

# SPECIFICATIONS

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## AT A GLANCE

- Temperature Range up to: 1000 °C
- 2" product clearance
- Belt Speeds: 8 - 80 inches/min
- Alloy Nichrome belt material for long belt life with 1000 °C zone temperatures
- Controlled Atmosphere Capability ( < 8 ppm Oxygen)
- Energy efficient
- Low tension, vibration-free transport system
- Top removable panels allow complete access to the chamber
- PLC for furnace control with Industrial PC for HMI
- Internet link to PLC for factory assistance with customer site
- Color coded graphical user interface with links to factory technical support
- Temperature differentials up to 300 °C between adjacent zones can be achieved
- Easy-access, pull-out electrical drawers equipped with troubleshooting aids and spare parts
- Class 1000 Clean Room Compatible



Innovative Furnace Technologies

# TF618X Infrared Furnace



## A Safe, Reliable, Flexible Furnace for thermal processes requiring controlled atmosphere . . . . .

The TF618X provides a safe, repeatable process capability for thermal processes requiring a controlled atmosphere Forming gas atmospheres. The furnace zones can be supplied with 100% N<sub>2</sub> or Forming Gas up to 4%. N<sub>2</sub> is supplied to the baffle areas to isolate the chamber from ambient air . It is capable of heating up from ambient to 950 °C and stabilize with tight temperature control in less than 30 minutes. The heat up rate and rapid cool down capability make this furnace ideal for manufacturing operations requiring multiple profile change -overs or a short production utilization during a single production day.

TP Solar , Inc designs equipment for easy access and low maintenance to ensure overall reliability and highest customer satisfaction.

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# Infrared Furnace Specification Summary



Innovative Furnace Technologies

	Metric Units	English Units
<b>Furnace Configuration</b>		
Overall Length	7000 mm	275 in
Overall Width	1270 mm	50 in
Load Station	600 mm	24 in
Unload Station	600 mm	24 in
Net Weight	TBD	
Shipping Weight (Crated)	TBD	
Parts Clearance	50.8 mm	2 in
Entrance Baffle	400 mm	15.74 in
Heated Length ( 4 Zones)	1524 mm	60 in
Transition Baffle	400 mm	15.74 in
Cooling Length	2286 mm	90 in
Fan Cooling Module	1206 mm	47.5 in
Maximum Temperature (Zones 1 to 4 )	1000 °C	1832 °F
<b>Electrical</b>		
Voltage:	380-480 VAC/3 Ph/50-60 Hz	
Peak Power	120 kw	
Lockable Safety Disconnect	Standard	
<b>Process Atmosphere Gas</b>		
Nitrogen @ 75 psi max	2880 SCFH	
Forming Gas, Non Combustible @ 75 psi max (Furnace Zones Only Plus 1st Transition Tunnel)	1200 SCFH	
<b>Cooling Water Requirements</b>		
Typical Flow @ 70 psi max (di-ionized recommended)	Optional	
Recommended Inlet Temperature	10 - 20 °C	50 - 68 °F
<b>Transport System (Low tension, vibration free)</b>		
Belt Speed	8 - 80 ipm	
Belt Width	18 in	
Speed Control/Accuracy	Closed-Loop / ± 0.5 %	

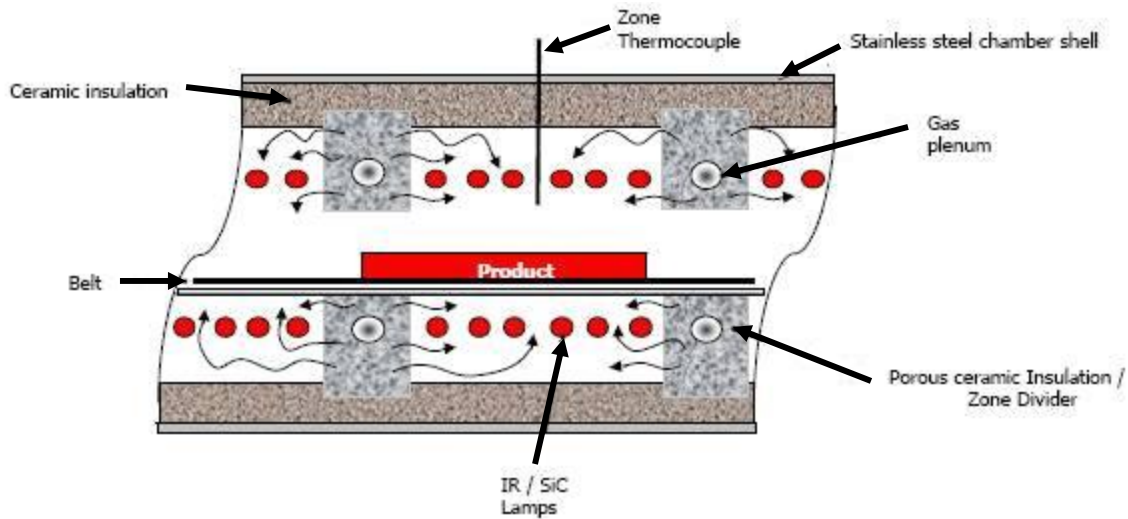
## Standard Features Included in the Base Price

Interface Rollers  
 Oxygen Analyzer  
 Rack-mounted Industrial Computer  
 Light Tower  
 Handshake (Smema Optional)  
 Lockable Safety Interlock  
 Load/ Unload Stations (400mm each)  
 High Voltage Operation 380-480 V / 3 Ph / 50-60 Hz  
 Spare Parts Kit (One Year)  
 Uninterruptible Power Supply (PLC & PC)  
 Water Cooling  
 Element Monitor

Controlled Atmosphere Capability ( < 8 ppm O<sub>2</sub> )

Patent Pending

## Cover Gas Delivery Method



A proven N<sub>2</sub> delivery system enables very low O<sub>2</sub> concentrations within the chamber. N<sub>2</sub> enters the chamber system through multiple flow meters, via multiple internal zone dividers and through end baffles. All N<sub>2</sub> supplies are separately adjustable to compensate for variations in processed product.

