

UPC·MARATHON

FurnaceDoctor®-Pro

V2.0

User Manual



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TECHNICAL ASSISTANCE

For all questions or concerns regarding the operation of the **FurnaceDoctor®-Pro V2.0**, please consult the last page of this manual for contact information.



Table of Contents

1	SAFETY	6
2	THEORY	7
2.1	Why Infrared?.....	7
2.2	Endothermic Atmosphere	7
2.3	How Can the FurnaceDoctor®-Pro Help Me with My Generator?	8
2.4	So How Can the FurnaceDoctor®-Pro Help?	9
2.5	How Will the FurnaceDoctor®-Pro Help Me with My Furnace Atmosphere?	10
3	OPERATIONS.....	11
3.1	Precautions Before Operations:.....	11
3.2	User Manual Specifics.....	11
3.3	Sample Gas	11
3.4	Particles	12
3.5	Humidity	12
3.6	Liquids.....	13
3.7	Entrained Oil	13
3.8	Gas Sampling Ports	13
4	INITIALIZING THE ANALYZER.....	15
4.1	Connecting the Gas Lines	15
4.2	Default Display	18
5	THE MENU SYSTEM.....	19
5.1	Accessing the Main Menu Screen	19
5.2	Main Menu Available Options.....	20
6	I/R Gas Values	21
6.1	Selecting the Dew point, Calculation Modes.....	21
6.2	Furnace Mode Selection.....	22
6.3	Generator Mode Selection.....	24
6.4	ENDO and EXO Selection.....	25
6.6	Data Logging Preparation.....	26
6.7	Enter Log I.D.	27
6.8	Enter Log File Name	28



6.9	Enter Data Log Interval	29
6.10	Enter Additional Comments	31
6.11	Insert USB Stick.....	33
6.12	Start Data Logging	34
6.13	Stop Data Logging	36
7	View Chart Icon	39
7.1	Stand Alone Chart Viewer	39
7.2	Viewing Log Files	40
8	CALIBRATION.....	41
8.1	Gas Requirements	41
8.2	Calibration: Span Gas Verification.....	42
8.3	To Begin Calibration.....	42
8.4	Starting Calibration.....	46
8.5	Zero Calibration.....	46
8.6	Span Calibration.....	50
8.7	Restoring Factory Calibration	52
9	PROCESS CALCULATOR.....	54
9.1	Accessing the Process Calculator	54
9.2	Calculation Method Set to: Options	58
10	UTILITIES	59
10.1	Utilities Configurable Options.....	59
10.2	Date and Time	60
10.3	Configure I/R Screen	62
10.4	Configure I/R Screen, Page 1 Options Include.....	63
10.5	Carrier Gas Selection Options	64
10.6	Please Select Carrier Gas	64
10.7	Configure I/R Screen, Page 2 Options Include.....	66
10.8	Generator Mode Process Temperature.....	67
10.9	Gas Generator Selection	68
10.10	Configure I/R Screen, Page 3 Options Include.....	70
11	BATTERY CHARGER	71
11.1	What's Included?	71
11.2	Charging.....	72



12	ETHERNET SETUP	72
12.1	Accessing the Ethernet Setup	72
13	VNC Viewer	75
13.1	What is VNC Viewer?	75
13.2	Example.....	75
14	General Maintenance	77
14.1	Inspecting and Replacing the Filter	77
15	TROUBLESHOOTING.....	82
15.1	How Can I Use the FurnaceDoctor®-Pro to Troubleshoot the Furnace?	82
15.2	How Do I Interpret the Gas Values?.....	83
16	Frequently Asked Questions (FAQs).....	84
17	EQUIPMENT RATINGS.....	85
18	SPARE PARTS.....	86
19	CUSTOMER SUPPORT	87



1 SAFETY

****CAUTION****

Make sure the exhaust of the
FurnaceDoctor®-Pro is properly vented

****WARNING****

DO NOT CLOSE LID with CHARGER IN
THE STORAGE POUCH

SCREEN CAN BE DAMAGED

NOT COVERED BY WARRANTY

Please read the instructions before operating the instrument.

This instrument complies with accepted industrial safety standards.

Do NOT operate this instrument with the internal top cover removed.



2 THEORY

2.1 Why Infrared?

Your new FurnaceDoctor®-Pro enhances process measurement methods and is an invaluable troubleshooting tool. It also assures your customer that you can verify the process and your existing oxygen probe. It not only answers the question “is that probe really working?” It confirms that the gases in your process are within specification.

In cases of excess methane, the oxygen probe and the carbon calculation derived from it can present misleading information. In situations like this I/R analysis is invaluable.

Whatever your reasons, the use of I/R analysis, and the FurnaceDoctor®-Pro will satisfy these requirements.

Since most FurnaceDoctor®-Pro owners are either performing gas carburizing, or neutral hardening in an endothermic atmosphere, or verifying exothermic atmospheres. The following discussion will explain the meaning of the measured values.

2.2 Endothermic Atmosphere

Endothermic atmospheres in use for these applications have this basic composition:

CO $\cong$ 20%	(carbon monoxide)
H ₂ $\cong$ 40%	(hydrogen)
CO ₂ $\cong$ Trace	(carbon dioxide)
CH ₄ $\cong$ Trace	(methane, usually from natural gas)
O ₂ $\cong$ Trace	(oxygen)
H ₂ O $\cong$ Trace	(water vapor)
N ₂ = Balance	(nitrogen)

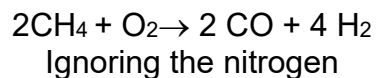
These ratios are typical whether you are producing gas by means of an endothermic generator or using prepared gasses such as nitrogen and methanol. Ratios are slightly different if propane is used rather than methane for the carrier gas.

Obviously, any increase in volume in one of the gasses means a decrease in one or more of the other gasses. We often get asked the question “Why is my generator producing 20% CO, but I am only measuring 17% at my furnace?” “It is even lower when I add ammonia!” One part of the answer to this question is simple volumetric displacement. There is only room in the furnace for 100% of the atmosphere!



2.3 How Can the FurnaceDoctor®-Pro Help Me with My Generator?

The basic chemical reaction taking place in an endothermic generator is as follows:
Remember you are mixing gas and air together, heating it up, and passing these gases



through a nickel catalyst to produce the above described gas composition. The reaction takes place in two stages:

- First some of the methane burns with air and makes heat. The by-products of this combustion are H₂O (water vapor), and CO₂.
- In the second stage, the remaining methane reacts with the CO₂, and H₂O. It becomes obvious that we want this reaction to be as complete as possible.

This is the reason for the nickel catalyst in the generator.

If the main air gas ratio is set somewhere between 2.7 and 2.85 parts air to 1-part gas, there are two considerations:

- The catalyst must be clean, and free from soot. If soot is present, the efficiency of the above reactions goes down.
- You must have adequate temperature to keep the rate of the reactions high enough.

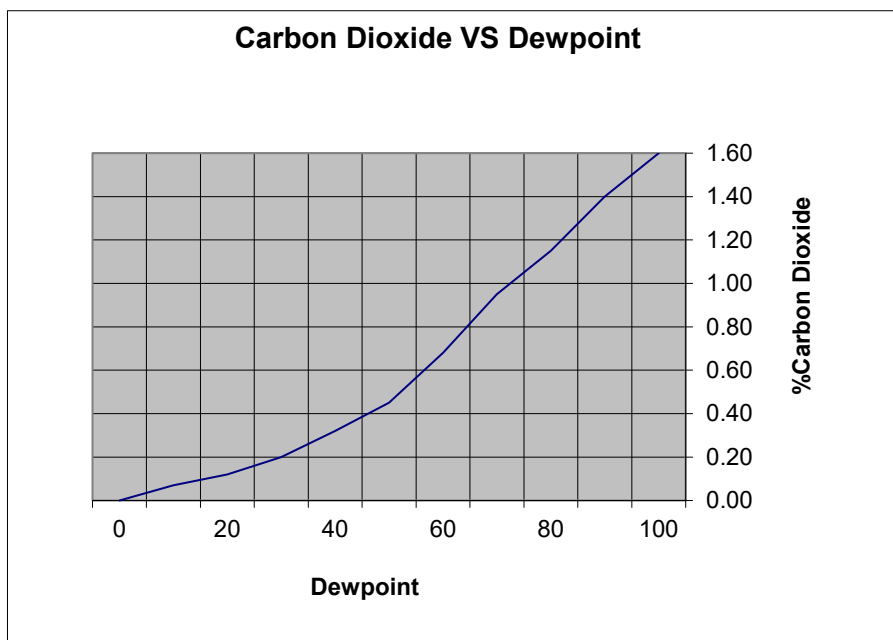


2.4 So How Can the FurnaceDoctor®-Pro Help?

First, by measuring the generator's methane content you can determine whether the catalyst is operating efficiently. .8% CH₄ is generally the upper limit. Above this level, it is possible that the catalyst is laden with soot, or the catalyst is simply spent. Another indication of this condition would be a high CO₂, or dew point. The FurnaceDoctor®-Pro provides a convenient way to obtain dew point, CO, CO₂, and CH₄.

Check to see that the basic gas composition is as expected.

- CO should be around 20%.
- Check the CH₄ level and be sure that it is less than .8%.
- Observe the CO₂, and the dew point readings. Note the relationship between dew point, and CO₂.



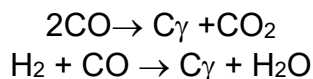
To obtain the desired dew point, adjustments are made to either your oxygen probe control system, or the generator carburetor.



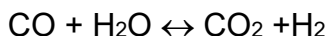
2.5 How Will the FurnaceDoctor®-Pro Help Me with My Furnace Atmosphere?

If you are using oxygen probes, the FurnaceDoctor®-Pro provides an independent, traceable verification of your probes accuracy. It will also give you a more complete picture of what is happening in your furnace atmosphere.

The primary reactions involved in carbon transfer are:



These reactions are assumed to be close to equilibrium. The theory behind this is that a reaction sometimes called the water-gas reaction, is busy keeping the H_2 and O_2 in balance:



The measurement of % Carbon in your atmosphere with an oxygen probe is based on the assumption that the above is true.



Note that it is assumed that the primary mechanism of carbon transfer is CO dependent.

What is really happening is that the ratio of CO to CO_2 is a much more accurate means of determining equilibrium carbon.

One potential problem is when CH_4 is used as an enriching gas, once it enters the furnace, it decomposes - mostly near the hot catalytic surfaces in your furnace.

It may be replenishing depleted CO, based on equilibrium “rules”, it may be making soot crumbs on your hearth, or it may be reacting directly with the surface of the material:



How much of the above reaction is happening is dependent on many variables, but primarily, how much methane is present in your furnace. This reaction also happens faster at higher temperatures but is still slow compared to the equilibrium reactions.

For example; at 1600 with an equilibrium carbon potential of .4%, and methane content of .5 the theoretical carbon potential is 0.44%. In reality, the effect is usually about 6/10 of what the theoretical calculations deliver making the carbon potential closer to .42%. By contrast if we were to increase the methane content to 5%, the actual carbon potential might be closer to .6%, a significant difference!



Whether the work really ends up seeing this is dependent on several variables – governing the rate of reaction, the surface area of the work and the level of saturation at the surface, atmosphere circulation, etc.

3 OPERATIONS

3.1 Precautions Before Operations:

- Dew point of sampling gas must be lower than the ambient temperature to avoid water contamination in the gas analyzer. If vapor is contained in the sampling gas, dew point should be lowered to 0°C. Add a desiccant filter to the gas sample line if this is a problem.
- Temperature of sampling gas should be within 0 to 50°C. Provide a means that prevents entry of hot gas directly into the instrument.
- Absolute pressure of sampling gas should be 926 – 1024 mBar. Avoid flow or pressure fluctuation during measurement. Observe the flow reading by viewing the provided flowmeter.
- Avoid installing this instrument near an electrical unit (high frequency furnace or electric welder) that generates electrical noise.
- Allow 20 minutes warm-up for stabilized readings.

3.2 User Manual Specifics

The User Manual has been created with a customer focus in mind. Certain aspects of various sections have been designed specifically to provide the user with a visual indication of technical functions of the various screens. UPC Inc. has developed a color-coded system of identification in order to assist the technician while interfacing with the FurnaceDoctor®-Pro.

The associated Color-Code key is as follows:

- Yellow highlighting indicates a reference location on the screen
- Green highlighting indicates a specific implemented change
- Red highlighting indicates that a user touch, or parameter entry is required

3.3 Sample Gas



The condition of the sample must conform to the following requirements to ensure that the performance of the product meets the stated technical specification. Contamination in the sample cell, particularly on the internal cell windows, will cause an error in gas readings.

Avoid degradation of the sample gas between the sample point and the sensor. Eliminate any large volumes (filters) or restrictions.

Avoid sampling when large transients in the operation can occur. These can cause pressure variations.

Maintain constant flow conditions.

Avoid the use of rubber compounds for the sample tubing (adsorption effects).

3.4 **Particles**

The gas to be measured must be well filtered. 100 % of 3 µm particles must be retained. The analyzer has a large built in pre-filter. Check this filter before use, or at minimum once per week. See section 16 “General Maintenance for filter maintenance.

Inspect the large pre-filter in the analyzer at least once a week. Verifying that the filter is clean is the single most important maintenance check you can perform to protect your investment and extend the operating life of the analyzer.

