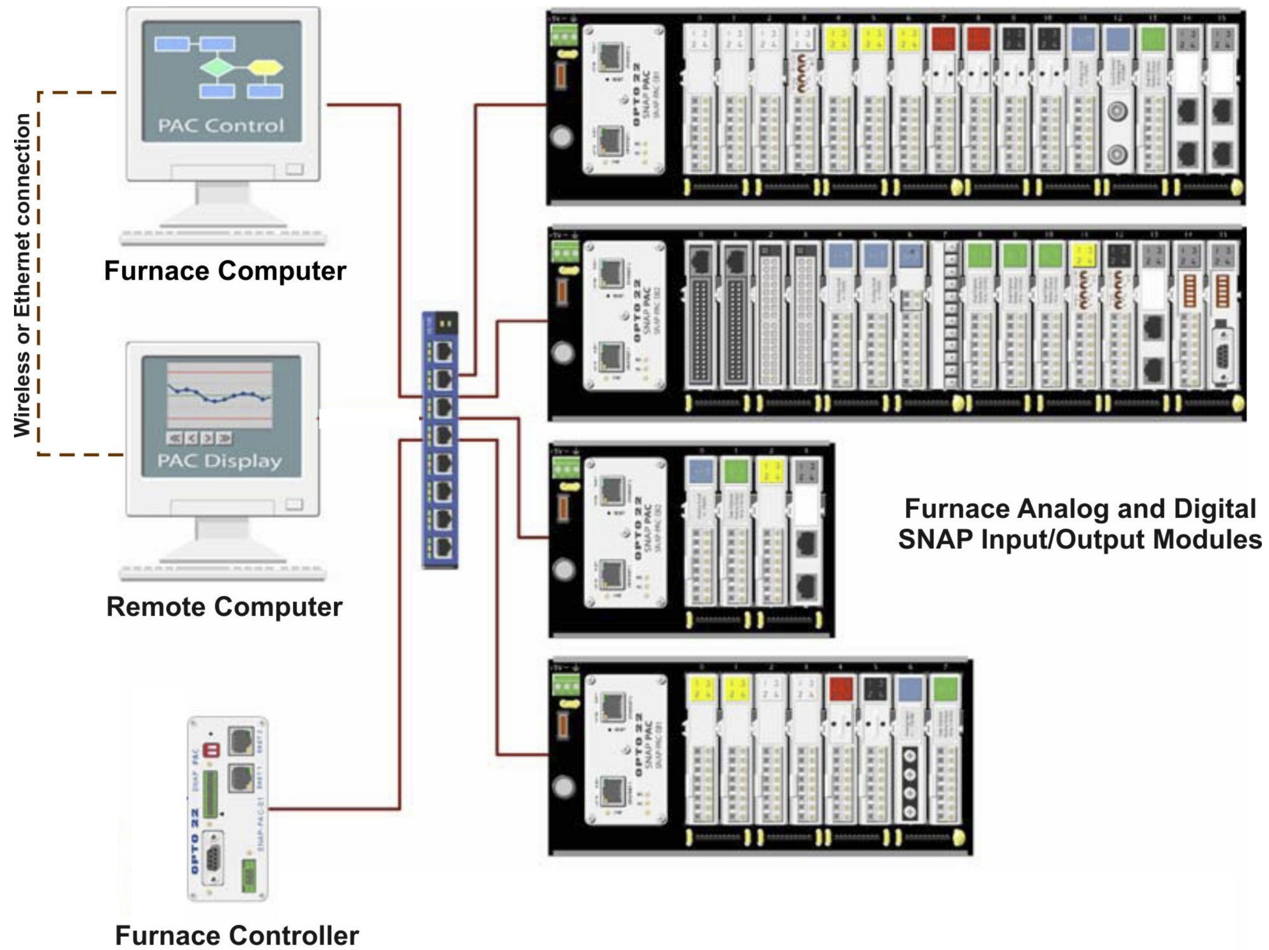


Figure 1-16 Furnace network

1.6 Auxiliary Equipment

1.6.1 Atmosphere Supply Gas

A. CDA, Nitrogen, Hydrogen, Forming Gas

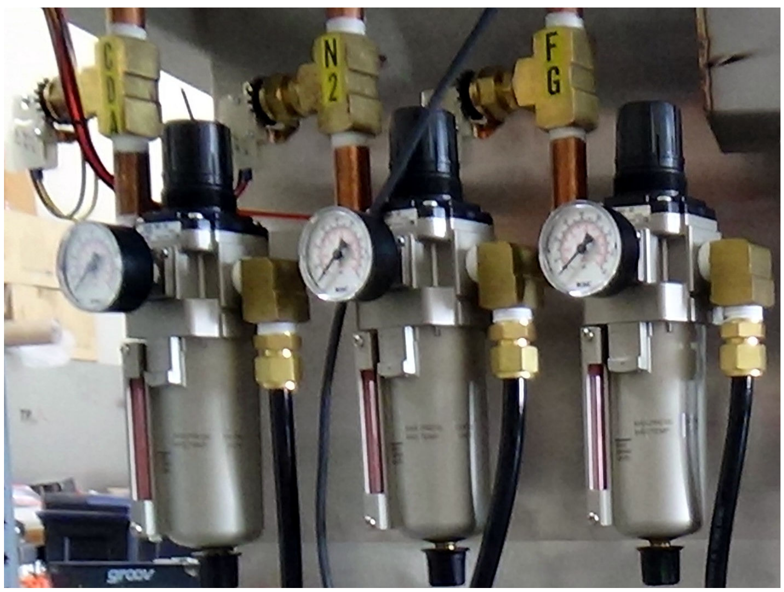
Plant supply process gas must be filtered and regulated before the furnace is started to assure consistent clean dry process gas is supplied during furnace operation.