## Other Design Features of the TF-618X

- Thicker, less permeable insulation
- Reinforced zone dividers
- Dual exhaust
- Removable top for chamber access

## Applications for the TF-618X

- Co-fired Ceramic Technology for producing electronic packages such as:
  - \* Pin Grid Array (PGA)
  - \* Quad Flat Packs (QFP)
  - \* LAN Grid Array
  - \* Leadless Chip Carriers
  - \* Multilayer Ceramic Inserts (MLC)
- Glass to Metal Seal Technology Applications
- Brazing operations



## INNOVATIVE FURNACE TECHNOLOGIES

Serial Number	2016286
Model Number	TF-618-FG
Input Service	480 Vac, 3 Wire / Neutral / Ground
Frequency	50 / 60 Hz
Peak Power	100 KW
Peak Amps	120 Amps
Water Input	19 LPM @ 4 Bar
Peak Flow	2000 SCFH
Max Input Pressure	75 PSI
Process Exhaust	350 SCFH
Cabinet Exhaust 1 & 2	500 CFM Each
Manufactured Date	11-2016

TPsolar + waveform is a registered trademark of TP Solar, Inc. All right reserved. TPSI furnace technology, furnaces, components and processing covered under one or more of: US Patent 7,805,064; R.O.C. Patent No. ZL200780023525.5; Taiwan Patent No. I-335978; and other pending US and Foreign Patents. Control programs are Copyright © 2015 TP Solar, Inc. MADE IN THE USA

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## INNOVATIVE FURNACE TECHNOLOGIES

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 <b>LCI Furnaces</b> DIVISION OF LOCHABER CORNWALL INC	<b>DATA SHEET</b>				DOC NBR:	16-005	802-101501-00	R0
	<b>IR FURNACE SYSTEM POWER &amp; CURRENT</b>				MODEL:	TPS TF-618	APVL:	AR 4/16/15
					SERIAL NBR:		CONF:	JMC 4/16/15
	Customer: GE Fuel Cells					PRINT:	01/18/17	SHT 1 of 1

INPUT TABLE		Entry OK?	VALID
Enter Line Voltage:	480 Vac	TRUE	
(208,220,380,400,415,480)			
Limit Lamps to Max Rating? (Y/N)	Y	TRUE	
Line Frequency (50/60)	60 Hz	TRUE	
Number of Phases:	3 Φ	TRUE	
Lamp Length (6, 9, 15, 24, 36)	18 inches	TRUE	
Typical Operating %	54 %	TRUE	

SUMMARY OF RESULTS	
Max Power:	119.8 kW
Max Current:	144.1 A
Typical Power:	65.6 kW
Typical Current:	78.9 A

HARDWARE	
Lamps: 56	SCRs: 10
EMs: 7	TCs: 4
EM IDC5: 7	
Nbr strings: 28	
Nbr Lamps in 10" zone: 6	AOV-25: 5
	AITM: 2

CONFIGURATION	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 6	Zone 7	Zone 8	Zone 9	Zone 10	Zone 11	Zone 12	Totals
Length (6.6,7.5,10,14.3,15,20,30) in.	10	20	20	10									60 in.
Length Entry OK?	TRUE	TRUE	TRUE	TRUE									
(F)urn., (1) SCR-Zn, (D)ryer	F	F	F	F									4
Zone Type OK?	TRUE	TRUE	TRUE	TRUE									
No. Lamps in Series/String (1-5)	2	2	2	2									
Lamps/String OK?	TRUE	TRUE	TRUE	TRUE									
No. Lamps in Top/Bottom Power	6/6	8/8	8/8	6/6									Plenum: 240
SCR PHASE	Zone Entry OK?	VALID	VALID	VALID	VALID								Lamp Balance (kW)
Top Lamp Phase (1/2/3):		1	2	3	3								Phase 1: 24.0
Bottom Lamp Phase (1/2/3):		1	2	3	3								Phase 2: 32.0
SCR POWER													Phase 3: 56.0
Rated Lamp Voltage	225	225	225	225									<-- Vrms
Max. Lamp Wired Voltage	225	225	225	225									
50% Power SCR Cal Span Setting	285	285	285	285									
Max. Lamp Wired Power (W)	2000	2000	2000	2000									
No. Strings per SCR	3	4	4	3									
Max. Current per String (A)	8.9	8.9	8.9	8.9									
No. Lamps in Zone	12	16	16	12									56
No. SCRs in Zone	2	2	2	2									8
No. Strings in Furnace Zones	6	8	8	6									28
													Nbr. lamp strings per element monitor: 4
Top Lamp Power (kW)	12.0	16.0	16.0	12.0									
Bottom Lamp Power (kW)	12.0	16.0	16.0	12.0									
Total Power/Zone (kW)	24.0	32.0	32.0	24.0									112.0
Current Required Top SCR (A)	26.7	35.6	35.6	26.7									
Current Required Bottom SCR (A)	26.7	35.6	35.6	26.7									
Color Temp (K) (nominal: 2500K)	2500	2500	2500	2500									
Peak Wavelength (µm)	1.16	1.16	1.16	1.16									
% Energy NIR (<2 µm)	67%	67%	67%	67%									
% Energy MW (2-4 µm)	33%	33%	33%	33%									
Estimated Lamp Life (hrs)	5000 hr	5000 hr	5000 hr	5000 hr									
Lumen Output vs. Rated (%)	100	100	100	100									