3.5 **Humidity**

Moisture in the gas must be adequately reduced. This means that the dew point of the gas must be below the operating temperature of the FURNACEDOCTOR®-PRO. No moisture can then condense in the IR benches.



3.6 Liquids

The sample gas must be free of any liquid.

3.7 Entrained Oil

The sample gas must be free of any contamination.

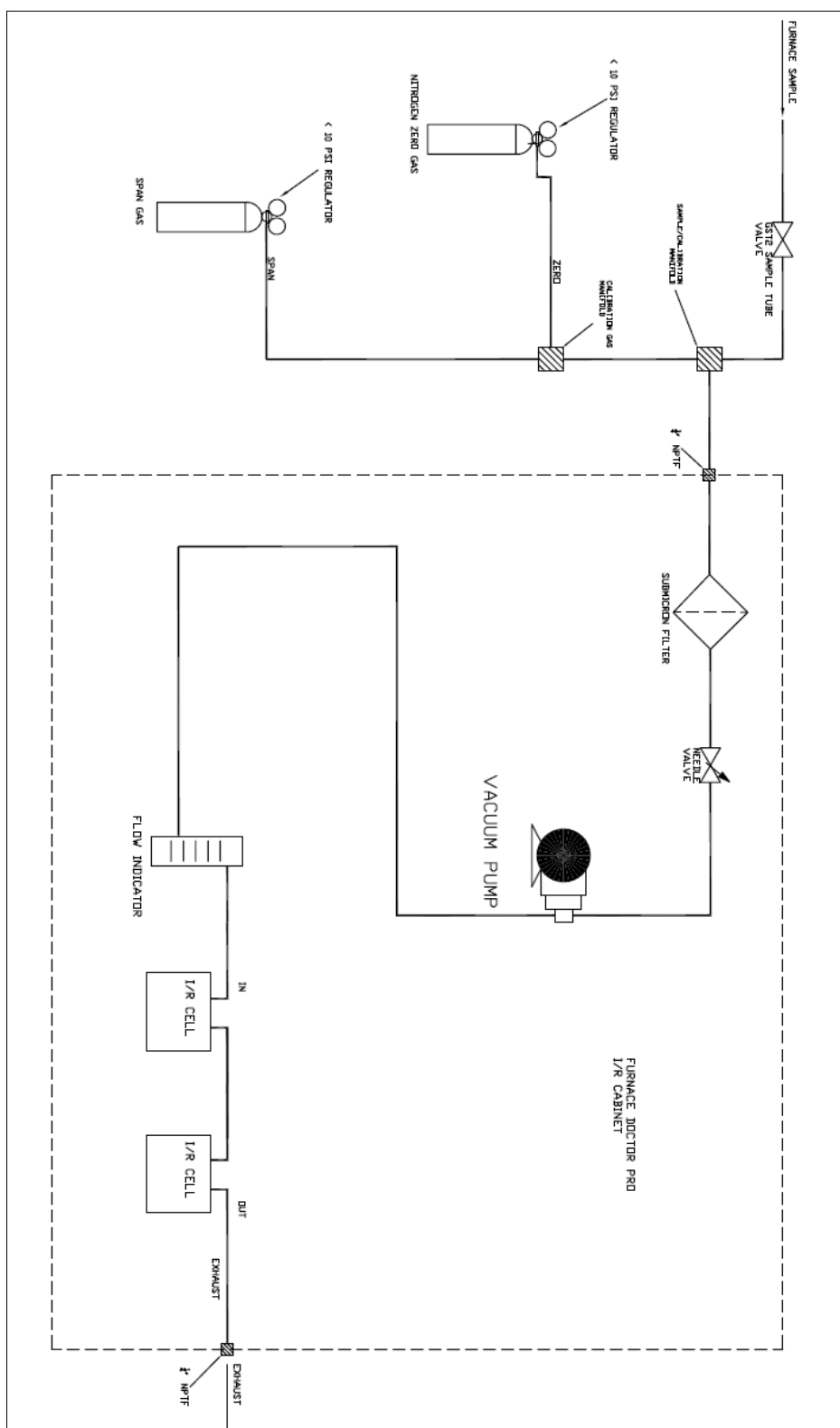
3.8 Gas Sampling Ports

In a large percentage of heat treating environments, we have found that the gas sample ports are either plugged or leaking. Even if you can see into the port, and it appears unobstructed, the port may leak somewhere behind the hot face of the refractory. This may cause the sample to be drawn from between the brick, and the furnace shell, or even outside of the furnace.

It is also necessary to keep the sample velocity high to quickly stabilize the CO₂.

For this reason, we strongly recommend the use of a ceramic sample probe like the UPC GST1-23-0.50 Sampling Tube. This will penetrate the furnace wall at least 2" past the hot face of the refractory.

If you are unable to use a non-metallic probe and you are getting numbers that are not making sense (i.e. extremely low CO values or high CO₂) then try taking a sample from the oxygen probe burn-off port (not the reference airport). ***Only use this method if no other working port is available. This method will affect the probe reading.***



4 INITIALIZING THE ANALYZER

***** **CAUTION** *****

4.1 Connecting the Gas Lines

Connect one end of the sample tube to the analyzer inlet. Connect the other end to the furnace sample port. Do not connect to a port with a lamb's wool, or angel hair filter already installed.

Be sure to properly vent exhaust!

We strongly recommend a small diameter ($\frac{1}{2}$ " id or less), ceramic sample tube that can be inserted at least 2" past the refractory wall hot face to ensure an accurate sample.



Sample Tube Connection

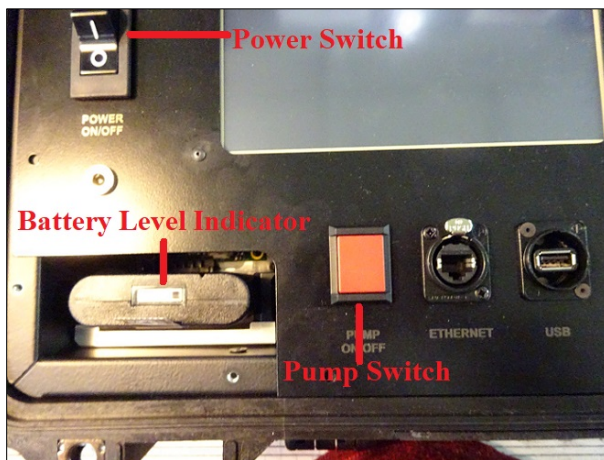


Exhaust Port Connection

Turn on the power switch. Apply power to the analyzer for at least 20 minutes to allow the IR cell temperature to stabilize. Depress the Pump button to start sampling.



Your FurnaceDoctor®-Pro is equipped with a battery monitor. When a battery level monitor is low, it is time to charge your FurnaceDoctor®-Pro.



Battery Level Indicator

The default “I/R Gas Values” screen will illuminate, and pressing the Pump ON/OFF switch will initialize the internal pump.

Manual entry fields are in white with orange borders, live and calculated fields are in white. Characteristic Fields are gray.

The screenshot shows the default screen of the FurnaceDoctor-Pro. The title bar includes the logo and 'FurnaceDoctor®-Pro' on the left, and 'www.group-upc.com' on the right. The screen is divided into two main columns of data fields. The left column contains: CO [%] (-0.0), CO2 [%] (-0.032), CH4 [%] (***), H2 [%] (40), a temperature field set to 9F (1,700), Alloy Factor [%] (100), CH4 Factor [%] (65.0), and a 'Furnace Mode' field with a 'Change' button. The right column contains: C [%] (***), C+CH4 [%] (***), O2 [mV] (***), DPT [°F] (***), a 'Logging: OFF' status with a 'Change' button, and a 'Main Menu' button at the bottom. A '***' indicator is also present below the logging status.

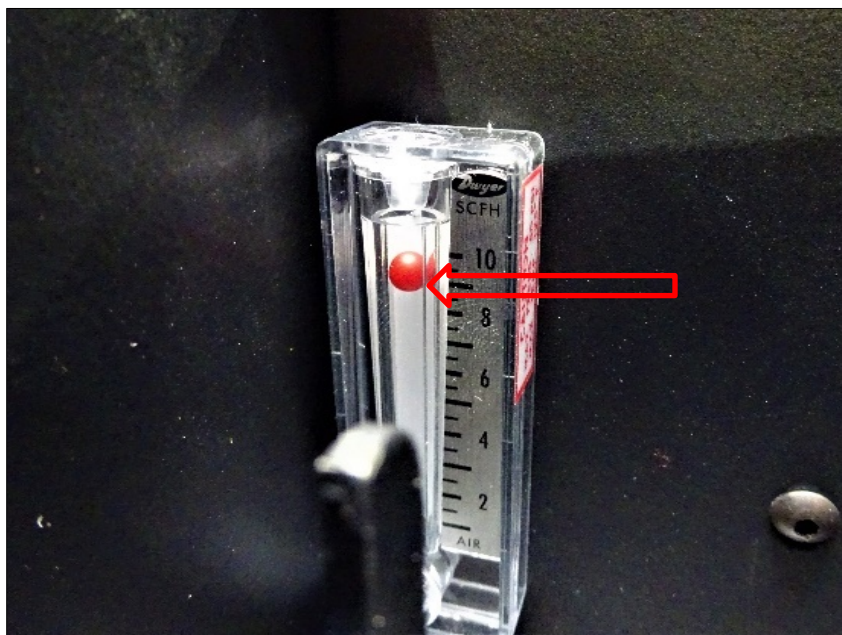
Field	Value
CO [%]	-0.0
CO2 [%]	-0.032
CH4 [%]	***
H2 [%]	40
Temperature [°F]	1,700
Alloy Factor [%]	100
CH4 Factor [%]	65.0
Furnace Mode	Change
C [%]	***
C+CH4 [%]	***
O2 [mV]	***
DPT [°F]	***
Logging	OFF
Change	Change

Main Menu	Main Menu

Default Screen

After 30 seconds gas values will be measured and displayed.

Ensure that sample flow is adequate. If you are sampling a generator keep the flow rate below 10 SCFH so you do not compress the gas, this can lead to inaccurate readings.



Flowmeter at ≤ 9 SCFH

Measurement begins approximately 1 min after start-up and is continuous after the process temperature is entered. The unit will not correctly display O₂ [mV], Carbon, or Dewpoint until temperature is entered. The display shows the measured CO, CO₂, CH₄ values and calculated theoretical carbon and dewpoint and expected sensor millivolts.

These calculated values are only valid if the actual process temperature is manually entered.

4.2 Default Display

The instrument's default display is the I/R Gas Values screen. The carbon, dewpoint for the measured CO, CO₂, CH₄ gasses and entered probe temperature can be viewed here. Additionally, it displays calculated probe millivolts.

FurnaceDoctor®-Pro		www.group-upc.com	
CO [%]	25.0	C [%]	0.22
CO2 [%]	0.954	C+CH4 [%]	0.60
CH4 [%]	10.00	O2 [mV]	1,050
H2 [%]	40	DPT [°F]	66
°F	1,700	Logging: OFF	Change
Alloy Factor [%]	100	***	
CH4 Factor [%]	65.0	Main Menu	
Furnace Mode	Change		
Endo Mode	Change		

Default Display I/R Gas Values

The instrument will take at least 20 minutes from a cold start to display any meaningful information. Ensure that sample flow is adequate!

5 THE MENU SYSTEM

5.1 Accessing the Main Menu Screen

The instruments default display is the I/R Gas Values screen.

FurnaceDoctor®-Pro		www.group-upc.com	
CO [%]	24.9	C [%]	0.20
CO2 [%]	1.057	C+CH4 [%]	0.59
CH4 [%]	10.36	O2 [mV]	1,044
		DPT [°F]	69
H2 [%]	40	Logging: OFF	Change
°F	1,700	***	
Alloy Factor [%]	100		
CH4 Factor [%]	65.0		
Furnace Mode	Change	Main Menu	

“System Default Screen”

Touching the “Main Menu” button on the “System Default Screen” will take you to the system main menu screen.



“System Main Menu Screen”



5.2 Main Menu Available Options

The following options are available from the Main Menu Screen:

- **I/R Gas values** – This is the display that you see when the instrument is first powered up. Data includes CO, CO₂, CH₄, and user entered temperature. Based on the temperature entry the CP%, C%, C+CH₄%, sensor mV, and dew point are determined in the “Configure I/R Screen”. The checked items will be displayed and logged.
- **View Chart** – Allows the user to view internally stored data on a graphical chart
- **Calibration** – This option allows you to calibrate the instrument to certified grade gasses
- **Proc Calc** – Allows you to enter temperature, oxygen probe millivolts or CO, CO₂, CH₄, H₂, Alloy Factor, and CH₄ Factor to compute carbon potential and dew point. You can also enter the dew point and temperature to compute the above.
- **Utilities** - This allows you to calibrate the touch screen, set the date and time, configure the I/R Gas Values screen, update firmware, review and reset accumulated runtime counter, and set factory calibration reminder. This page is password protected.
- **About** - tells about software version, customer support and the members of United Process Controls.

6 I/R Gas Values

6.1 Selecting the Dew point, Calculation Modes

If your display is not already on its default (I/R Gas Values) screen, then this can be accomplished by selecting the “I/R Gas Values” Icon from the Main Menu Screen.



Main Menu Screen

The instrument will compute dew point using either a temperature-based calculation, used when measuring furnace atmospheres where you can identify the process temperature, or a simplified table look up method based on CO₂ to be used when measuring the dew point of endothermic generators.