The flowmeters on the furnace are scaled to 70 psig. Process gas pressure at the furnace should be regulated according to Table 1-3.

If the furnace supply gas pressure drops below the set point during operation, the operator should put the furnace into Cool Down. The operator can reset the system to Warm Up when air pressure is again over 65-75 psig.

Table 1-3 Gas Supply Pressure

Location	Default Setting	
Plant Process Gas Regulator supply to furnace	100-150 psi	6.9 – 10.3 bar
Regulators at Furnace (N_2, H_2)	65-75- psig	4.5-5.2 bar
Low Gas Pressure Alarm Switches	55-60 psig	3.8 - 4.1 bar



WARNING: The flowmeters on these furnaces are rated at 100 psi (5 bar) maximum. Operating above 100 psi exposes the operator to possible injury, may cause damage to the furnace internals and insulation and voids the furnace warranty.

See Section 3 for information calibration and service of the pressurized gas (N_2/H_2) system.

1.6.2 Cabinet Cooling

Cabinet Vents. The furnace is equipped with a 10-inch diameter vent with duct ring on the top of the furnace cabinet over the furnace heating section. This vent exhausts heat emitted from the outside of the furnace chamber and cooling tunnel into the room or customer installed exhaust system. The intake grill is located on top of the furnace enclosure near the exit and above the cooling section

Cooling System Fans. The Closed Atmosphere Cooling Tunnel (CACT) system is cooled by an integral fan mounted above the tunnel finned heat exchanger. Cabinet air is forced over the fins to transfer heat extracted from the belt and product on the belt to the furnace enclosure. Warm air is evacuated via the cabinet vent ring.

1.6.3 Low Pressure Alarms (IPS)

Gas Supply Pressure Switches are installed on critical process gas manifolds. These switches are normally closed. They open when proper pressure is present in the process gas supply lines.

The pressure switches are factory set to open when pressure falls below the pressure set points in Table 1-4 for Gas 1 and Gas 2.

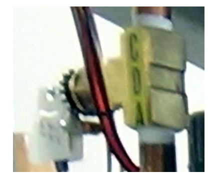


Figure 1-17 Pressure Switch

Table 1-4 Initial Pressure Alarm Settings

Manifold	Process Gas	Design Pressure	Pressure Set Points	
Gas 1	Nitrogen	75 psi (5 bar)	55-60 psi	3.8-4.1 Bar
Gas 2	Hydrogen	75 psi (5 bar)	55-60 psi	3.8-4.1 Bar
Gas 3	Forming Gas or other	75 psi (5 bar)	55-60 psi	3.8-4.1 Bar

The pressure switch set points can be adjusted manually. Locate the switch in the process gas supply line. To increase the set point turn the wheel clockwise. Turn the top of the switch counter clockwise to decrease the pressure set point so the alarm will not occur until the pressure drops to a lower point.

1.6.4 Transport Belt

The standard conveyor belt is manufactured of 316 stainless steel as installed on this furnace.

For high temperature applications (>450°C) such as this one, the conveyor belt is a close weave Nichrome-V belt manufactured from high temperature wire comprised of 80% nickel and 20% chromium.

These belts offer fast heat-up times, more uniform operating temperatures and excellent mechanical stability. This belt exhibits minimum shrinkage, growth, sag or distortion in use.

1.6.5 Transport Drive Motor

The transport drive motor assembly is typically mounted near the exit of the process section. Depending upon belt width, product mass, product number and belt speed, the motor-sprocket may appear different than the example shown in Figure 1-18 Transport Drive Motor.

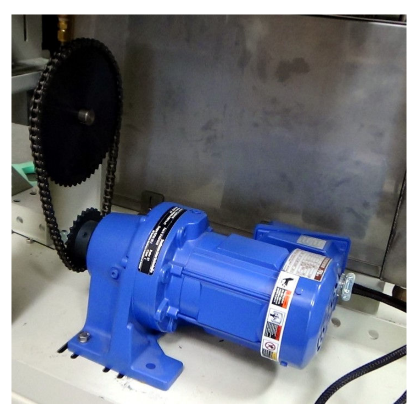


Figure 1-18 Transport Drive Motor

1.6.6 Transport Motion Fault (TMF)

The transport motion fault consists of a chopper wheel and a sensor that sends a step signal to the controller. As the motor turns the controller records the counts per minute and triggers an alarm if drive roller stops turning, even if the motor is turning.