Furnace Total	Number of Item?	Voltage (Vac)	Current (Amps)	Power (kW) Max	Power (kW) Typical	Phase Assigned	EH in EM? (y/n)	Other Items
Lamps	56	480	as above	112.0	60.5	as above	N	10" Cabinet or CACT Fans, 117 Vac, 0.30/029 A for 50/60 Hz
PC, Monitor	1	117	1.3	0.2	0.2	1	TRUE	4" Box (Muffin) Fans, product cooling, 117 Vac, 0.16 A
Belt, Opto22, EM	1	117	2.1	0.2	0.2	1		Cross-flow Fans, product cooling, 230 Vac, 1.27 A max
UC (Pump & Gen)	1	117	10.0	1.2	1.2	1	OK	Lower Cabinet Blowers (Impellers), 230 Vac, 0.72 A max
UC (Tank Heater)		117	8.4					H2 Igniters, 120 Vac, 5 A 24 Vdc PS, 120 Vac, 2 A
UCD (Blower)		117	2.0					No more than 8 SCRs/phase per TRx xfmr 24 Vac secondary
UCD (Heater)		480	16.0					TR1: 2 TR2: 4 TR3: 4
Edg Htr 1 Length	60	480	12.0	5.8	3.1	2	OK	EH1 Ω: 81 Current: 6.0 A Cal Span: 305 Vac
Edg Htr 2 Length								EH2 Ω: Current: Cal Span:
Edg Htr 3 Length								EH3 Ω: Current: Cal Span:
Cabinet Vent Fan 10"	0	117	0.29					Cabinet/CACT/Control Box Fans: 1.74 A
CACT Fans 10"	6	117	0.29	0.2	0.2	1	OK	
CACT Fans 4"	0	117	0.16					
Control Box Fans 4"	0	117	0.16					
Prod Cooling fans	6	117	0.16	0.1	0.1	1	OK	
OA & Pump	1	117	1.0	0.1	0.1	1	OK	
Furnace Totals:				119.8	65.6			

PHASE	PHASE BALANCING			TOTAL
	1	2	3	ALL
LAMP PWR, kW	24.0	32.0	56.0	112.0
EH/OTHER	2.0	3.1	0.0	5.1
TOTAL	26.0	35.1	56.0	117.1



**OXYGEN ANALYZER  
SETUP**

DOC NBR:	16-005	802-101543	R1
MODEL NBR:	TPS TF-618	DATE	5Oct16
SERIAL NBR:	2016286	APVL	JCLARK 28Oct15
SIZE: <b>A</b>	PRNT	18Jan17	SHT 1 of 1

**FACTORY SETTINGS**

O2 ANALYZER, ILLINOIS INSTRUMENTS MODEL EC913

SERIAL NUMBER 900G10257

**COMMENT**

1 PAGE		1
2 AL1	NO	n/a
3 AL2	NC	n/a
4 SET PAGE0 to either RANGE0 or RANGE1	<b>SCALE</b>	<b>RANGE0</b>
4a OPH1 = 0.1%. Sets upper limit of analog output	pct	0.100%
OPH1 = 0.1%. Sets upper limit of analog output (ppmv)	ppmv	1,000
4b OPL1 = 0%. Sets lower limit of analog output	pct	0.00%
OPL1 = 0%. Sets lower limit of analog output (ppmv)	ppmv	0
OPH2		
OPL2		
OPH3		
OPL3		
SPn1	Read Only	1.295
SPn2	Read Only	0.362
SPH	Read Only	20.9%
SPLo	Read Only	107 ppm
7 LIFEL	Read Only	100.0
8 LIFEH	Read Only	100.0
8 GO TO PAGE1 (Password is 1234)		1234

PAGE 0 functions (no password required).  
 See PAGE1 for latch configuration.  
 See PAGE1 for latch configuration.  
 Note: Analog Card not factory configured.  
 For GE datalogging use  
 For GE datalogging use  
 not installed  
 not installed  
 not installed  
 not installed  
 Remaining life of ppm cell  
 Remaining life of % cell  
 PAGE 1 functions (password required)

9 OL ALARM CONFIGURATION 30

DIGIT 1	ALARM 1	ALARM 2	DIGIT 2	ALARM 1	ALARM 2
0	Low	Low	0	Unlatched	Unlatched
1	High	Low	1	Latched	Unlatched
2	Low	High	2	Unlatched	Latched
3	High	High	3	Latched	Latched

Sets alarm level and latch conditions.  
 self-clearing.  
 latched requires pressing enter button to clear.