6.2 Furnace Mode Selection

“Furnace Mode” dew point calculation can be selected by touching the “Change” button to the right of the “Furnace Mode” field for measuring your endothermic generator.

H2 [%]	40
°F	1,700
Alloy Factor [%]	100
CH4 Factor [%]	65.0
Furnace Mode	Change

Furnace Mode Selection

The “Furnace Mode” process temperature can be manually entered by touching the numerical entry button “1,700”.

H2 [%]	40
°F	1,700
Alloy Factor [%]	100
CH4 Factor [%]	65.0
Furnace Mode	Change

Numerical Entry Button

Upon touching the numerical entry button, a keyboard will appear on the display which will allow the process temperature to be manually entered. Enter the numerical value, then touch Ok.



1,700 [Enter a value between 760 & 2,500]

1	2	3	4	5	6	7	8	9	0
Q	W	E	R	T	Y	U	I	O	P
A	S	D	F	G	H	J	K	L	Back
Z	X	C	V	B	N	M	.	-	Clear

Ok Cancel

Keyboard Entry for Process Temp

Dew Point calculations for endothermic conditions are only valid for temperatures of 1900 °F/ 1038 °C or less.



6.3 Generator Mode Selection

To select the “Generator Mode” dew point calculation method, touch the “Change” button to the right of the “Furnace Mode” field.

H2 [%]	40
°F	1,700
Alloy Factor [%]	100
CH4 Factor [%]	65.0
Furnace Mode	Change

Furnace Mode Change

If you have the Generator Mode selected, it is not necessary to enter a process temperature as the default value is 1680.

H2 [%]	40
°F	1,680
Alloy Factor [%]	100
CH4 Factor [%]	65.0
Generator Mode	Change

Generator Mode Change



If “Generator Mode” is selected, the correct carrier gas for your process must also be selected. Please refer to the Utilities Section 8.6 of this user manual for instructions on selecting the carrier gas.

6.4 ENDO and EXO Selection

If ENDO and EXO Gas has been selected under the Utilities Icon Page 2 Tab, then ENDO or EXO mode must be selected via the I/R Gas Values Screen.

The screenshot shows the 'I/R Gas Values' screen in the FurnaceDoctor®-Pro application. The interface is divided into two main columns. The left column contains fields for CO [%] (0.0), CO2 [%] (0.028), CH4 [%] (-0.00), H2 [%] (40), a temperature field set to 1,700 °F, Alloy Factor [%] (100), CH4 Factor [%] (65.0), and a 'Furnace Mode' field with a 'Change' button. The 'Endo Mode' field is highlighted with a yellow box, and its 'Change' button is highlighted with a red box. The right column contains fields for C [%] (***), C+CH4 [%] (***), O2 [mV] (***), DPT [°F] (***), a 'Logging: OFF' status with a 'Change' button, and a 'Main Menu' button at the bottom.

“ENDO Change”

To change from ENDO to EXO touch the Change button to the right of the “ENDO” or “EXO Field”. Touching the change button will switch between the 2 modes.

The screenshot shows the 'I/R Gas Values' screen in the FurnaceDoctor®-Pro application, identical to the previous one but with 'Exo Mode' selected. The 'Exo Mode' field is highlighted with a green box, and its 'Change' button is highlighted with a red box. The values for CO2 [%] (0.010) and CH4 [%] (-0.01) have changed from the previous screen.

“EXO Change”

6.5 Data Logging Preparation

From the I/R Gas Values Screen, locate and touch the “Change” button to the left of the Logging: On/Off Selection field.

FurnaceDoctor®-Pro		www.group-upc.com	
CO [%]	11.5	C [%]	0.28
CO2 [%]	0.178	C+CH4 [%]	0.47
CH4 [%]	3.19	O2 [mV]	1,100
H2 [%]	40	DPT [°F]	41
°F	1,700	Logging: OFF	Change
Alloy Factor [%]	100	***	
CH4 Factor [%]	65.0	Main Menu	
Furnace Mode	Change		

Logging On/Off Button

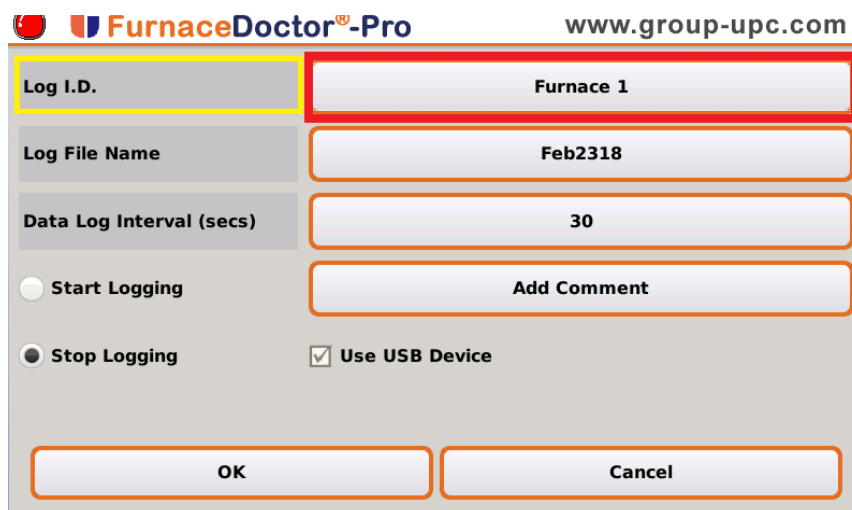
Touching the Logging: On/Off “Change” button will result in the following Data Log Identification Screen being displayed.

FurnaceDoctor®-Pro		www.group-upc.com	
Log I.D.	Furnace 1		
Log File Name	Feb2318		
Data Log Interval (secs)	30		
☐ Start Logging	Add Comment		
☒ Stop Logging	☒ Use USB Device		
OK	Cancel		

“Log ID Screen”

6.6 Enter Log I.D.

To enter the Log I.D. simply touch the “Log I.D.” field.



The screenshot shows the FurnaceDoctor®-Pro interface. The 'Log I.D.' field is highlighted with a yellow box and contains the text 'Furnace 1'. Below it are fields for 'Log File Name' (Feb2318), 'Data Log Interval (secs)' (30), and a section for logging settings with radio buttons for 'Start Logging' and 'Stop Logging', a checkbox for 'Use USB Device', and an 'Add Comment' button. At the bottom are 'OK' and 'Cancel' buttons.

“Log ID Field”

The Log I.D. field allows you to enter an identifier that will be automatically logged with the I/R data.

For example; you may identify the log file by typing “Furnace 1” in the second line of the keyboard screen, then touch Ok in the bottom left corner of the screen.



The screenshot shows the 'Log I.D. Entry' screen. It features a numeric keypad (0-9) and an alphanumeric keypad (QWERTY). The input field contains 'Furnace 1'. At the bottom, there are 'Ok' and 'Cancel' buttons. The 'Ok' button is highlighted with a red box.

“Log ID Entry”



Notice that the Log I.D. Field has changed in accordance with the text that was entered using the keyboard for Log I.D. entry

The screenshot shows the FurnaceDoctor®-Pro interface with the following elements:

- Header: FurnaceDoctor®-Pro logo and www.group-upc.com
- Log I.D. field: Highlighted in yellow, containing "Furnace 1" (highlighted in green).
- Log File Name field: Highlighted in yellow, containing "File Name" (highlighted in green).
- Data Log Interval (secs): 30
- Start Logging: Unchecked radio button.
- Stop Logging: Checked radio button.
- Use USB Device: Checked checkbox.
- Add Comment: Button.
- OK and Cancel: Bottom buttons.

"Furnace 1 Entry"

6.7 Enter Log File Name

Touch the "Log File Name" field button.

The screenshot shows the FurnaceDoctor®-Pro interface with the following elements:

- Header: FurnaceDoctor®-Pro logo and www.group-upc.com
- Log I.D. field: Contains "Furnace 1".
- Log File Name field: Highlighted in yellow, containing "File Name" (highlighted in red).
- Data Log Interval (secs): 30
- Start Logging: Unchecked radio button.
- Stop Logging: Checked radio button.
- Use USB Device: Checked checkbox.
- Add Comment: Button.
- OK and Cancel: Bottom buttons.

"Log Filename Selection"

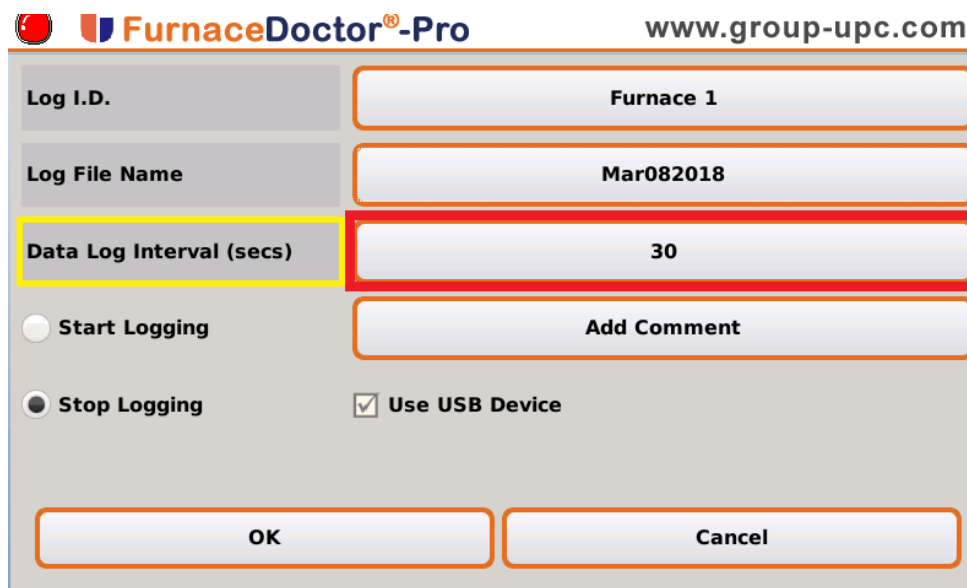
Enter the Filename of your choosing, using the Log Filename keyboard entry screen, then touch "Ok" in the bottom left corner of the screen.



“Log File Name Entry”

6.8 Enter Data Log Interval

The “Data Log Interval should be selected next, by touching the orange box to the right of the “Data Log Interval (secs)” field.



“Data Log Interval” Selection

Data Log Interval has been designed to record data points based on the numerical value in seconds entered in this field. Interval range is from 30 – 3600 Seconds.



In the image above, a snap-shot of data will be captured every 30 seconds.

Alternatively, if a value of 60 is entered in this field then a snap-shot of data will be captured every minute or once every 60 seconds.

Enter the numerical value in the Data Log Interval (secs) screen that represents the time in seconds that data samples will be captured, then touch “Ok”.

30 [Enter a value between 30 & 3,600]

60

1 2 3 4 5 6 7 8 9 0

Q W E R T Y U I O P

A S D F G H J K L Back

Z X C V B N M . - Clear

Ok Cancel

“Data Interval” Entry Screen



6.9 Enter Additional Comments

The “Add Comment” field has been added to allow the operator the ability to annotate any pertinent details to the Data Log file.

Touch the “Add Comment” button to bring up the add comments entry screen.

The screenshot shows the FurnaceDoctor®-Pro settings screen. At the top, there is a logo and the text 'FurnaceDoctor®-Pro' and 'www.group-upc.com'. Below this, there are several input fields: 'Log I.D.' with the value 'Furnace 1', 'Log File Name' with the value 'Mar082018', and 'Data Log Interval (secs)' with the value '60'. There are two radio buttons: 'Start Logging' (unselected) and 'Stop Logging' (selected). A checkbox labeled 'Use USB Device' is checked. The 'Add Comment' button is highlighted with a red rectangle. At the bottom, there are 'OK' and 'Cancel' buttons.

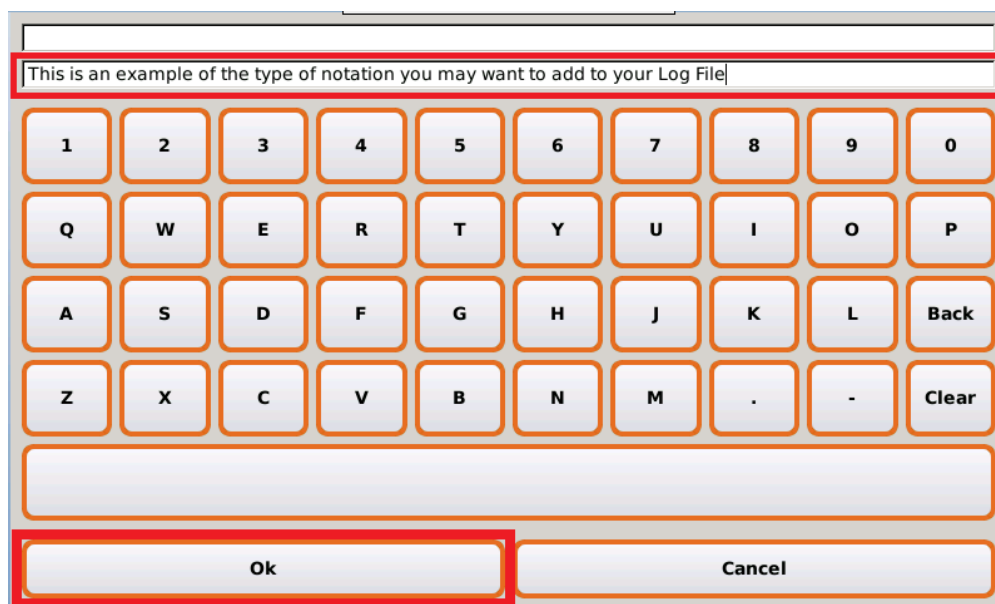
“Add Comment” Button

Touch the “Enter Text” button.