TMF wheel and sensor are shown in Figure 1-19

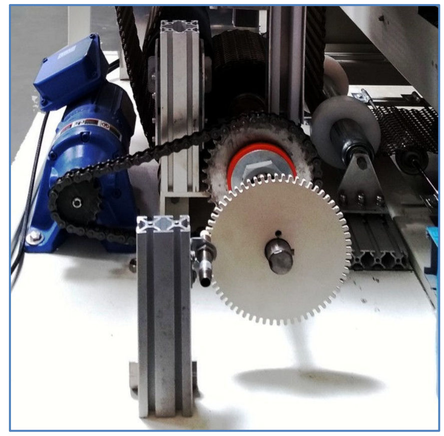


Figure 1-19 Transport Motion Fault

1.6.7 Universal Transformers

All primary transformers used in the furnace are manufactured specifically for our furnaces. These transformers are 50/60 Hz multi-tap and can be configured to operate the furnace at most commonly available voltages worldwide. The main transformer (TR0) is located on the safety Panel. Reference Safety Enclosure drawing (-01).

A universal transformer is shown in Figure 1-20

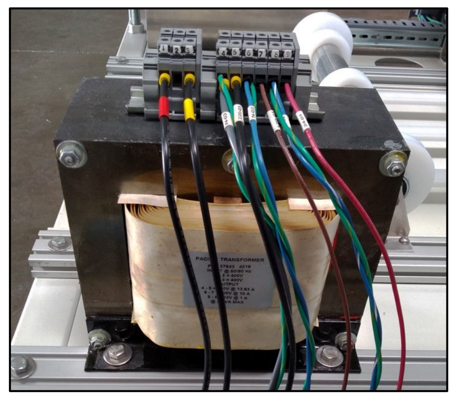


Figure 1-20 TR0 Main Transformer

1.7 Configuration Choices

1.7.1 Belt Travel (LTR / RTL)

Standard direction for belt travel is from left to right when facing the furnace Control Console. As an option, the furnace can be configured for right to left operation. This arrangement allows two production furnaces to be easily operated by a single person if one is configured RTL and the other LTR, Figure 1-21.

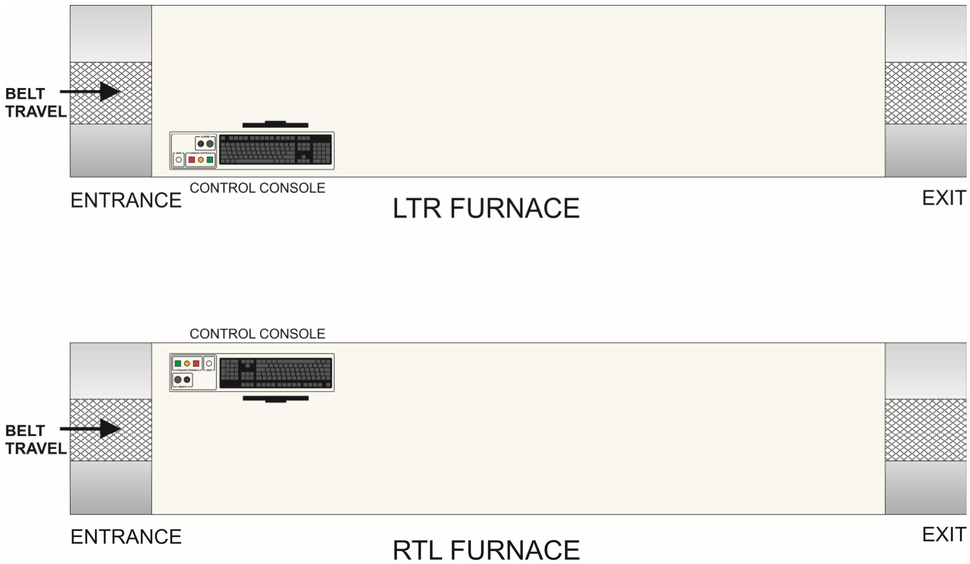


Figure 1-21 Direction of Belt Travel

1.7.2 Units of Measure, English (standard) or Metric, (SI option)

The furnace software and flowmeters are in English (ENG) units, but can be supplied with standard ANSI or optional SI units of measure at no additional cost if specified at time of order.

Table 1-5 Units of Measure		
Parameter	**English** units (ENG)	Metric **units** (SI)
Belt Speed	ipm (inches per minute)	mm/in or cm/min
Flowmeters	SCFH	Lpm

Most fasteners on the furnace are metric in any event.

1.8 Optional Equipment

Features and operation of the most common furnace equipment options that may have been included with the furnace or added later. See Table 1-6 for a summary of featured options. Unshaded items in bold were supplied on the furnace.

Table 1-6 Summary of Advanced Features & Options					
AFR	**Air filter/trap regulator**	GSM	Supply gas mixing system	**OSS**	**Gas sampling system**
CB-3	**3-phase circuit breaker**	HO/NHM	H_2 operation N_2/H2 mixing	PH1, PH4	25, 100 mm chamber height
CE	CE mark	HSK	**Handshake Signaling, Up/Dwn**	**PPG**	**Pre-purge system, Nitrogen**
CXE	**200 mm Load station extension**	LFI	Line Interference Filter	RTL	Right to Left Belt Travel
CXX	**200 mm Unload station extension**	**LT**	**Light Tower,3-Color Process Ready**	SMEMA	**Product alert system**
DGO	**Dual gas operation**	MA	Moisture analyzer	**SSP**	**Sample ports**
EM	**Element Monitoring system**	**OA**	**Oxygen Analyzer**	UCD	Ultrasonic belt cleaner

1.8.1 Air Filter/Trap Regulator (AFR option ❐)

Each process gas supply line is provide with an air filter with moisture trap and pressure regulator to assure supply is properly pressure is clean, dry and at a safe pressure.