9a ALARM CONTACTS	Contacts	Type	Setting
Alarm 1	9-10	NC	100
Alarm 1	11-10	NO	100
Alarm 2	12-13	NC	n/a
Alarm 2	14-13	NO	n/a

SPARE, not connected to furnace  
 To Furnace Alarm system  
 SPARE, not connected to furnace  
 SPARE, not connected to furnace

10 ANCH1 SET ANALOG OUTPUT TYPE

10a ANCH1	Sets channel 1 output to 0=4-20mA; 1=0-20mA; 2=0-10V.	2
ANCH2	Sets channel 2 output to 0=4-20mA; 1=0-20mA; 2=0-10V.	not installed
ANCH3	Sets channel 3 output to 0=4-20mA; 1=0-20mA; 2=0-10V.	not installed
11 GAS = 28.02	Set molecular weight for Nitrogen	28.02
12 PUMP = 1.	Enables sample pump. (=0 Disables pump)	1

0-10 V  
 Factory setting  
 Factory setting



# EC900 Process Oxygen Analysers



The EC900 offers unsurpassed accuracy, reliability and flexibility under the most demanding on-line operating conditions



## Features & Benefits

- Specific to oxygen
- Ambient air or traceable gas calibration
- Microprocessor controlled functions
- Long life, maintenance-free, disposable oxygen sensors
- Fast response. Ultra fast response version also available
- This instrument has a 36 month warranty which covers any faulty workmanship and normal component failure relating to electronic circuit cards
- Large, autoranging LED display
- Unaffected by vibration or position
- Sturdy, reliable construction with three sensor options
- Insensitive to sample flow rate - percentage through ppm
- Nitrosave flushing gas control option

Conforms to European Directives:

Electromagnetic Compatibility Directive 2004/108/EC Low Voltage Directive 73/23/EEC

# Unmatched in High Performance On-Line Oxygen Analysis

## Applications

### Chemical / Petrochemical

Chemical Production  
High Purity Gas Production  
Hydrocarbon Refining  
Natural Gas Transmission

### Curing

Electron Beam  
Ultraviolet

### Electronics

Reflow / Wave Soldering  
Solder Powder Production  
Semiconductor Furnaces  
Gas Quality

### Metals

Heat Treating / Annealing  
Steel Production  
Alloys and Powdered Metals

### Pharmaceutical

Inert Packaging  
Vessel Blanketing  
Fermentation

### Process

Ceramics  
Combustion Analysis  
Contact Lens Manufacturing  
Food Packaging  
Glass Fibre Optics  
Inert Gas Welding  
Lamp Manufacturing

### General

Controlled Environments  
R & D  
Glove Boxes  
Oxygen Deficiency

## Unmatched Performance

Systech Illinois has long been recognised worldwide as a leader in oxygen analysis.

Utilising a variety of specially engineered electrochemical fuel cells, the EC900 Oxygen Analysers are designed to monitor oxygen within most industrial gases and atmospheres. These highly advanced instruments incorporate user-friendly software and the highest quality sensors to provide accurate, reliable results.

Whatever your measuring range, the EC900 series has an analyser to suit your needs.

## Cabinetry & Mounting

Three different configurations to match your needs.

- NEMA 4X / IP66 waterproof and weatherproof
- 19 in. rack mount
- Panel or bench mount
- UL and CUL approved Ex-proof

## Explosion Proof Version

- UL and CSA approved
- Split architecture version for:  
Class I, Groups B, C& D; Class II and Class III
- Nema 4/7 rated

## Operator Interface /Diagnostics

- User-friendly menu
- Read-only mode available
- Diagnostic capabilities
- Fault alarms

## Optional Nitrosave Feature

- Control of Nitrogen or flushing gas
- Reduced gas consumption
- Improved productivity
- Reduced product wastage
- Better quality control
- Integrated electronics with analyser
- Control hardware available

## Outputs & Alarm Options

For charting, process control, or remote monitoring.

- USB and RS485
- Analogue outputs (one or three channels)
- High / low alarms
- Fault alarms

## Sensor Selection

No need to compromise! Now you can match sensor to application for the best possible reliability and performance. All sensors are manufactured to rigid tolerances and exacting production specifications.

EC920



EC930



EC910



Ex- Proof



## Sampling Systems

- Bypass flowmeter
- Pressure regulator
- Sample pump
- Flow alarm

## Principle of Operation

The EC900 Oxygen Analysers use a variety of electrochemical fuel cells for the detection of oxygen. When oxygen diffuses to the cathode of the cell, a current output is produced directly proportional to the concentration of oxygen in the sample gas.

Specialising in trace oxygen measurements, Systech Illinois' sensors are used in applications from ppb up to 100% oxygen. In addition, sensors can be used on gas streams such as hydrogen, combustibles, hydrocarbons and inert gases.

All Systech Illinois' sensors are easily calibrated to ambient air. For ISO purposes and in specific applications, traceable calibration gases can be used to meet the most demanding quality assurance programmes.

## Trace (part per million) Sensor

The trace sensor is designed for measuring 0.1ppm – 1% oxygen in most industrial gas streams. Can be calibrated to air. This sensor when used in a normal operating range typically lasts 3 – 5 years.

## Sensor RACE™

The RACE™ Sensor is a breakthrough in electrochemical technology. Our patented design\* prevents the sensor from being saturated by high levels of oxygen. With TURBOPURGE™ levels as low as 20ppm can be reached from ambient air within 2 minutes. This sensor is unaffected by hydrocarbons or volatile atmospheres making it the ideal choice in applications such as wavesolder and reflow ovens.

The RACE™ Sensor is maintenance-free, requires only occasional calibration and has no caustic electrolyte to monitor or replace. The RACE™ Sensor carries a 3 year limited warranty.

## Percent Sensor

The Systech Illinois percent sensor is capable of accurate measurements from 0 – 100% oxygen. Unlike most electrochemical sensors, this sensor is not affected by acid gases such as carbon dioxide.