The screenshot shows the 'Enter Text' screen. At the top, there is a logo and the text 'FurnaceDoctor®-Pro' and 'www.group-upc.com'. Below this, there is a large text input area. At the bottom, there are two buttons: 'Current' and 'Select'. A 'Close' button is at the very bottom.

“Enter Text” Button

Here you can add any special notes pertaining to the Data Log. First enter text, then touch Ok.



“Add Comment” Keyboard Screen

Notice that the entered text is now being displayed in the “Notes” field on the “Add Comments” screen. Touch the Close button at the bottom of the screen.



“Add Comment” Close Button

The Data Log I.D. screen will appear reflecting the changes that were entered in sections 6.4 – 6.8 above, Touch Ok.

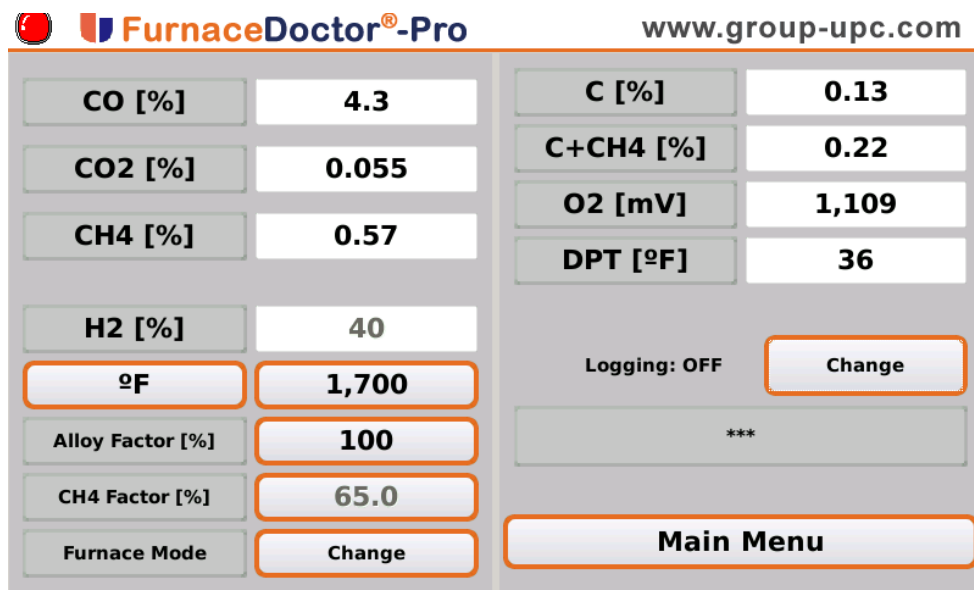


The dialog box is titled "FurnaceDoctor®-Pro" and "www.group-upc.com". It contains the following fields and controls:

- Log I.D.:** A text box containing "Furnace 1".
- Log File Name:** A text box containing "Mar082018".
- Data Log Interval (secs):** A text box containing "60".
- Add Comment:** A text box containing "Add Comment".
- Start Logging:** A radio button.
- Stop Logging:** A radio button.
- Use USB Device:** A checked checkbox.
- OK:** A button highlighted with a red border.
- Cancel:** A button.

Data Log I.D. Reflected Changes

You will be returned to the Default Screen (Gas IR Values).



The default screen displays various gas IR values and controls. The layout is as follows:

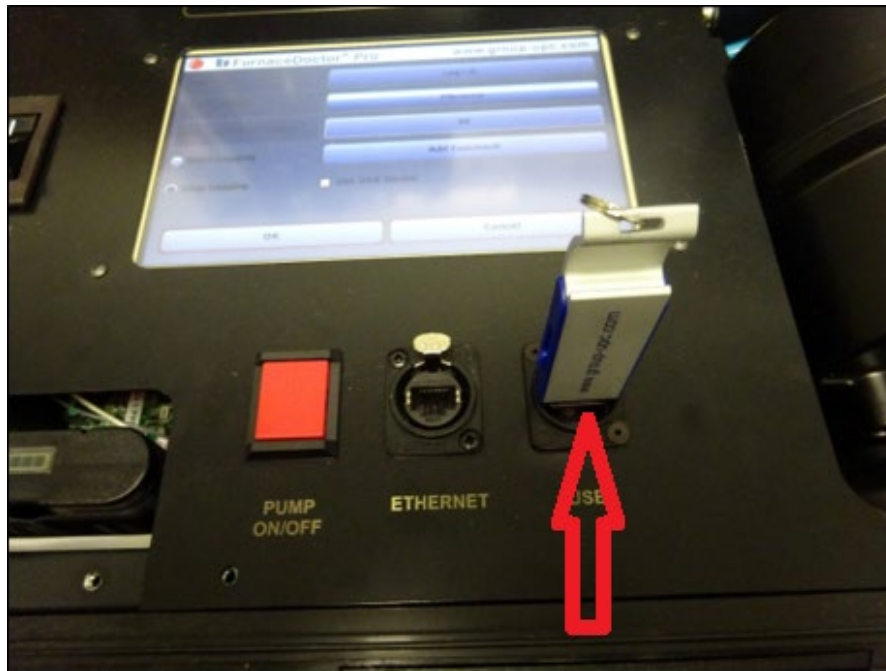
FurnaceDoctor®-Pro		www.group-upc.com	
CO [%]	4.3	C [%]	0.13
CO2 [%]	0.055	C+CH4 [%]	0.22
CH4 [%]	0.57	O2 [mV]	1,109
		DPT [°F]	36
H2 [%]	40		
°F	1,700	Logging: OFF	Change
Alloy Factor [%]	100	***	
CH4 Factor [%]	65.0		
Furnace Mode	Change	Main Menu	

Default Screen

6.10 Insert USB Stick



To start data logging insert the factory configured CQI9 compliant USB flash drive in to the top of the FurnaceDoctor®-Pro. The Furnace Doctor Firmware Update Procedure has been included and is on the USB stick provided with your purchase.



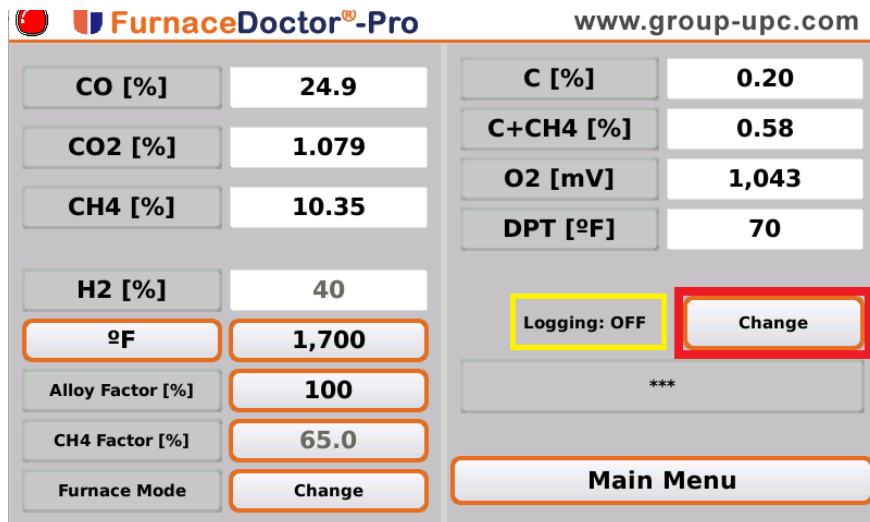
Insert USB Stick

Compatible USB FLASH Memory Sticks:

- | | |
|-------------------------|---------------------------|
| • Dane Electric | (DA-ZMP-02G-CA-W1-R) |
| • PQI Mr. Flash U172 | (Model # BB55-B1G3-0221) |
| • Corsair | (Model # CMFUSBSF2.0-128) |
| • Viking Interworks | (Model # USB00256L2) |
| • Kingston DataTraveler | (Model # DTI/1GBKR) |
| • PNY Technologies | (Attaché 256 or 512) |
| • Lexar JumpDrive | |
| • Viking | (Model # USB0032L) |
| • Sony | (Model # Microvault) |
| • Dell | (Model # Memory Key) |

6.11 Start Data Logging

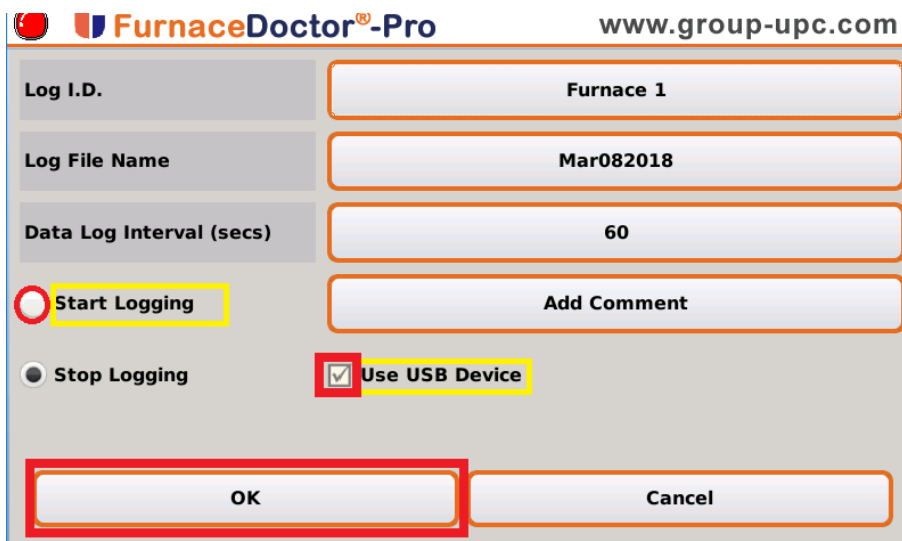
Upon start-up the Furnace Doctor Pro will display, by default, the I/R Gas Values Screen. Locate the “Logging: OFF” field and touch the “Change” button to the right.



The screenshot shows the main menu of the FurnaceDoctor®-Pro application. The interface is divided into two columns. The left column displays various gas and temperature readings: CO [%] (24.9), CO2 [%] (1.079), CH4 [%] (10.35), H2 [%] (40), °F (1,700), Alloy Factor [%] (100), CH4 Factor [%] (65.0), and Furnace Mode (Change). The right column displays: C [%] (0.20), C+CH4 [%] (0.58), O2 [mV] (1,043), DPT [°F] (70), and a 'Logging: OFF' status with a 'Change' button. A 'Main Menu' button is located at the bottom right. The website address 'www.group-upc.com' is displayed in the top right corner.

“Default Screen” = I/R Gas Values

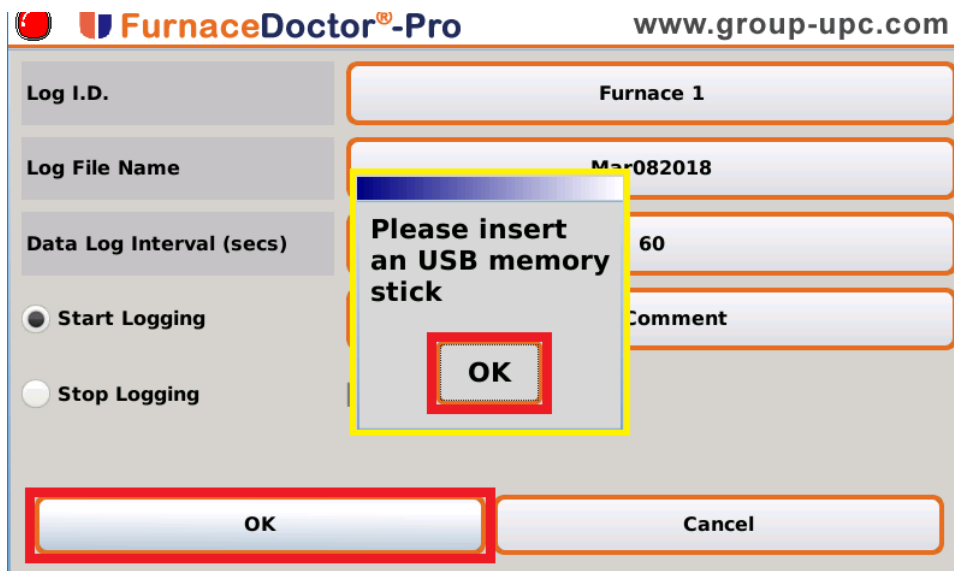
Locate the “Use USB” field and touch the small “Change” button to the left., then touch the circle to the left of the “Start Logging” text, and finally touch Ok.



The screenshot shows the logging settings screen of the FurnaceDoctor®-Pro application. The interface includes fields for 'Log I.D.' (Furnace 1), 'Log File Name' (Mar082018), and 'Data Log Interval (secs)' (60). There are radio buttons for 'Start Logging' (selected) and 'Stop Logging'. A 'Use USB Device' checkbox is checked. An 'Add Comment' field is also present. At the bottom, there are 'OK' and 'Cancel' buttons. The website address 'www.group-upc.com' is displayed in the top right corner.