Figure 1-22 AFR

1.8.2 Circuit Breaker (CB-3 supplied option ◙)

A three phase circuit breaker is installed on the rear side of the furnace near the entrance for convenient shutoff of the furnace when not in use. The circuit breaker is sized to prevent damage to the furnace. If the circuit breaker trips, reset by turning to ON position. If it trips again, shutdown furnace and trouble-shoot for high current draw. The CB-3 must be in OFF position to allow removal of the cover panel.

Figure 1-23 3-Phase Circuit Breaker

Figure1-24 3-Phase Circuit Breaker-Panel OFF

1.8.3 Closed Atmosphere Water Cooling (CAWC option ◙)

A high efficiency water cooled section in lieu of the standard CACT, Figure 1-25. Water flowmeters control flow, Figure 1-26. User supply of chilled deionized water, demineralized water, or water that has been passed through a reverse osmosis process to remove harmful minerals and salts is highly recommended in order to avoid chloride and scale buildup. ***A suitable corrosion inhibitor must be used with deionized or demineralized water.***

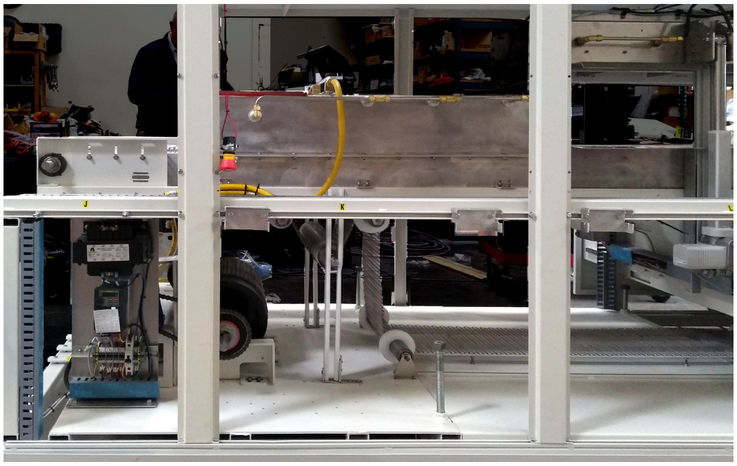


Figure 1-25 CAWC Chamber

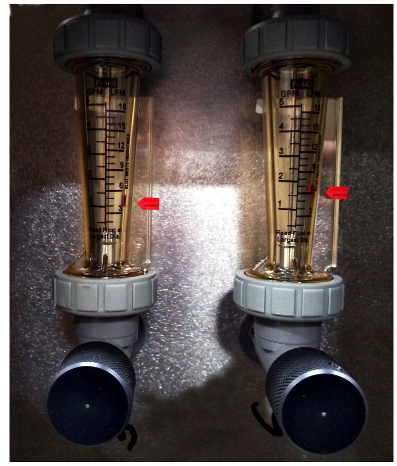


Figure 1-26 CAWC Flowmeters

1.8.4 CE Compliance (CE option)

Provides equipment and documentation to conform to applicable EC directives:

- 2006/42/EC Mach
- 2006/95/EC LV
- HS EN 60204-1:2006

Adds English certification, labels & 3-phase circuit breaker with EMC Line Filter. Compliance with all safety relevant provisions referring to:

- Controls
- Protection against mechanical hazards
- Protection against other hazards such as electrical, fire, noise and vibration
- Required characteristics of guard and protection devices

Figure 1-27 CE Mark

1.8.5 Load Extension (600 mm ❐)

Increases standard 400 mm (15 3/4-inch) stainless steel Load station at the entrance of the furnace in 200 mm (7-7/8-inch) increments. Useful if a longer product load area is needed. (Similar to Figure 1-28).

Increases furnace length by a like amount.

Figure 1-28 600 mm Load station

1.8.6 Unload Extension (600mm ❐)

Increases standard 400 mm (15 3/4-inch) stainless steel Load station at the exit of the furnace in 200 mm (7-7/8-inch) increments. Used for product inspection or to provide a longer period for product removal.

Increases furnace length by a like amount.

1.8.7 Dual Gas Mode system (DGO supplied option ◙)

Dual mode systems can allow a specialty gas to be introduced into the furnace chamber while another gas is be provided to all furnace auxiliaries.

A. DGO Equipment

Includes separate manifold for supply of a different gas to the furnace heating zones (Furnace Gas2). Aux (Gas 1, CDA or nitrogen) is supplied to eductors, transition tunnels baffle sections and closed atmosphere cooling. Furnace (Gas 2) can be either the same as Gas 1, or Gas 2, forming gas or other specialty gas supplied to the furnace chambers and lamp plenums. The Control Console will sound an audible alarm and provide visual indication for a low Gas 1 or 2 supply pressure condition.

B. Single Gas Operation (CDA or N2)

A furnace plumbed for dual gas can be operated in single gas mode. To operate in single gas mode: To operate

1. Assure that gas is flowing from supply source at the proper supply pressure (70 psig).
2. To run furnace with compressed air in the furnace and auxiliary areas, select CDA Mode.
3. To run furnace with nitrogen in the furnace and auxiliary areas, select Nitrogen Mode.