\* UK Patent no. 2324870. USA Patent no. 5929318

## EC900 Process Oxygen Analysers



### EC910

Bench/Panel Mount  
190H x 237W x 410D (mm)  
7.9 kg



### EC920

IP66/NEMA 4X  
Wall Mount/Weatherproof  
460H x 380W x 160D (mm)  
15.5kg



### EC930

Rack Mount 4U - 19 inch  
Houses 1 or 2 Analysers  
178H x 484W x 410D (mm)  
9.7kg (single unit)

## Technical Specifications

Sensor Type	Trace	Race	Percent
Ranges	0.1ppm - 1%	0.1ppm - 30%	0.3% - 100%
Accuracy: >10ppm	±2% of reading at 20°C ±5% of reading over temperature range	±2% of reading at 20°C ±5% of reading over temperature range	±0.2% of calibrated value at 20°C ±1% of calibrated value over temperature range
<10ppm	±2% of reading + 0.4ppm at 20°C ±5% of reading + 0.6ppm over temperature range	±2% over temperature + 0.4ppm at 20°C ±5% over temperature + 0.6ppm over temperature range	
Response Time	90% within 30sec	Air to 20ppm within 2min	90% within 30sec
Measuring Cell Type	Electrochemical, percentage, trace and RACE™ Cell (US & UK) patents		
<b>Operating Conditions</b>			
Sample Inlet Pressure	0.25 - 2 Barg, 3-30psi		
Sample Flow Rate	Approximately 140 cc/min		
Sample Temperature	-5 to 50°C		
Ambient Temperature	-5 to 50°C, RH 0-99% non-condensing		
Sample Connections	1/8" OD compression fittings, as standard		
Communications	USB and RS485		
Unsuitable Gases	Acid gases, corrosives and solvents in significant concentration		
<b>Power Requirements</b>			
Power Supply	115/230VAC selectable		
Display Type	4-digit high-visibility LED		
<b>Options</b>			
High/Low Alarms	2 Volt-free changeover contacts. Rated 240V 3A		
Analogue Outputs	Analogue output channels: scaleable 0-10V, 4-20mA or 0-20mA all isolated. Option for one channel or three.		
Autocalibrate	Provision for remote cal start and autocal in progress		
Sample Stream Options	Bypass flowmeter, sample pump, flow alarm, stainless steel sample system in place of brass/copper. Sample conditioning advice available.		
Nitrosave	O <sub>2</sub> measurement and control system EC9500.		
Ex Proof	Consult factory for various configurations.		

Systech Illinois have over 30 years experience of providing analysis solutions for a wide range of industries. From our manufacturing plants in the UK and U.S. we produce gas analysers for industrial process industries, headspace analysers for monitoring gas flushing of food products and our range of permeation analysers.

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# CERTIFICATION AND CALIBRATION REPORT

NUMBER  ISSUE DATE   
 MODEL  SERIAL

### Sensor(s)

Part Number	<input type="text" value="900 057 (H2 RACE)"/>	<input type="text" value="0916-0347"/>	Serial Number
	<input type="text" value="900 168 (Percent)"/>	<input type="text" value="0916-0597"/>	

## OXYGEN CALIBRATION

CERTIFIED GAS	REFERENCE NUMBER	INSTRUMENT READING
<input type="text" value="N2 (&lt;2 ppm)"/>	<input 2="" ppm)"="" type="text" value("&lt;=""/>	<input type="text" value="0.85 ppm"/>
<input type="text" value="107.1 ppm"/>	<input type="text" value="54-124525388-2"/>	<input type="text" value="107 ppm"/>
<input type="text" value="AIR (20.9%)"/>	<input type="text" value="20.9 %"/>	<input type="text" value="20.9 %"/>
<input type="text"/>	<input type="text"/>	<input type="text"/>

- \* All gases are N.I.S.T. traceable mixtures of oxygen in nitrogen.
- \* This certificate expires 12 months from the issue date.

### This Analyzer is equipped with the following option(s):

- |   |   |   |  |
|---|---|---|--|
| <input type="checkbox"/> 1/4" Bulkheads                     | <input type="checkbox"/> Auto Calibration           | <input type="checkbox"/> Low Flow (10cc)    | <input type="checkbox"/> Special Configuration     |
| <input type="checkbox"/> 24VDC Input                        | <input type="checkbox"/> Bypass Flow                | <input type="checkbox"/> Nitro Save         | <input type="checkbox"/> Stainless Steel Bulkheads |
| <input type="checkbox"/> Alarms                             | <input type="checkbox"/> Female NPT Bulkeads        | <input type="checkbox"/> Pressure Regulator | <input type="checkbox"/> Stainless Steel Plumbing  |
| <input checked="" type="checkbox"/> Analog Output 1 Channel | <input type="checkbox"/> Flow Alarm                 | <input checked="" type="checkbox"/> Pump    |  |
| <input type="checkbox"/> Analog Output 3 Channel            | <input checked="" type="checkbox"/> Hydrogen Sensor | <input type="checkbox"/> Solenoid Shutoffs  |  |
- Remote Sensor with 50'-100' Cable(s) and Explosion-Proof Enclosure

CALIBRATED BY :

SIGNATURE : \_\_\_\_\_



**I/O Channel Assignments**

**Analog Module Thermocouple Input 1 (TC 1)**

Channel	Description
0	Thermocouple Input Zone 1
1	Thermocouple Input Zone 2
2	Thermocouple Input Zone 3
3	Thermocouple Input Zone 4
4	Thermocouple Input Water In
5	Thermocouple Input Water Out