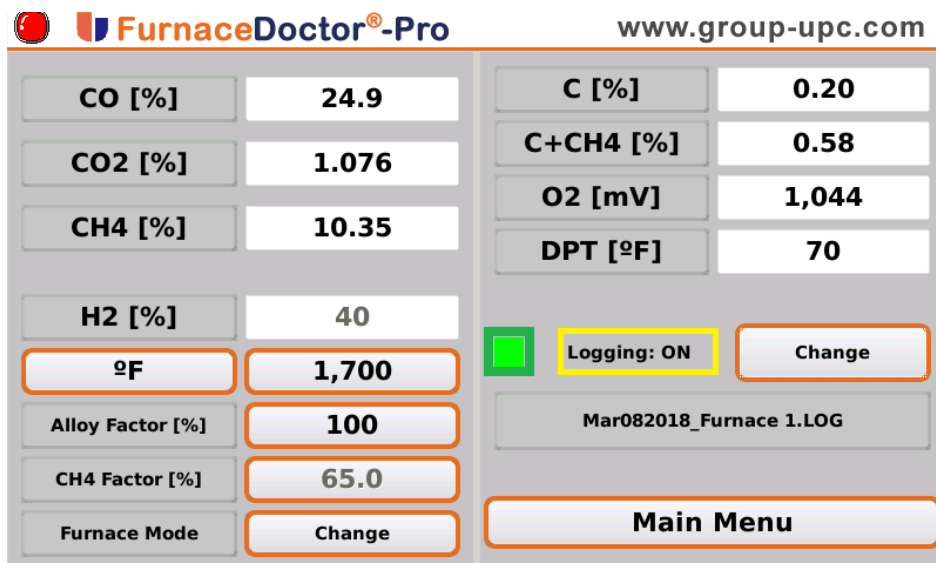
Touch the “Use USB Device” Button

You will be prompted with a reminder to Please Insert the USB memory stick. Ensure the USB Memory Stick has been installed, then Touch Ok inside the pop-up, then touch Ok in the bottom of the screen.



“Please Insert USB”

This will return you to the I/R Gas Values screen. The neon green indicator box to the left of the “Logging: ON” text will illuminate.



“Logging On” Indicator

6.12 Stop Data Logging

To stop Data Logging push the orange “Change” button to the right of the “Logging: ON” text.



FurnaceDoctor®-Pro www.group-upc.com

CO [%]	24.9	C [%]	0.20
CO2 [%]	1.076	C+CH4 [%]	0.58
CH4 [%]	10.35	O2 [mV]	1,044
H2 [%]	40	DPT [°F]	70
°F	1,700	Logging: ON	Change
Alloy Factor [%]	100	Mar082018_Furnace 1.LOG	
CH4 Factor [%]	65.0	Main Menu	
Furnace Mode	Change		

“Logging: ON” Change button

The following screen will be displayed. Touch on the circle to the left of “Stop Logging” and then touch OK.

FurnaceDoctor®-Pro www.group-upc.com

Log I.D.	Furnace 1
Log File Name	Mar082018
Data Log Interval (secs)	60
☐ Start Logging	Add Comment
☒ Stop Logging	☒ Use USB Device
OK	Cancel

“Stop Logging”

You will be returned to the I/R Gas Values Screen, notice that Logging has now been turned off.



The screenshot displays the FurnaceDoctor-Pro software interface. At the top, the logo and website URL 'www.group-upc.com' are visible. The interface is divided into two main columns. The left column contains several input fields for gas analysis: CO [%] (24.9), CO2 [%] (1.064), CH4 [%] (10.36), H2 [%] (40), a temperature field set to 1,700 °F, Alloy Factor [%] (100), CH4 Factor [%] (65.0), and a 'Furnace Mode' field with a 'Change' button. The right column contains fields for C [%] (0.20), C+CH4 [%] (0.59), O2 [mV] (1,044), and DPT [°F] (70). Below these, there is a 'Logging: OFF' indicator (highlighted with a yellow box) and a 'Change' button. A 'Main Menu' button is located at the bottom right. A separator line '***' is positioned above the 'Main Menu' button.

Parameter	Value
CO [%]	24.9
CO2 [%]	1.064
CH4 [%]	10.36
H2 [%]	40
Temperature [°F]	1,700
Alloy Factor [%]	100
CH4 Factor [%]	65.0
Furnace Mode	Change
C [%]	0.20
C+CH4 [%]	0.59
O2 [mV]	1,044
DPT [°F]	70
Logging	OFF
Change	Change

Main Menu	

“Logging: Off” Indicator

Remove the USB drive and insert into your PC to read the data of the encrypted file on the standalone chart viewer.



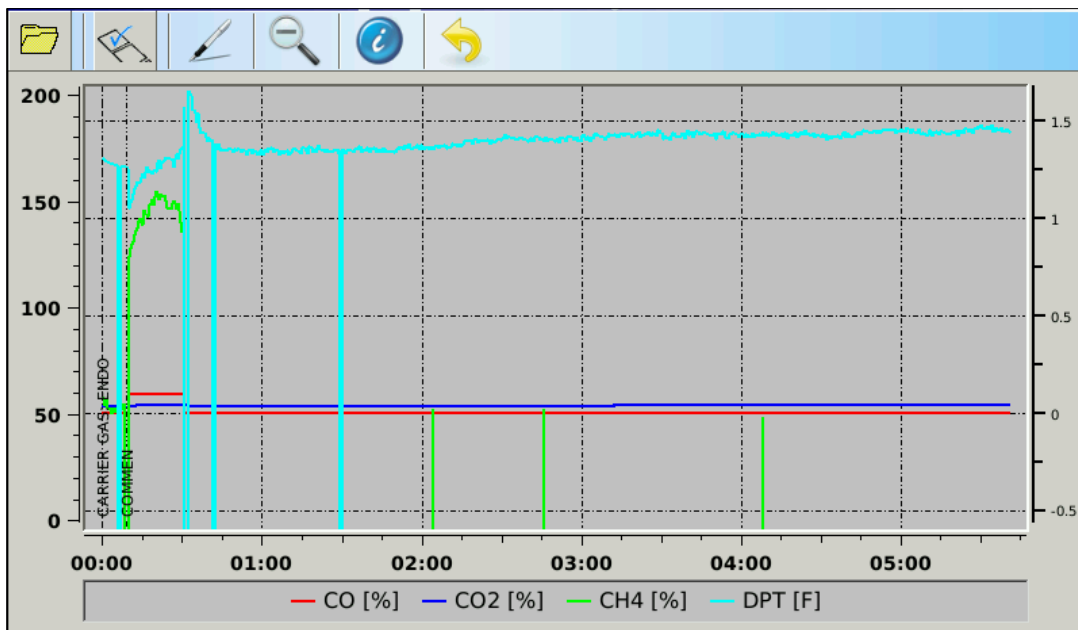
7 View Chart Icon

7.1 Stand Alone Chart Viewer

Your FurnaceDoctor®-Pro is equipped with a built-in memory data logging system. Data on all gas values is stored on 30-3,600 second intervals and is available for review from your PC on our Stand-Alone chart viewer by touching the View Chart Icon on the Main Screen.

Log data is stored internally or on an industry standard USB memory stick.

File types are encrypted and are easily read by our Stand-Alone chart viewer program.



Stand Alone Chart Viewer

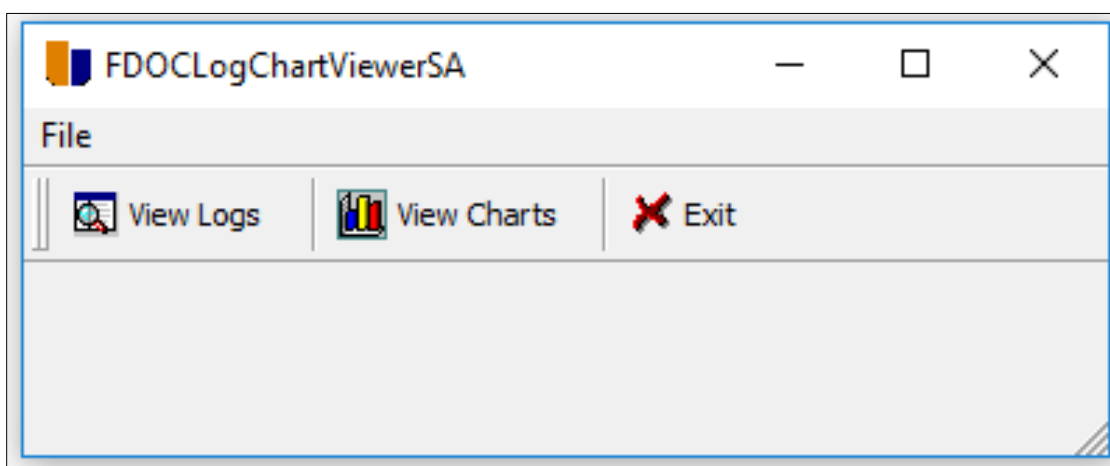
Data saved will include time, date, Log Id, CO, CO2, CH4, and user entered temperature. Expected O2mv, dew point, %Carbon, will be determined in the "Configure I/R Screen". The checked items will be data logged. (See Utilities).

7.2 Viewing Log Files

Viewing and printing of the data log files collected by the FurnaceDoctor®-Pro Gas Analyzer requires installation of the “FDLowView” software program.

Please follow the instruction included on the USB stick to install the “FDLowView” on a Windows computer

Running the installation software required for this program requires the operator to have administrator rights for the computer that the “FDLowView” program is being installed on.



“Chart Viewer”



8 CALIBRATION

8.1 Gas Requirements

You may calibrate your unit with certified grade span gas, and nitrogen. If you have plant nitrogen available be sure to regulate it to approximately 1 PSI.

Span bottle gas must have a bottle top regulator that will be capable of regulation at 1 PSI. Use only dual stage regulators for any calibration gas.

Be sure that your gas supplier provides you with a certified analysis of the gas in the bottle!

Valid ranges for span gas are:

CO	20 - 25.0%
CO ₂	.7 - 1.0%
CH ₄	8 - 15.0%
H ₂	40%
N ₂	balance

It is recommended that you select span gas with values approximately 20% higher than the typical observed process value. Span gas values may be higher, or lower, but should not exceed the ranges of the measuring cells.

Maximum cell ranges are:

CO	30%
CO ₂	2%
CH ₄	15%

Be sure to keep the second stage regulator pressure around 1-2 PSI. Your FurnaceDoctor®-Pro is equipped with good internal pressure regulation, but too much pressure may override the regulator's ability to control the pressure in the cells.

It is important to understand I/R cells are very pressure sensitive by nature. Realize that for a given species of gas there are more molecules of that gas present in a cell with a pressure of 1.5 PSI., than in a cell with a cell pressure of .5 PSI. This will lead to measurement error if the unit is calibrated at a high pressure, and then applied to low pressure measurements.

You may observe this phenomenon by closing off the exhaust of the instrument while measuring a furnace. Note the quick rise in the CO value.

It is recommended that the zero condition of the analyzer is checked and adjusted if necessary before any measurements are made. The zero check is more important than a span check if only nitrogen is available.



8.2 Calibration: Span Gas Verification

Connect the span bottle to the instrument and check the analyzer span on a weekly basis. If the instrument measures the span bottle within 2% of the analyzed values on the bottle, it is not necessary to calibrate the instrument.

If calibration is required do it in the environment that the instrument will be used in. If you calibrate the instrument in an office that is 70 °F, and then go use the instrument in a 110 °F heat treat, you will probably experience some error in measurement.

8.3 To Begin Calibration

The procedure for Span gas values only needs to be performed when a new span bottle is to be used.

Touch the Main Menu button from the default “I/R Gas Values: screen.

FurnaceDoctor®-Pro		www.group-upc.com	
CO [%]	21.00	O2 [mV]	1,145
CO2 [%]	0.2	DPT [°F]	24
CH4 [%]	0	CP atm [%]	1.30
H2 [%]	40.0	C [%]	1.30
°F	1,550	C+CH4 [%]	***
Alloy Factor [%]	100	Sat.C [%]	1.000
CH4 Factor [%]	0	O2 [%]	4.186E-20

Calculation Method Set to:

☒ Use Gas Input ☐ Use mV Input ☐ Use DPT Input

CALCULATE **Main Menu**

Touch Main Menu from Default Screen

From the Main Menu Screen, touch the Calibration Icon to select calibration Mode.



Main Menu Screen

The Calibration screen will open and the “Span” Gas Values will need to be checked to verify that the numerical values under the “Value” heading match the “Actual Concentration (Mole %) values as seen on the Vendor’s Gas Analysis Certificate.

	Value	Offset	Span	Reading
%CO	25.0	-0.0	0.8	0.6
%CO2	1.002	-0.049	1.921	0.062
%CH4	10.01	-0.39	0.38	0.03

Cell Pressure (mb) 978 973 Range: (926-1024)
Cell Temp.(°F) 90.2 88.6 Range: (77-87)

Calibrate

Last Factory Calibration

Due in days

Last calibration date: 03/08/2018

“Calibration Screen”





an Air Liquide company

Airgas Great Lakes region
Airgas USA, LLC
1290 Combermere Dr.
Troy, MI 48063
Airgas.com

CERTIFICATE OF ANALYSIS

Grade of Product: PRIMARY STANDARD

Customer: UNITED PROCESS CONTROLS INC
Part Number: X05NI24P15AC000
Cylinder Number: CC174844
Laboratory: 112 - Troy-32 (SAP) - MI
Analysis Date: Jan 10, 2018
Lot Number: 32-401043753-1

Expiration Date: Jan 10, 2026

Reference Number: 32-401043753-1
Cylinder Volume: 138.7 CF
Cylinder Pressure: 2015 PSIG
Valve Outlet: 350

Primary Standard Gas Mixtures are traceable to N.I.S.T. weights and/or N.I.S.T. Gas Mixture reference materials.