The furnace will operate with the selected gas, CDA or nitorogen flowing to all auxiliary and furnace sections.

Figure 1-29 CDA - Single Gas mode

Figure1-30 N_2 – Single Gas mode

C. Dual Gas Operation - FG (N_2 / H_2)

A furnace plumbed for dual gas is operated in much the same way as a single gas furnace. To operate in dual gas mode:

1. Assure that gas is flowing from both supply sources at the proper supply pressure (70 psig).
2. On the Process Screen, Select Forming Gas Mode.

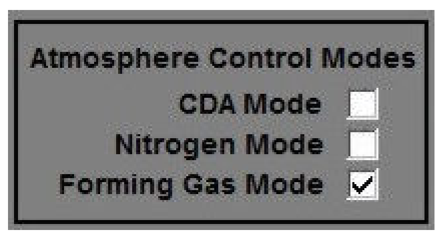


Figure 1-31 N_2/H_2 Dual Gas mode

Forming Gas will flow to the furnace chamber and plenums. Nitrogen will flow to all auxiliary areas.

The furnace will operate with nitrogen flowing to the Aux furnace sections and Gas 2, forming gas or other alternate supplied gas flowing to furnace and lamp plenums.

D. Dual Gas with Hydrogen (H2)

A furnace plumbed for hydrogen gas can be operated in single gas mode with Nitrogen only or in Hydrogen mode with nitrogen to all areas and hydrogen only flowing to the zones. To operate in hydrogen mode:

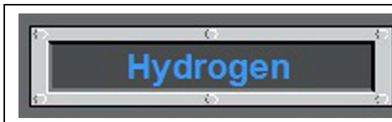


Figure 1-32 Hydrogen mode;

1. Operate in nitrogen only mode until furnace is properly balanced with sufficiently low oxygen levels in all zones.
2. Select hydrogen mode and increase hydrogen flow to the heating zones while decreasing nitrogen feed to the zones making sure that oxygen levels remain adequately low and no combustible gas sensors alarm.

1.8.8 Edge Heaters (EH option ◙)

Edge Heaters (not available on 306, optional on 309 and 310 models). The Edge heaters are resistance wire heaters that run parallel to the belt and provide a user-adjustable level of heat at the chamber sides. In critical applications, especially in furnaces greater than 14 inches wide, properly adjusted edge heaters can enable greater use of the furnace width because they make possible a flatter temperature profile across the width of the furnace often improving across the belt variation to ±1 ^{0}C.

Use the furnace software to add edge heat power (0-100%) in small increments to improve across the belt performance.

Caution: because the edge heaters are controlled only with a feedforward signal, addition of large amounts of edge heat power relative to lamp power can contribute to an instable operating condition.

1.8.9 Hermetic Chamber (HC option ◙)

Includes plenums and plenum covers to enclose all element ends. Adds plumbing and flowmeter to feed gas to the plenums to keep the heating elements cool, prolong the life of the lamp and improve lamp IR performance. Figure 1-33 shows the top and bottom plenums for each zone. Figure 1-34 shows a single zone plenum with plenum cover in place.

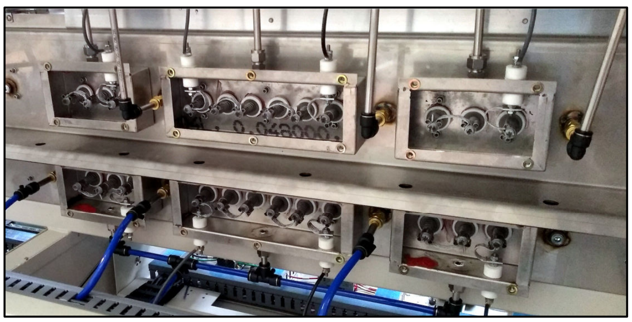


Figure 1-33 HC Plenums

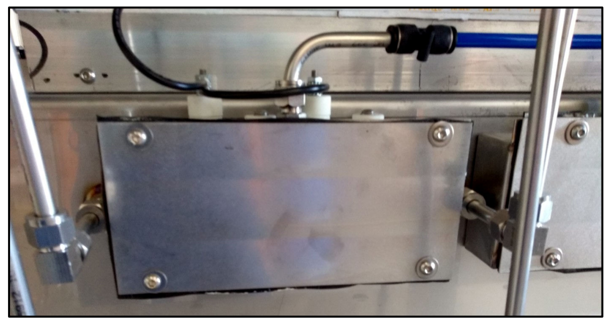


Figure 1-34 HC Plenum Covers on

Introducing gas at heating element penetrations and balancing the furnace gas inflows and outflows enable the furnace to maintain a hermetic seal. While not gas-tight, a hermetic seal resists the mixing of the outside atmosphere with the furnace atmosphere by maintaining a higher pressure inside the furnace chamber.

1.8.10 Handshake (HSK, option ❒)

Normally Open and Normally Closed contacts supplied at entrance of the furnace that are activated when the furnace system is ready to receive a part (PROCESS_READY).

Normally Open and Normally Closed contacts supplied at exit of the furnace that are activated when a part is sensed at the exit (PART_AVAILABLE).

Facilitates notification to upstream and downstream equipment that the furnace is ready to process product.