**Analog Module Output (AO1)**

Channel	Description
0	SCR ZONE 1 TOP
1	SCR ZONE 1 BOTTOM
2	SCR ZONE 2 TOP
3	SCR ZONE 2 BOTTOM
4	SCR ZONE 3 TOP
5	SCR ZONE 3 BOTTOM
6	SCR ZONE 4 TOP
7	SCR ZONE 4 BOTTOM
8	SCR EDGE HEAT RIGHT
9	SCR EDGE HEAT LEFT
10	Motor Control Signal Control

**Analog Module Input (AI1)**

Channel	Description
0	Motor Control Signal Feedback
1	Oxygen Analyzer Feed Back

**Digital Module DO 1**

Channel	Description	
0	Main Power	Output
1	Lamp Power	Output
2	Alarm	Output
3	Auto OFF	Output
4	Light Tower Yellow	Output
5	Light Tower Green	Output
6	Oxygen Valve Source	Output
7	Oxygen Valve Zone 1	Output
8	Oxygen Valve Zone 2	Output
9	Oxygen Valve Zone 3	Output
10	Oxygen Analyzer ON/OFF	Output
11	CDA Main Valve	Output
12	Nitrogen Main Valve	Output
13	Forming Gas Main Valve	Output

**Digital Module DI 1**

Channel	Description	
0	Air Flow Sensor CDA	Input
1	Air Flow Sensor NITROGEN	Input
2	Air Flow Sensor FORMING GAS	Input
3	Transport Motion Fault	Input
4	SMEMA Sensor Entrance	Input
5	SMEMA Sensor Exit	Input

**GE FUEL CELLS**  
**IR Sintering System**  
**Furnace System Scope 05122016**

Item	Specification	GE Requirement	Comment	TPSI TF-618 sn 2016286
1	VOLTAGE	3 PH 480V preferred		YES
2	BELT WIDTH	18" preferred		18-inch
3	HEATING SECTION	4-Zone, 60-inches		YES
	COOLING SECTION	80 inch, 4 chiller radiators in gas chamber - 2 top, 2 bottom. Down the middle gas flow jets as in 1st furnace. Air cooling section outside of chamber, 4 cross flow fans top and 4 on bottom. Fans mounted cross wise to conveyor, tilted back, and even spaced out over distance.	See GE provided pictures. Water flow to radiators individually adjustable. Air flow from cooling fans adjustable top and bottom.	YES
4	FUEL CELL SPRAY PANEL DIMENSIONS	8" square - large cell See fuel cell drawing and sample parts.		YES
5	FUEL CELL CLEARANCE AND LOADING	Simple conveyor belt system - part with ceramic coating facing up to IR heat source or heated from IR lamps below.	2" product clearance. No fixturing required.	CONFIRM: NO FIXTURING from TPSI
6	CONVEYOR Capacity	Conveyor to be capable of (13) 10 lbs per part so fixturing could be provided by GE if required.		YES, ADDED QUARTZ
7	CELL SINTERING TEMPERATURE	800/900 degrees C	<b>Must reach 940C</b> temp on part - measured on top of surface in center.	YES
8	TIME AT SINTER TEMP	10-60 seconds	Reach min temp (820 C) in all top parts of cell during run - for 30 min seconds.	YES
9	CELL EXIT TEMP	50C exit temp preferred. (Sintering at 800C/25IPM or drying at 400-500C/35IPM). 100C max, exit temp with all cooling air fans on.	Requesting 50C exit temps using secondary air blowers. 100C max is acceptable. - measured center part. <b>Current furnace is reaching just below 100C with 8 cross flow fans.</b>	YES
10	TEMPERATURE CONTROL and MONITORING	Oven should be controlled by type K TC's. TC's need to be shielded with ceramic tubes all the way until 1/8 inch below end of TC.	Type K TC's with ceramic tube shielding from IR heating. Ceramic tube should extend 1/8" beyond tip of T/C.	YES
11	LOADING	Allow for loading fuel cells on conveyor or in loading fixture (if required).	Allow for fixtures - 2" oven clearance. Conveyor must hold up to 10 lbs fixture with part weight of 3 lbs..	Fixtures by GE
12	OVEN ATMOSPHERE	Nitrogen in oven and in cooling chamber - down to 200-300 C. Forced air blowers can be used for cooling below 300C. Also forming gas (N2 w/small %H2) capability required.	3 gas system to be provided as per current RGL	YES, PLENUMS ON FURNACE CHAMBERS WITH NEW DESIGN PLENUM COVERS
13	OVEN GAS BAFFLING DESIGN	Baffles at entrance, between furnace and cooling sections, and at exit. Baffles should extend fully to sides of furnace. There should be gas flow barriers under conveyor beneath baffles - extended to sides of chamber. All baffles should be hung with minimum of 5 CLOSED hooks to prevent them from falling off.	This was an issue with first furnace.	YES. ADDED 5 BAFFLES BLADES, ENTRANCE AND EXIT
14	DESIRED SPEED (W/TRANSPORT)	Based on length - 3 min desired full process time - minimum 8 inches per minute conveyor speed to max 80 inches per minute.	8-80 IPM desired speed - positive feedback loop controlled	8-80 ipm, AC Motor
15	PROCESS CYCLE REQUIREMENTS	Load FC part, convey to IR oven thru door (slit) to IR furnace section with N2 or N2/H2 atmosphere, reach 800C/900C surface temp, convey to cooling chamber (Water cooled) with fans - N2). Cool down post oven (blowers - centrally applied to part).	Need to reach safe exit temps on parts - 50C (up to 100C is acceptable).	YES
16	CYCLE TIME (8X8 FC, 8-900C PROCESS)	25 IPM conveyor speed. 1.5 to 2 part/min @ load/unload		1st PART: 9.4 min, 1.6 PARTS/min @ 25 IPM-single lane
17	CYCLE TIME (8X8 FC, 350C PROCESS)	35-50 IPM conveyor speed. 3 to 4 part/min @ load/unload		1ST PART: 4.7 min, 3.2 PARTS/min @ 50 IPM single lane