Component	Req Conc	Actual Concentration (Mole %)	Analytical Uncertainty
CARBON DIOXIDE	1.000 %	1.002 %	+/- 1%
METHANE	10.00 %	10.01 %	+/- 0.02% abs
CARBON MONOXIDE	25.00 %	25.01 %	+/- 0.02% abs
HYDROGEN	40.00 %	39.98 %	+/- 0.02% abs
NITROGEN	Balance		

Notes:
PRODUCED BY ISO17025, ACCREDITED FACILITY



Certificate of Analysis

Visual comparison between the current cylinder in use, Certificate of Analysis Actual Concentration (Mole %) and the Gas Analyzers' Calibration Screen indicates a numerical discrepancy between the current value shown on the Gas Analyzer in the "Value" field for %CO, %CO₂, and %CH₄, and these values will need to be adjusted to match the Actual Concentration (Mole %) values shown on the Certificate of Analysis.

Touch the orange button containing the numerical value to allow for modification next to its corresponding gas type. For demonstration purposes we will be focusing on the %CO₂



FurnaceDoctor®-Pro www.group-upc.com

	Value	Offset	Span	Reading
%CO	25.0	-0.0	0.8	0.3
%CO ₂	1.003	-0.049	1.921	0.063
%CH ₄	10.01	-0.39	0.38	0.01

Cell Pressure (mb) 979 973 Range: (926-1024)
Cell Temp.(°F) 90.2 88.8 Range: (77-87)

Calibrate
ZERO
SPAN

Last Factory Calibration
07/22/2016
Restore

Due in days
Past Due

Last calibration date: 03/08/2018 **Main Menu**

%CO₂ Value Entry Button

The %CO, %CO₂, and %CH₄ “Value Fields can be manually changed by touching the orange buttons under the “Value” field next to the corresponding gas type but must be changed one at a time. For demonstration purposes, we will focus on the %CO₂ number.

Using the keyboard enter the % CO₂ (Carbon Dioxide) Actual Concentration (Mole %) value obtained from the Certificate of Analysis, then touch “Ok”.

1.003 [Enter a value between 0.200 & 2.000]

1.002

1 2 3 4 5 6 7 8 9 0
Q W E R T Y U I O P
A S D F G H J K L Back
Z X C V B N M . - Clear

Ok Cancel

%CO₂ Keyboard Entry Screen



Notice the %CO₂ “Value” field has changed. The corresponding “values” for %CO, and %CH₄ can also be changed to match the Actual Concentration (Mole %) value as seen on the Certificate of Analysis for the current cylinder in use by adhering to paragraphs 9.3.7 & 9.3.8 of this manual.

	Value	Offset	Span	Reading
%CO	25.0	-0.0	0.8	0.3
%CO ₂	1.002	-0.049	1.921	0.063
%CH ₄	10.01	-0.39	0.38	0.02

Cell Pressure (mb)	979	973	Range: (926-1024)
Cell Temp.(°F)	90.0	88.6	Range: (77-87)

Calibrate	Last Factory Calibration	Due in days
ZERO	07/22/2016	Past Due
SPAN	Restore	

Last calibration date: 03/08/2018

Main Menu

Changed %CO₂ Value

8.4 Starting Calibration

To prevent over pressurizing during calibration, please adhere to the following:

- Decrease regulator pressure by turning the regulator control knob counter clockwise.
- Connect the tubing to the inlet port of the analyzer.
- Do not turn on the analyzer pump.
- Open the shut-off valves on the gas cylinder. There will be a main shutoff on the top of the cylinder and usually a smaller one on the outlet side of the regulator.
- Slowly turn the regulator control clockwise while observing the small flow meter near the bottom of the large analyzer filter.
- Stop the adjustment so that you are seeing a mid-scale indication on the flow meter, but ensuring that you do not over pressurize the analyzer by exceeding a SCFH reading of > 10.

8.5 Zero Calibration

Always perform a zero calibration before you perform a span calibration. It is recommended that the zero state of the analyzer should be checked before any measurement is made.

Connect and turn on the nitrogen following the above procedure. Touch the Zero button.



FurnaceDoctor®-Pro www.group-upc.com

	Value	Offset	Span	Reading
%CO	25.0	0.0	1.0	14.3
%CO2	1.002	0.003	0.991	0.128
%CH4	10.01	0.01	1.00	0.83

Cell Pressure (mb) 979 973 Range: (926-1024)
Cell Temp.(°F) 89.9 87.0 Range: (77-87)

Calibrate

ZERO

SPAN

Last Factory Calibration 07/22/2016 Due in days Past Due

Restore

Last calibration date: 03/09/2018 **Main Menu**

Touch Zero Button

Immediately after Touching zero you will see a pop-up as viewed here. verify that the Zero Gas is connected, adjust flowmeter to mid-scale indication SCFH, using caution to not exceed 10 SCFH as read on the flow meter.

FurnaceDoctor®-Pro www.group-upc.com

	Value	Offset	Span	Reading
%CO	25.0	0.0	1.0	14.2
%CO2	1.002		0.991	0.109
%CH4	10.01		1.00	0.73

Cell Pressure (mb) Cell Temp.(°F) Range: (926-1024) Range: (77-87)

Calibrate

ZERO

SPAN

Restore

Last calibration date: 03/09/2018 **Main Menu**

Calibration

You have to have calibration gas ready. Are you sure you want to proceed?

Yes **No**

Calibration Gas Ready

You will receive another prompt, reminding you to connect zero gas.



The screenshot shows the FurnaceDoctor-Pro interface. At the top, there is a header with the logo and the website address www.group-upc.com. Below the header is a table with columns: Value, Offset, Span, and Reading. The table contains data for %CO, %CO2, and %CH4. A yellow box highlights a prompt that says "Please connect zero gas" with an "OK" button. Below the table, there are sections for "Cell Pressure (mb)", "Cell Temp.(°F)", "Calibrate" (with ZERO and SPAN buttons), "Due in days" (with Past Due), and "Last calibration date: 03/08/2018". A "Main Menu" button is at the bottom right.

	Value	Offset	Span	Reading
%CO	25.0	-0.0	0.8	0.0
%CO2	1.002		1.921	-0.027
%CH4	10.01		0.38	-0.22

Cell Pressure (mb)
Cell Temp.(°F)

Range: (926-1024)
Range: (77-87)

Calibrate

ZERO

SPAN

07/22/2016

Restore

Due in days

Past Due

Last calibration date: 03/08/2018

Main Menu

Connect Zero Gas Prompt

Verify that the Nitrogen (Zero Gas) has been connected to the Gas Analyzer's "Sample In" Port and gas flow has been properly adjusted to mid-scale indication on the flow meter, press OK to start the calibration.

The orange Zero button in the Calibration Field will change to a 120 second count-up timer. Notice the "Readings numbers at start of calibration.

The screenshot shows the FurnaceDoctor-Pro interface. At the top, there is a header with the logo and the website address www.group-upc.com. Below the header is a table with columns: Value, Offset, Span, and Reading. The table contains data for %CO, %CO2, and %CH4. A yellow box highlights the "Calibrate" section, which now shows a "40/120" timer instead of the "ZERO" button. Below the table, there are sections for "Cell Pressure (mb)", "Cell Temp.(°F)", "Last Factory Calibration" (with 07/22/2016), "Due in days" (with Past Due), and "Last calibration date: 03/09/2018". A "Main Menu" button is at the bottom right.

	Value	Offset	Span	Reading
%CO	25.0	0.0	1.0	0.0
%CO2	1.002	0.003	0.991	-0.002
%CH4	10.01	0.01	1.00	0.00

Cell Pressure (mb)
Cell Temp.(°F)

1,014
90.4

1,009
88.2

Range: (926-1024)
Range: (77-87)

Calibrate

40/120

SPAN

Last Factory Calibration

07/22/2016

Restore

Due in days

Past Due

Last calibration date: 03/09/2018

Main Menu

Zero Calibration Count-Up Timer

When the counter has finished counting to 120, you will receive another on-screen prompt, informing you that the Calibration data has been saved, touch Ok.



The screenshot shows the FurnaceDoctor-Pro calibration interface. A dialog box with the text "Calibration data are saved" and an "OK" button is centered on the screen. The background interface includes a table for gas calibration, cell pressure and temperature readings, and calibration buttons.

	Value	Offset	Span	Reading
%CO	25.0	0.0	1.0	0.0
%CO2	1.002		0.991	0.000
%CH4	10.01		1.00	-0.01

Cell Pressure (mb)
Cell Temp.(°F)

Calibrate
120/120
SPAN

Due in days
Past Due

Last calibration date: 03/09/2018

Main Menu

Calibration Data are Saved

Upon visual inspection of the “Span” and the “Reading” columns you should see numbers in very close proximity to those viewed here.

The screenshot shows the FurnaceDoctor-Pro calibration interface after zero calibration. The "Span" and "Reading" columns are highlighted with green borders. The "Offset" column now shows values for %CO2 and %CH4. The "Calibrate" section now includes a "ZERO" button.

	Value	Offset	Span	Reading
%CO	25.0	0.0	1.0	0.0
%CO2	1.002	-0.001	0.991	0.001
%CH4	10.01	-0.00	1.00	-0.01

Cell Pressure (mb)
Cell Temp.(°F)

Calibrate
ZERO
SPAN

Last Factory Calibration
07/22/2016
Restore

Due in days
Past Due

Last calibration date: 03/09/2018

Main Menu

After Zero Calibration Readings

Disconnect the Nitrogen (Zero) gas supply and connect the Span Gas, the Zero Gas Calibration is now complete.



8.6 Span Calibration

Touch the orange Span Gas button in the Calibrate field.

The interface displays calibration data for %CO, %CO2, and %CH4. Below this, it shows cell pressure and temperature. The 'Calibrate' section has 'ZERO' and 'SPAN' buttons. The 'Last Factory Calibration' section shows the date '07/22/2016' and a 'Restore' button. The 'Due in days' section shows 'Past Due'. At the bottom, there is a 'Main Menu' button and a 'Last calibration date: 03/09/2018' label.

	Value	Offset	Span	Reading
%CO	25.0	0.0	1.0	24.7
%CO2	1.002	-0.001	0.996	0.799
%CH4	10.01	-0.00	0.99	10.27

Cell Pressure (mb) 978 973 Range: (926-1024)
Cell Temp.(°F) 93.3 89.2 Range: (77-87)

Calibrate
ZERO
SPAN

Last Factory Calibration
07/22/2016
Restore

Due in days
Past Due

Last calibration date: 03/09/2018 Main Menu

Touch Span

Immediately after Touching Span you will see a pop-up as viewed here, verify that the Span Gas is connected, adjust flowmeter to mid-scale SCFH, using caution to not exceed 10 SCFH, then touch Ok inside the pop-up window.

The interface is the same as the previous one, but with a 'Calibration' pop-up dialog box in the center. The dialog box contains the text: 'You have to have calibration gas ready. Are you sure you want to proceed?' and two buttons: 'Yes' and 'No'. The 'SPAN' button in the background is highlighted with a red box.

	Value	Offset	Span	Reading
%CO	25.0	0.0	1.0	24.5
%CO2	1.002		0.996	0.740
%CH4	10.01		0.99	10.22

Cell Pressure (mb) Range: (926-1024)
Cell Temp.(°F) Range: (77-87)

Calibrate
ZERO
SPAN

Last Factory Calibration
Restore

Due in days
Past Due

Last calibration date: 03/09/2018 Main Menu

Calibration
You have to have calibration gas ready. Are you sure you want to proceed?
Yes No

Span Gas Ready?



Re-verify that the Span Gas has been connected to the Gas Analyzer's "Sample In" Port and gas flow has been properly adjusted to mid-scale on the flow meter, press OK to start the calibration.

The interface displays a table for gas calibration parameters. A modal dialog box is centered on the screen, prompting the user to connect span gas. The background interface includes fields for gas concentrations, cell pressure/temperature, and calibration buttons.

	Value	Offset	Span	Reading
%CO	25.0	0.0	1.0	23.8
%CO2	1.002		0.996	0.639
%CH4	10.01		0.99	10.29

Cell Pressure (mb) 983 977 Range: (926-1024)
Cell Temp.(°F) 85.5 84.1 Range: (77-87)

Calibrate: ZERO, SPAN
Due in days: Past Due
Last calibration date: 03/09/2018
Main Menu

Connect Span Gas Prompt

The orange Span button in the Calibration Field will change to a 120 second count-up timer.

The interface shows the calibration screen with the Span button now displaying a count-up timer. The background interface is similar to the previous screenshot but with updated values.

	Value	Offset	Span	Reading
%CO	25.0	0.0	1.0	23.9
%CO2	1.002	0.000	1.000	0.887
%CH4	10.01	0.00	1.00	9.94

Cell Pressure (mb) 983 977 Range: (926-1024)
Cell Temp.(°F) 85.5 84.1 Range: (77-87)

Calibrate: ZERO, 38/120
Last Factory Calibration: 07/22/2016
Due in days: Past Due
Last calibration date: 03/12/2018
Main Menu

Span Gas Count-up Timer



Once the unit has counted-up to 120 the calibration is complete, and you will see another pop-up window indicating that the “Span” Gas calibration data has been saved, touch Ok inside of the pop-up window.