1.8.11 Light Tower (LT, supplied option ◙)

Three color light tower that indicates when furnace is in Process Ready, Warmup or Alarm condition.

Figure 1-35 Light Tower

1.8.12 Moisture Analyzer (MA option ❐)

For processes that are sensitive to moisture, a moisture analyzer can provide status of monitored zones.

The moisture analyzer can be connected to any one sample port (with SSP option) or can used with a 3-port sample system (OSS option).

A. MA Equipment

Figure 1-36 MM510 Moisture Analyzer

The brand of moisture analyzer can generally be specified by the owner. A high quality choice, the MM510 electrolytic moisture analyzer is designed for precise measurement of moisture in gas over a wide range (0.1 ppm to 1000 ppm with ± 5% accuracy). The analyzer is configured with an internal sample pump. The sample systems are manufactured using stainless steel with 1/8-inch tube connections on the sample line. Sample flow is controlled to 0.05-0.5 L/min (50-500 cc/minute).

MM510 Sensor. The phosphorus pentoxide moisture sensor consists of a dual platinum winding formed around a quartz tube about 8 cm long. A constant voltage is applied across the windings and the current monitored. The moisture in the sample gas stream causes the resistance of the platinum coil to change. The change in resistance results in a change in measured current providing an absolute measure of the moisture contained in the process sample gas. Unlike aluminum oxide sensors, the phosphorus pentoxide sensor does not require annual factory calibration.

B. MA Operation

The model of moisture analyzer selected will be factory set for your application.

1. Startup of the furnace will start the moisture sampling if the analyzer is left enabled by the operator.
2. A switch on the back of the analyzer allows shutoff of the analyzer while the furnace is running, if desired.
3. Sample line flow is controlled by the valve knob on the back of the analyzer Adjust to 0.15 L/min.

1.8.13 Motorized Chamber Lift (MCL option ◙)

The motorized chamber lift includes hardware to raise the top of the furnace chamber for access to internals (Figure 1-37). Also included is a controller with an easy to use pendant for raising and lowering the chamber (Figure1-38). Location of MCL controls vary and are sometimes installed in a pull-oud drawer.

Figure 1-37 Motorized Chamber Lift

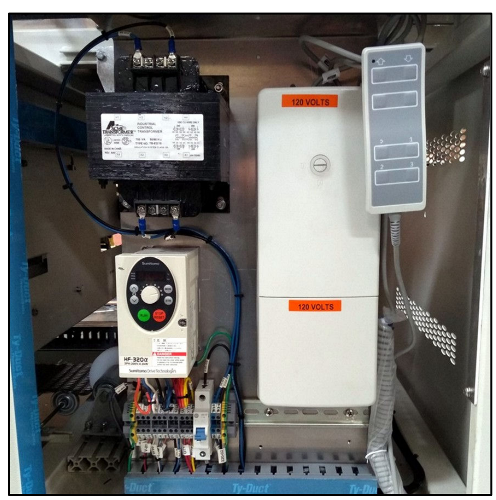


Figure1-38 MCL Pendant

1.8.14 Oxygen Analyzer (OA option ◙)

This furnace may be equipped with an oxygen analyzer and 3-port sampling system with source gas purge. An oxygen analyzer can assure furnace settings result in a low oxygen environment in the furnace chamber during operation.

The EC913 process oxygen analyzer features an electrochemical RACE™ fuel cell for accurate measurement of oxygen (measuring range: 0.1 ppm-30% at ± 2%) and features microprocessor-controlled functions, large auto-ranging LED display, and fast response. To avoid interference, indicate if hydrogen gas will be present.

The analyzer is fitted with an integral sample pump downstream of the sensor. The sampling valve on the back of the analyzer is used for flow control and is adjustable from 0.05-0.5 L/min (50-500 cc/min) sample rate (default is 0.1 to 0.15 L/min).

Figure 1-39 EC913 Oxygen Analyzer

The oxygen analyzer itself is usually mounted inside the flowmeter enclosure. The analyzer outputs are integrated with the furnace control system with the oxygen concentration displayed on the Process screen, Figure 1-40. Alerts and alarms are set from the Process screen or the Recipe screen on the furnace computer.

1.8.15 Sample System, Computer (OSS option ◙)

This system consists of electrical controls and piping of a 4-port manifold to a source gas and 3 sample ports. The sample ports are located on the bottom of each furnace chamber zone. The Source is piped from Gas1 (or the nitrogen source) through a pressure regulator adjusted to 35 mbar (0.5 psig) and connected to port 1 on the manifold.

The analyzer and sample system can be enabled from a popup on the Process screen or by sending a recipe to the furnace controller.