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18	PROCESSING CTQ'S (Critical to Quality)	Cell coating reaches 800C/900C, stays at this temp min 10 seconds. N2 (or N2/H2) atmosphere thru heating and N2 cooling (at least down to 300C). Need fan cooling to 50C after leaving N2 cooling.	temp may need to reach maximum of 940C peak - instantaneous	YES
19	ATMOSPHERE	Inlet manifold for N2, FG, CDA for heat section and Transition; Separate inlet manifold for aux and cool sections for N2 or CDA.	CONTROLLED FOR CDA, N2 AND FG/N2 - use DGO option as provided for RGL	YES - See DGO
20	O2 MONITORING	Zone 1,2,3 selectable ports monitoring plus one port for GE at Zone 4.	Zone 1,2,3 selectable ports monitoring plus one port for GE at zone 4. Sample lines to be 1/8" diameter PTFE.	YES
21	POST DRYER COOL DOWN	After N2 section, blower system to cool panels quickly to hand touch. Will require N2 atmosphere down to 300C.	Include secondary squirrel cage blower modules as seen on TPSI solar furnace during plant visit.	Gas air rakes in baffle and water cooling sections.
22	SYSTEM DESIGN	Straight through conveyor with SMEMA	GE will provide return system.	YES, but no return
23	RELIABILITY	6000 hr MTBF desired.		1 Year Warranty
24	PLC & DATA LOGGING	Simple control or programmable for various cycles, cells, speeds, cooling, etc. At minimum, chamber temperature and conveyor speed data logging with recording of operating parameters and alarms.		Yes, includes datalogging of act belt speed and zone temps, alerts, alarms, recipe load, operator log-in, Barcoding not included.
25	TEST METHOD	Thermal test runs with parts or coupons to verify time at temperature and then lab tests to verify sintering.	TC profiling equipment by GE	N/A
26	TEST METHOD CALIBRATION COUPON	TC's mounted in actual fuel cells	TC profiling equipment by GE	N/A
27	EHS REQUIREMENTS	Meets operator safety requirements. Monitoring of N2 leaks, combustion gases, and NOX may be required. Conveyor front and back sections must have pinch point guarding.	E-stops 2 on each end - N2, N2/H2, and NOX detection N/A. GE to buy separate ambient NOX detector if required	(4) EMO (emergency shutoff switches)
28	FOOTPRINT	5 foot by 20-30 feet flexible for conveyor return, etc. or rotary system - 10 -15 feet outer diameter.	20 feet - maybe 23 feet with forced air. Want forced air secondary cooling.	50"W x 275.5"L
29	DELIVERY	No later than 4TH QTR 2016	Must deliver by year end.	14-16 weeks ARO
30	OPERATING MANUAL	Instructions, drawings, troubleshooting, and tuning information for successful operation and maintenance of the equipment	Format - electronic is acceptable.	Electronic is OK.
31	ENTRANCE AND EXIT LOAD/UNLOAD STATION	24" or 600mm - Minus entrance hoop mounting area.	24" or 600mm	YES
32	DGO	3-Gas, Dual Mode (allows CDA, N2/CDA and FG/N2 operation ). Pipe so GAS2 (N2/CDA) can be supplied to process heating sections and GAS1 (FG) can be supplied to remaining sections.	Valved for N2, FG, CDA for heat section cool section for N2 or CDA	YES. Computer select CDA or N2 or N2/FG.
33	ETHERNET CONNECTIVITY	Wired or wireless	INCLUDE	YES, Wired only
34	EH	Edge heaters to reduce temperature differences across belt	INCLUDE	YES
35	EM	Element monitor system (lamp failure indicator)	INCLUDE	YES, Software Integrated
36	COOLING, WATER	Water cooling after heating sections	INCLUDE	YES, 90 Inches
37	COOLING, FORCED AIR	Air cooling after water cooling section	Post N2 water cooled chamber.	30-INCH Forced Air Cooling