The screenshot shows the FurnaceDoctor-Pro calibration interface. A pop-up window in the center displays the message "Calibration data are saved" with an "OK" button. The background interface includes fields for gas calibration (CO, CO2, CH4) with Value, Offset, Span, and Reading columns. It also shows cell pressure and temperature, calibration buttons (ZERO, 120/120), a date field (07/22/2016), a Restore button, and a Main Menu button. The last calibration date is noted as 03/12/2018.

	Value	Offset	Span	Reading
%CO	25.0	0.0	1.0	24.2
%CO2	1.002		1.000	0.936
%CH4	10.01		1.00	10.02

Cell Pressure (mb)
Cell Temp.(°F)

Calibrate
ZERO
120/120

Due in days
Past Due

Range: (926-1024)
Range: (77-87)

07/22/2016
Restore

Last calibration date: 03/12/2018
Main Menu

Expected Readings

You can now return to the I/R Gas Values screen. The instrument should read the values in the bottle within 2% of the cell range. (I.e. 25% CO should be +/- .5% CO. or 24.5 – 25.5).

The screenshot shows the I/R Gas Values screen. It displays calibrated gas concentrations for CO, CO2, and CH4, along with C, C+CH4, O2, and DPT. The values are shown in a table format with green borders around the data fields. The screen also includes a Logging status (OFF) with a Change button, a Main Menu button, and a Furnace Mode button with a Change button.

CO [%]	25.0	C [%]	0.21
CO2 [%]	1.006	C+CH4 [%]	0.59
CH4 [%]	10.04	O2 [mV]	1,047
		DPT [°F]	68

H2 [%] 40

°F 1,700

Alloy Factor [%] 100

CH4 Factor [%] 65.0

Furnace Mode Change

Logging: OFF Change

Main Menu

I/R Gas Values After Calibration

Annual Factory Calibration is suggested. Retain original box and custom packing foam for return shipment to UPC. Annual factory calibration will ensure your analyzer performs at a high degree of accuracy throughout its life.

8.7 Restoring Factory Calibration



If you wish to restore the calibration performed at the factory then touch the Restore Factory Cal. button.

The interface displays the following data:

	Value	Offset	Span	Reading
%CO	25.0	0.0	1.0	25.8
%CO2	1.002	0.000	1.073	1.151
%CH4	10.01	0.00	1.00	10.27

Cell Pressure (mb): 985, 979 Range: (926-1024)
Cell Temp.(°F): 92.4, 87.7 Range: (77-87)

Calibrate buttons: ZERO, SPAN

Last Factory Calibration: 07/22/2016
Due in days: Past Due

Restore button (highlighted in red)

Last calibration date: 03/12/2018
Main Menu button

Restoring Factory Calibration

You will be prompted with “Are You Sure you want to restore factory calibration?” Touch OK on the dialog box and the last factory calibration data will be restored

The interface displays the same data as the previous screen, but with a dialog box overlay:

Calibration
Are you sure that you want to restore factory calibration?
Yes No

The 'Yes' button is highlighted with a red box.

Restore Factory Calibration Prompt

You will see this screen next. Touch Ok to complete the restoration of factory calibration.

	Value	Offset	Span	Reading
%CO	25.0	0.0	1.0	24.9
%CO2	1.002		1.073	1.068
%CH4	10.01		1.00	10.30

Cell Pressure (mb)
Cell Temp.(°F)

Range: (926-1024)
Range: (77-87)

Calibrate

ZERO

SPAN

07/22/2016

Restore

Due in days
Past Due

Last calibration date: 03/12/2018

Main Menu

Factory Calibration Restored

When you send your analyzer into United Process Controls Inc. Corp. for calibration, the calibration data, and the factory calibration date are entered and stored in the analyzer's memory, and is password protected.

9 PROCESS CALCULATOR

9.1 Accessing the Process Calculator

Touch the "process calculator" icon on the Main Menu Screen.

I/R Gas Values

View Chart

Calibration

Proc Calc

Utilities

About



Main Menu, Process Calculator Icon

This feature has several options for computing carbon potential, dew point, and probe millivolts.

FurnaceDoctor®-Pro		www.group-upc.com	
CO [%]	20	O2 [mV]	1,100
CO2 [%]	0.2	DPT [°F]	45
CH4 [%]	0	CP atm [%]	***
H2 [%]	40.0	C [%]	***
°F	1,550	C+CH4 [%]	***
Alloy Factor [%]	100	Sat.C [%]	***
CH4 Factor [%]	0	O2 [%]	***
Calculation Method Set to:			
☒ Use Gas Input ☐ Use mV Input ☐ Use DPT Input			
CALCULATE		Main Menu	

“Process Calculator” Screen

Input fields include, the carbon monoxide percentage- %CO, the carbon dioxide percentage- %CO₂, the methane percentage- %CH₄, the hydrogen percentage- %H₂, and °F or °C temperature.

To change from °F to °C, touch the “°F” button. Touching the °C button will change it back to °F.

FurnaceDoctor®-Pro		www.group-upc.com	
CO [%]	20	O2 [mV]	1,100
CO2 [%]	0.2	DPT [°F]	45
CH4 [%]	0	CP atm [%]	***
H2 [%]	40.0	C [%]	***
°F	1,550	C+CH4 [%]	***
Alloy Factor [%]	100	Sat.C [%]	***
CH4 Factor [%]	0	O2 [%]	***
Calculation Method Set to:			
☒ Use Gas Input ☐ Use mV Input ☐ Use DPT Input			
CALCULATE		Main Menu	



Changing form °F to °C

Other inputs are CO [%], CO₂ [%], CH₄ [%], H₂ [%], Alloy Factor [%], CH₄ Factor [%], O₂ [mV], and DPT [°F].

The CH₄ Factor is a process factor that corrects for the catalytic effect that is happening in the furnace from free CH₄. 0 turns this feature off.

To change any of the input values, touch the associated Button. For example; let's assume that we need to modify the CO [%] value from 20 to 21. The following steps will provide clear instruction on how this is accomplished.

Touch the orange change value button associated with the input parameter that needs to be modified. For demonstration purposes, the CO [%] field will be changed.

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CO [%]	20	O ₂ [mV]	1,100
CO ₂ [%]	0.2	DPT [°F]	45
CH ₄ [%]	0	CP atm [%]	***
H ₂ [%]	40.0	C [%]	***
°F	1,550	C+CH ₄ [%]	***
Alloy Factor [%]	100	Sat.C [%]	***
CH ₄ Factor [%]	0	O ₂ [%]	***

Calculation Method Set to:

☒ Use Gas Input ☐ Use mV Input ☐ Use DPT Input

CALCULATE **Main Menu**

“CO [%]” Change Value

The CO [%] value entry screen will open immediately, enter the new value in the space provided. For this example, the new value to be entered is “21”. Touch “Ok”.



A numeric keypad interface for entering a CO [%] value. At the top, a text field shows '20' with a hint '[Enter a value between 1.00 & 50.00]'. Below it, another text field shows '21'. The keypad consists of four rows of buttons: the first row has digits 1-0; the second row has letters Q-P; the third row has letters A-L and a 'Back' button; the fourth row has letters Z-M, a decimal point, a hyphen, and a 'Clear' button. At the bottom, there are 'Ok' and 'Cancel' buttons. Red boxes highlight the top text field, the '21' input, the keypad, and the 'Ok' button.

CO [%] Value Entry Keyboard

Notice that the CO [%] value has now changed to 21.00. To perform the calculation based on the new value entered, touch calculate.

The main screen of the FurnaceDoctor-Pro application. At the top, it shows the logo, the text 'FurnaceDoctor®-Pro', and the website 'www.group-upc.com'. Below this is a table of input and output fields. The 'CO [%]' field is highlighted with a yellow box and contains '21.00'. The 'O2 [mV]' field contains '1,100'. The 'CO2 [%]' field contains '0.2'. The 'DPT [°F]' field contains '45'. The 'CH4 [%]' field contains '0'. The 'CP atm [%]' field contains '***'. The 'H2 [%]' field contains '40.0'. The 'C [%]' field contains '***'. The '°F' field contains '1,550'. The 'C+CH4 [%]' field contains '***'. The 'Alloy Factor [%]' field contains '100'. The 'Sat.C [%]' field contains '***'. The 'CH4 Factor [%]' field contains '0'. The 'O2 [%]' field contains '***'. Below the table, there is a section for 'Calculation Method Set to:' with three radio buttons: 'Use Gas Input' (selected), 'Use mV Input', and 'Use DPT Input'. At the bottom, there are 'CALCULATE' and 'Main Menu' buttons. Red boxes highlight the 'CO [%]' field, the 'CALCULATE' button, and the 'Main Menu' button.

“Calculate”

Notice that the Calculated values, CP atm [%], C [%], Sat. C [%], and O2 [%] have been recalculated based upon the new value of 21 that was entered in the CO [%] field.



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CO [%]	21.00	O2 [mV]	1,145
CO2 [%]	0.2	DPT [°F]	24
CH4 [%]	0	CP atm [%]	1.30
H2 [%]	40.0	C [%]	1.30
°F	1,550	C+CH4 [%]	***
Alloy Factor [%]	100	Sat.C [%]	1.000
CH4 Factor [%]	0	O2 [%]	4.186E-20

Calculation Method Set to:

☒ Use Gas Input ☐ Use mV Input ☐ Use DPT Input

CALCULATE **Main Menu**

“New Calculations”

All input values can be changed by following this procedure as outlined in Paragraphs 8.1.7 thru 8.1.11 of this Manual.

9.2 Calculation Method Set to: Options

Use Gas Input

By entering the CO, CO2, CH4, Alloy Factor [%], CH4 Factor [%] and process temperature, the O2MV, DPT, CP atm, %C, %C+CH4, Sat. %C, and % Oxygen will be computed. Touch the CALCULATE button to calculate.

Use mV Input

By entering the oxygen probe millivolts, Alloy Factor [%], CH4 Factor [%] and process temperature, the DPT, CP atm, %C, %C+ch4, Sat. %C, and % Oxygen will be computed. CO2 is also calculated. Changing the % CO will calculate the %H2. This will change the calculated DPT, CP atm, %C, and % C+ ch4. Touch the CALCULATE button to calculate.

Use DPT Input

By entering the dew point (DPT), Alloy Factor [%], CH4 Factor [%] and process temperature the O2MV, CP atm, %C, %C+ch4, Sat. %C, and % Oxygen will be computed. CO2 is also calculated. Changing the %CO will calculate the %H2. This will change the calculated, O2MV, CP atm, %C, %C+ch4. Touch the CALCULATE button to calculate.

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CO [%]	21.00	O2 [mV]	1,145
CO2 [%]	0.2	DPT [°F]	24
CH4 [%]	0	CP atm [%]	1.30
H2 [%]	40.0	C [%]	1.30
°F	1,550	C+CH4 [%]	***
Alloy Factor [%]	100	Sat.C [%]	1.000
CH4 Factor [%]	0	O2 [%]	4.186E-20

Calculation Method Set to:

☒ Use Gas Input
 ☐ Use mV Input
 ☐ Use DPT Input

CALCULATE **Main Menu**

Calculate Method Set to

10 UTILITIES

10.1 Utilities Configurable Options

Select the “Utilities” Icon from the Main Menu Screen.



Select “Utilities” Icon



The “Utilities” Password request keyboard will open, and you will need to enter the password by typing “45069” into the data entry field to access the various configurable parameters pertaining to system utilities, then Touch “Ok”.

The image shows a password entry interface. At the top, there is a text prompt "Please enter the password". Below it is a text input field containing five asterisks "*****". Under the input field is a numeric keypad with buttons for digits 1-0, a QWERTY keyboard layout, and a "Back" button. Below the keyboard is a "Clear" button. At the bottom of the screen are two large buttons: "Ok" and "Cancel". Red rectangular boxes highlight the password input field, the numeric keypad, and the "Ok" button.

“Password” Entry

The “Utilities Parameters” screen will open to the following page displaying the various configurable options available under the “Utilities” subject:

The image shows the "Utilities Parameters" screen. At the top left is the FurnaceDoctor logo, and at the top right is the website "www.group-upc.com". The screen contains a list of menu items, each in a white button with an orange border. The items are: "Calibrate Touch Screen", "Set Date and Time", "Configure I/R Screen", "Update Firmware", "Accumulated Runtime", "Set Factory Calibration Reminder", "Set Ethernet", and "Main Menu". A red rectangular box highlights the "Set Date and Time" button.

“Utilities” Menu

10.2 Date and Time



Touch the “Set Date and Time” box and the following screen will appear:

Date		
Year	Month	Day
2018	2	21
Time		
Hours	Minutes	Seconds
13	47	50

OK **Cancel**

“Set Date & Time” Screen

Touch the “Year” box and the “Year” entry keyboard will be displayed.

Date		
Year	Month	Day
2018	3	8
Time		
Hours	Minutes	Seconds
12	15	7

OK **Cancel**

“Year” Field

Enter the 4-digit year on this screen, then touch “Ok” in the bottom left of the screen.