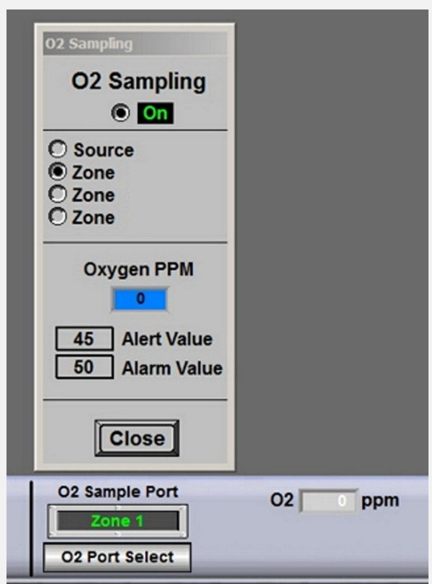


Figure 1-40 Process popup

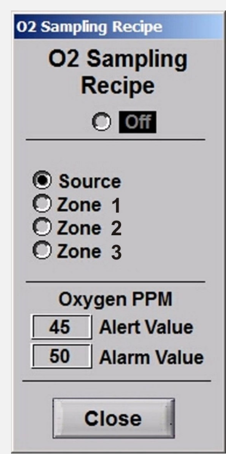


Figure 1-41 Recipe popup

The Process screen popup (Figure 1-40) provides user the ability to enable or disable the analyzer and selection of any one of 3 furnace ports or the source gas (nitrogen) to be sampled in real time. The settings immediately become active as selections are made from the Process screen popup.

The Recipe screen popup (Figure 1-41) provides user the ability to enable or disable the analyzer and selection of any one of 3 furnace ports or the source gas (nitrogen) to be sampled. These settings can be stored with each recipe and become active when the recipe is selected and sent to the furnace controller.

1.8.16 Over Temperature Option (OT option ◙)

The Over Temperature Alarm (OT) option provides a scanner to monitor each zone and respond to overtemperature conditions serving as an additional safeguard against a runaway furnace. A runaway furnace is a very unlikely, but possible condition where the furnace continues to apply current to zone heating elements even though the setpoint temperature has been reached. Normally the furnace software puts the furnace into Cooldown if the temperature deviation in any zone reaches the user's alarm setpoint. The OT system is a redundant system where its alarm setpoints are set higher than those in the furnace recipe in case the initial trigger is ignored.

The OT system consists of redundant zone thermocouples, an Automatic Temperature Scanner/LCD display (Figure 1-42) integrated into the furnace software. The Automatic Temperature Scanner display is mounted on the front side of the furnace near the control console.

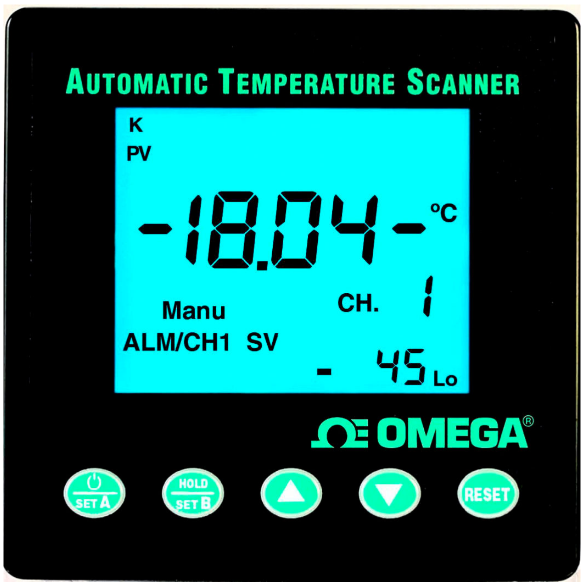


Figure 1-42 OT Automatic TemperatureScanner

Figure 1-43 Redundant Type K Thermocouples

In each zone, redundant thermocouples are installed, Figure 1-43. One thermocouple supplies analog temperature signals to the zone controller, the other to the OT Automatic Temperature Scanner.

Table 1-7 Redundant Zone Thermocouples						
Furnace		Thermocouple				
Series	Model	Type	Operating Range	Max Continuous	Tolerance (Greater of)	Material
LA-300 series	STD	K	0-1250 C	1100 C	+/-2.2 C or 0.75%	Chromel-Alumel
LA-300-series	SiC	R	0-1600 C	1480 C	+/-1.5 C or 0.25%	Platinum-Rhodium

FEATURES. The Automatic Temperature Scanner scans each zone in succession. The operator can view the temperature of the zone being scanned on the LCD panel display. The active channel (zone) being monitored will be indicated on the scanner.

ALARM. Each channel has individual, independent and programmable alarm setpoints with alarm indicator. If the temperature in any zone reaches the user set alarm set point, an alarm will sound in the Automatic Temperature Scanner and trigger the furnace into Cool Down. The heating elements will immediately be shut off by the controller. The furnace cannot be restarted until the zone temperature drops below the alarm set point.

Memory and setpoints are retained when power is OFF.

1.8.17 SMEMA Product Alert (option ❐)

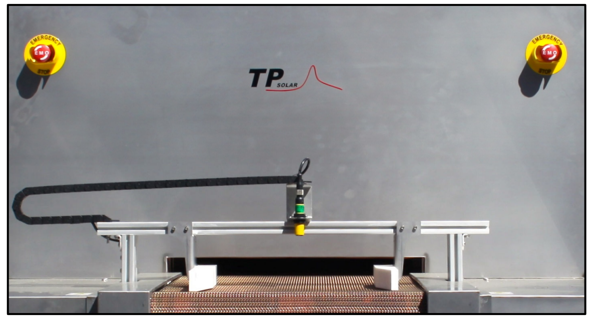


Figure 1-44 SMEMA Sensor Mount

The SMEMA system consists of sensors located at the entrance and exit above the belt that send signals to the software when parts are detected. Each sensor is mounted on an extruded bar that allows the sensor to be placed anywhere across the belt.