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38	OXYGEN ANALYZER	Analyzer with sample pump	INCLUDE Illinois Instruments EC-913	YES - same as last furnace.
39	OSS	Oxygen sample system	INCLUDE	YES, Software Integrated
40	SSP	Sample Ports	(4) Z1, Z2 Z3 for O2 sampling. Cap and pipe Z4 for GE.	YES, 4 TOTAL
41	INTERFACE ROLLERS	Small diameter rollers and entrance and exit for easy product LOAD and UNLOAD	INCLUDE	YES
42	COMPUTER	Computer interface.	INCLUDE	YES, INDUSTRIAL RACK-MOUNT
43	FLOWMETER SECURITY	Lockable flowmeter compartment	INCLUDE	YES, Lockout
44	UPS	900 to 1000 Watt UPS preferred to eliminate "overload" alarm issues.	Was issue with 1st furnace. Make suitable for furnace load through all phases of operation. Also socket must be suitable for USA plug.	YES, 900-1000 W
45	PARTS CLEARANCE	Height above belt	2 inch throat	YES
46	SMEMA INTERFACE	Signal to upstream and downstream equipment: FURNACE READY, PARTS AVAILABLE	INCLUDE parts counting if possible.	YES, contact closure at ENTR (FURNACE READY) and EXIT (PART AVAILABLE)
47	IR TEMP SENSOR	GE will install IR sensors but we need viewing ports (4) as on 1st furnace. See QUARTZ GLASS PORT below.	NO Sensors needed - just ports.	CONFIRM, NO SENSORS
48	QUARTZ GLASS PORT	PROVIDE PORT FOR IR SENSOR WITH 1/2 INCH QUARTZ ROD (NOT TUBE) THRU INSULATION	INCLUDE (4) 1/2-inch rods.	YES, 1/2" GLASS ROD, Zones 1-4
49	ENTRANCE GAS COLLECTOR	6" Long Entrance Exhaust Pre-hood for NOX and FG fumes. Fit with standard 4" ring for exhaust duct connection.	Add to system like 1st furnace. Should have front baffle, but it must be full length and height of collector box. All baffle bottoms shall be 3/16-1/4 inch above conveyor belt with (5) properly crimped rings or hooks so they don't come off.	YES, WIDER BAFFLE AND WE ARE USING THE RING
50	INDIVIDUAL LAMP ZONE CONTROL	Independent Top and Bottom lamp control by % Power. Temp shall be controlled by zone.	Top/Bottom balance adjustment by power. Again we want to be able to control at 100% bottom lamps only and 100% top lamps only based on our desire for a given cycle.	YES, THE SAME AS SN 2015260
51	DECOMPOSITION CYCLE - STABILITY	For 350C Drying Process must be stable at 35-50 IPM speed to 350 C with individual top/bottom controls (0-100%) and same (0-100%) control by zone.	Test and tune furnace under these conditions.	YES, WILL BE TUNE AT 350 C CONDITION
52	AUTOMATIC SHUTOFF	When machine is put in "Cool Down" mode, gas solenoid should switch to CDA and the oven should begin cool down. At this point, an automatic shutdown mode can be actuated and when the furnace hot zones all fall to below 175C, the furnace shuts off, including conveyor, gas flow, etc.		YES, THE SAME AS SN 2015260
53	WATER COOLING - CHILLER CONNECTIONS	3/4" or 1"NPT connections.		YES
54	FLOW METERS RECESSED	All flowmeters - water chiller and gas flow to be recessed in side machine panels to prevent accidental damage.		YES
55	CABINET VENTILATION	Include cabinet ventilation with fan to discharge to shop environment not to duct work.		10" Dia, 8.5" tall
56	PID Furnace CONTROL	Like current control system but with true derivative control.	Asking for added derivative control. <b>TPS is taking exception on this requirement.</b>	NO, THE SAME AS SN 2015260, no Derivative
57	TREND ANALYSIS ADJUSTMENT	On current software, display limits for all time temperature data have to adjusted for each hot zone TC (1-4). We would like the ability to adjust all 4 zones together to display on same trend graph.	N/A - this has been addressed with "shift" OK on trend screen.	YES, THE SAME AS SN 2015260



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Item	Specification	GE Requirement	Comment	TPSI TF-618 sn 2016286
58	PROCESS GAS HOSES	ParkerFlex hoses used on original furnace were melting at furnace hot zone connections. All hot zone connections should have an 10-12 inch SS tubing lead out of zone and then plumb to PTFE hoses.	Process gas lines must be metal (AL or SS) tubing for 10-12 inches connected to a 6-foot lead of 3/8" dia. Teflon connected to Parkerflex.	YES
59	O2 SAMPLING HOSES	All hot zone connections should have an 9-12 inch SS smooth wall tubing lead out of zones and then plumb with compression fittings to 1/8" PTFE teflon hoses. Lines to O2 sensor to be 1/8" diameter. No brass on sample lines.		Stainless in heated section, teflon to control
60	EXIT FAN COOLING DESIGN	We have currently modified exit air cooling to (8) 230VAC Sofasco axial fans with 8 inch long air flow, mounted crosswise (center) to conveyor travel. 4 fans on top and 4 fans on bottom, tilted slightly toward exit end of furnace.	GE will provide pictures of cooling fan modifications	YES, BASED ON YOUR PICTURES PROVIDED BY GE
61	PLENUM COVERS	Redesign plenum covers to improve seal and eliminate leakage		YES
62	GUARDING. Front and rear conveyor sides and end guarding.	Pinch points on conveyor belt sides and bottom (back end) must be guarded per GE EHS regulations.	Marconi provided example pictures of proper guarding done by TPSI in the past.	YES
63	Software DB transpose.			Can log up to 16 items; giving us a database that is 4 zone temps; 4 bottom power; 4 top power; 1 belt speed; Making a program to transpose database - cannot change set up; will transpose when machine is shut off or every 24 hours + button for instant send
64	Software: Log the power			see item 64
65	Can we get access to code?		Have Michael tell them to have Rick call James	
66	Lamp Failure fix.			Verifying when shutting off cooling
67	45 amp lamp fuses.			Verified
68	Temperature Testing	CP 10, CP 15 (See separate sheet) Does this replicate what we are currently doing? What does the power line look like? Bottom lamps only	Put power limits in? TC in sides of part, 10th part (maybe 12th) Looking for 300-320 part temp	
69	Lift Plug	Need separate place to plug lift motor in, we have to shut the whole furnace down to do maintenance		
70	Saddle on zone barrier			
71	Belt adjustment			Springs removed
72	Cooling fans			Added 2 fans