A. Product Alerts

The SMEMA system alerts operators when product enters and exits the furnace. With the HSK handshake feature, the system provides SMEMA 1.1 **Busy/Board_Available** signal generation to coordinate product handling from upstream and downstream equipment.

Sensors at the entrance and exit of the furnace system (Figure 1-44) will generate a **BUSY** or **BOARD_AVAILABLE** signal. If a **BUSY** signal at the entrance or a **BOARD_AVAILABLE** signal at the exit persists for more than a fixed period of time (3 seconds), a board jam may have occurred. The conveyor motion will not be stopped in the event of a jam, but the machine goes into Cool-Down and an Alarm condition is displayed.

Figure 1-45 SMEMA Sensor closeup

B. Product Sensors

The Product Tracking Sensors are self-contained fixed-field 880 nm infrared diffuse mode sensors located at the entrance and exit of the furnace. Their high excess gain and fixed-field technology allow them to detect objects of low reflectivity, while ignoring background surfaces. The cutoff distance is fixed. The most common furnace sensor model has a cutoff of 100 mm (4 inches). Backgrounds and background objects must always be placed beyond the cutoff distance.

Part Number	Sensor Model	Output	Range (cutoff)
350-79752-25	S18SN6FF25	NPN	25 mm (1 inch)
350-79752-50	S18SN6FF50	NPN	50 mm (2 inches)
350-79752-01	S18SN6FF100Q	NPN	100 mm (4 inches)

Table 1-8 Product Tracking Sensor Range (cutoff distance)

The Sensor compares the reflections of its emitted light beam from the product unit back to the sensor’s two differently aimed detectors. If the near detector light signal is stronger than the far detector light signal, the sensor responds to the object. If the far detector light signal is stronger than the near detector light signal, the sensor ignores the object.

The cutoff distance is fixed (**Table 1-8**). Objects lying beyond the cutoff distance are usually ignored even if they are highly reflective.

1.8.18 Sample Ports (SSP option ◙)

This option includes control enclosure port connection to one or more of the sample ports located on the underside of each zone. Allows connection of an oxygen analyzer, moisture analyzer or other gas analyzer. Must be used with a sample pump (not included). Port connections are located under the chamber. Figure 1-46 shows a typical port location on a chamber.

Note: The chamber is fitted so that even if this option is not included at the time of manufacture, sample ports can be added later, if required.

Included with OA, MA and OSS options.

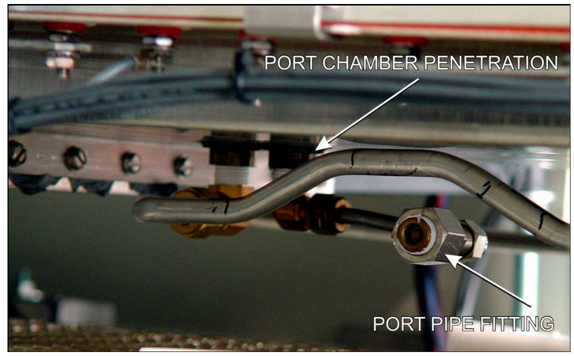


Figure 1-46 Sample Port Chamber Penetration

This furnace is equipped with 4 ports. Ports on zones 1, 3 and 4 are connected to the OSS sample system.

1.8.19 Touchscreen Interface (TSI option ❒)

This option includes monitor and software for a touchscreen interface (Figure 1-47 and Figure1-48).

Figure 1-47 Touchscreen Mounted

Figure1-48 Touchscreen Monitor

1.8.20 Factory UPS (UPS option)

Uninterruptable power supply to keep the computer, monitor and PLC controller running for at least six (6) minutes in the event the power to the furnace is disconnected or during a power outage. The UPS provides time for the operator to properly power down the furnace computer using the Windows operating system.

When the furnace loses power either by:

Throw open furnace circuit breaker

Open EMO or interlock

Loss of facility power

Press Furnace Control Panel OFF

The belt and all auxiliaries will stop, but the computer, monitor and PLC will continue to run. Use the Windows™ "Shut down" procedure to shut down the computer. The PLC will shut down after 6 minutes or so.

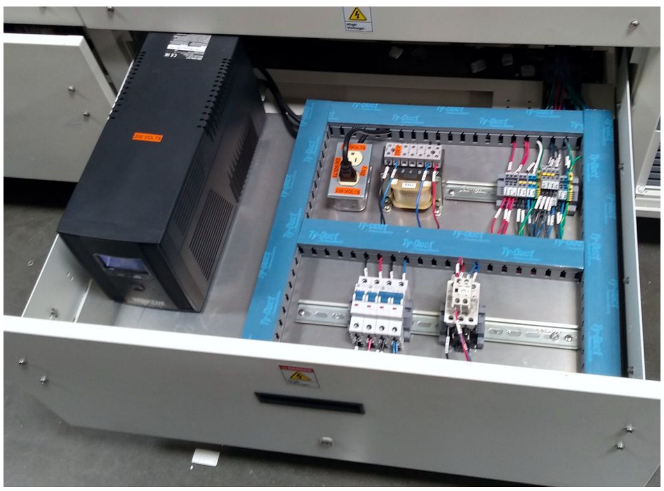


Figure 1-49 UPS Drawer

Figure 1-50 UPS, Rear View