The image shows a 'Year Entry Keyboard' interface. On the left, there are labels for 'Date', 'Year', 'Time', and 'Hour'. The 'Date' field contains '2018' with a red box around it. The 'Year' field is empty. The 'Time' field contains '12' and the 'Hour' field is empty. To the right of these fields is a numeric keypad with buttons for digits 1-0, a QWERTY keyboard layout, and a 'Back' button. Below the keypad are buttons for 'Ok' and 'Cancel', both highlighted with red boxes. At the top, a text box says '2018 [Enter a value between 2,000 & 3,000]'.

“Year Entry Keyboard

Repeat this process to enter the 1-Digit Month, 2-Digit Day, 2-Digit Hours, 2-Digit Minutes, and finally the 2-Digit Seconds.

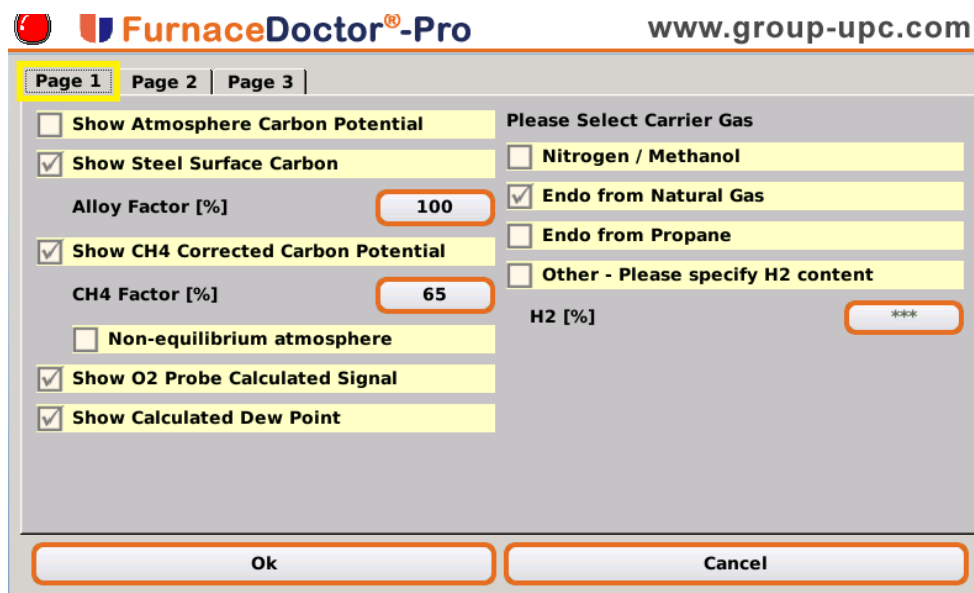
10.3 Configure I/R Screen

Touch “Configure I/R Screen which is for configuring the I/R Gas Values.

The image shows the 'FurnaceDoctor-Pro' main menu. At the top, there is a logo and the text 'FurnaceDoctor®-Pro' and 'www.group-upc.com'. Below this is a list of menu items, each in a button: 'Calibrate Touch Screen', 'Set Date and Time', 'Configure I/R Screen' (highlighted with a red box), 'Update Firmware', 'Accumulated Runtime', 'Set Factory Calibration Reminder', 'Set Ethernet', and 'Main Menu'.

Touch “Configure I/R Screen”

The “Configure I/R Screen” will open to Page 1 of 3 pertaining to Gas Values Information.



Configure I/R Screen, “Page 1”

10.4 Configure I/R Screen, Page 1 Options Include

Show Atmosphere Carbon Potential

This is displayed on the I/R Gas Values screen as CP. It is a carbon calculation that displays the carbon potential of the atmosphere using CO, CO₂, and manually entered process temperature.

Show Steel Surface Carbon

This is displayed on the I/R Gas Values screen as %C. It is a carbon calculation that displays the carbon potential of the steel surface using CO, CO₂, and manually entered process temperature with the option of an Alloy Factor.

The Alloy Factor

A process factor that can be determined by a shim stock test. The FurnaceDoctor®-Pro can then be adjusted to match your shim stock tests. 100 is nominal. unchecking this option will invalidate the C+CH₄ calculation.

Show CH₄ Corrected Carbon Potential

This is displayed on the I/R Gas Values screen as %C + CH₄. It is a carbon calculation that displays the carbon potential of the atmosphere using CO, CO₂, CH₄, and manually entered process temperature with the option of a CH₄ Corrected Carbon Potential.

The CH₄ Corrected Carbon Potential



A process factor that corrects for the catalytic effect that is happening in the furnace from free CH₄. The % + CH₄ box that will be displayed on the I/R Gas Values page will turn red if the furnace is not in equilibrium. 65 is the recommended default setting if you choose to use this feature.

Show O₂ Probe Calculated Signal

This is displayed on the I/R Gas Values screen as O₂MV. It is a calculated O₂ Probe millivolt using CO, CO₂, and manually entered process temperature.

Show Calculated Dew Point

This is displayed on the I/R Gas Values screen as DPT. It is a calculated Dew Point using CO, CO₂, and manually entered process temperature and H₂.

10.5 Carrier Gas Selection Options

Nitrogen / Methanol which calculates the amount of H₂ from the amount of CO that is present in the atmosphere to calculate dew point, and carbon potential.

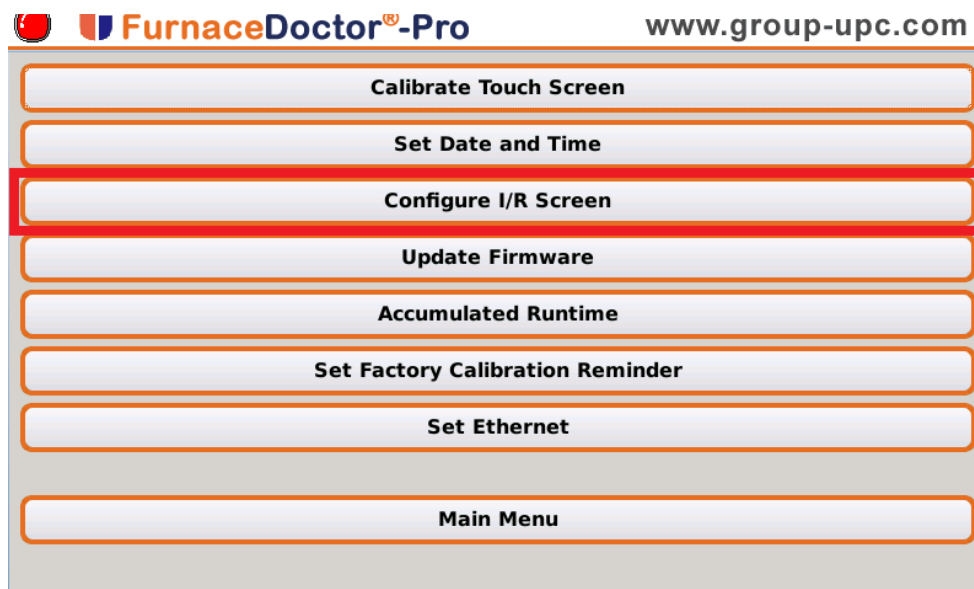
Endo from Natural Gas which will use a 40% H₂ to calculate dew point and carbon potential.

Endo from Propane which will use a 31% H₂ to calculate dew point and carbon potential.

Other – Please specify H₂ content which will use a manually entered H₂ to calculate dew point.

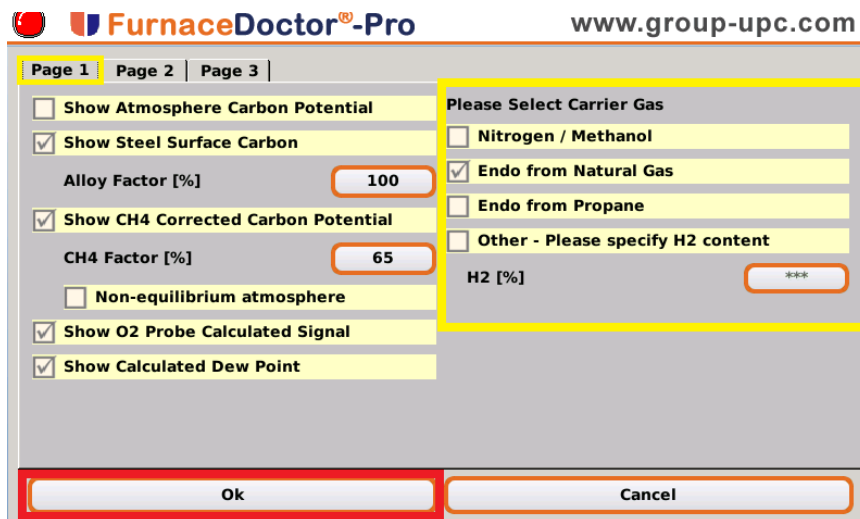
10.6 Please Select Carrier Gas

If “Generator Mode” has been selected in Section 6.3, the correct carrier gas for your process must also be selected. Touch the “Configure I/R Screen” button.



Configure I/R Screen

The “Configure I/R Screen” display will immediately open to the Page 1 configuration Page. The carrier gas can be selected by touching the box next to the most appropriate selection under “Please Select Carrier Gas”, on the left side of the screen, once selected, touch Ok at the bottom of the screen.



“Please Select Carrier Gas”

To Enter the Alloy Factor [%], CH₄ Factor %, and the H₂ % for Dew Point and carbon potential calculations touch the corresponding box.



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Page 1 | Page 2 | Page 3

☐ Show Atmosphere Carbon Potential

☒ Show Steel Surface Carbon

Alloy Factor [%] 100

☒ Show CH4 Corrected Carbon Potential

CH4 Factor [%] 65

☐ Non-equilibrium atmosphere

☒ Show O2 Probe Calculated Signal

☒ Show Calculated Dew Point

Please Select Carrier Gas

☐ Nitrogen / Methanol

☒ Endo from Natural Gas

☐ Endo from Propane

☐ Other - Please specify H2 content

H2 [%] ***

Ok Cancel

“Alloy Factor, CH4 %, or H2 % Entry Fields

The default values for these entries are:

Alloy Factor % 100

CH₄ Factor % 65

H₂ % 40

10.7 Configure I/R Screen, Page 2 Options Include

Touch the Page 2 Tab on the “Configure I/R Screen”, and the following Screen will be displayed.

FurnaceDoctor®-Pro www.group-upc.com

Page 1 | Page 2 | Page 3

Gas Generators

☒ ENDO Only

☐ EXO Only

☐ ENDO and EXO

Generator Temp. °F 1,680.0

Baud Rate

☐ 4800 ☐ 19200

☒ 9600 ☐ 57600

Language

☒ English ☐ Chinese Traditional

☐ French ☐ Chinese Simplified

☐ Spanish ☐ Japanese

☐ German ☐ Use Comma

☐ Russian

Ok Cancel



“Configure I/R Screen”, Page 2

The Page 2 Tab allows for the configuration of the Gas Generator measure mode, Baud Rate settings, and Language Preference Selection.

Gas Generators-

- **Endo Only** – selects low CO₂ bench for gas data.
- **EXO Only** – select high CO₂ bench for gas data.
- **ENDO and EXO** – automatically selects CO₂ for best reading.

Generator Temp. - Actual generator temperature for Dewpoint calculation.

Baud Rate – The speed at which a bit goes from one part of a computer to another. One Baud is one bit per second.

The default Baud rate for the FURNACEDOCTOR®-PRO is 9600.

10.8 Generator Mode Process Temperature

The Generator Mode Process Temperature can be edited, but is only editable on this page. Touch the numerical value button to the right of Generator Temp.

The screenshot shows the 'Configure I/R Screen' Page 2 of the FurnaceDoctor®-Pro software. The interface includes a title bar with the logo and website, and three tabs: Page 1, Page 2 (selected), and Page 3. The main content area is divided into three sections: 'Gas Generators', 'Language', and 'Baud Rate'. In the 'Gas Generators' section, 'ENDO Only' is selected. In the 'Language' section, 'English' is selected. In the 'Baud Rate' section, '9600' is selected. The 'Generator Temp.' field is highlighted with a red box, showing a value of 1,680.0 °F. The 'Ok' and 'Cancel' buttons are at the bottom.

“Generator Process Temp”

The Generator Process Temperature keyboard entry screen will open. Enter your new value in the entry field, then select OK.



“Generator Process Temperature Entry”

10.9 Gas Generator Selection

It is also possible to select the gas mode here with either:

- ENDO Only
- EXO Only
- ENDO and EXO



Gas Generator Selection Field



It is recommended that “ENDO Only” or “EXO Only” should be selected depending on the process to be measured.

“ENDO Only” is the default setting for Heat Treat type applications.

“EXO Only” would be selected in a combustion application environment for example; furnace burner exhaust measurements.

The ENDO and EXO selection allows you to switch between either mode in the I/R Gas Values page but may cause confusion if the basic operator does not understand the setting.

If “Endo and Exo” mode has been selected from the Utilities Page 2 Tab then it will be necessary to refer to the I/R Gas Values Section 6 of this manual for instructions for Endo or Exo selection.

H2 [%]	40
°F	1,700
Alloy Factor [%]	100
CH4 Factor [%]	65.0
Furnace Mode	Change
Endo Mode	Change

ENDO Selection



H2 [%]	***
°F	1,700
Alloy Factor [%]	100
CH4 Factor [%]	65.0
Furnace Mode	Change
Exo Mode	Change

EXO Selection

10.10 Configure I/R Screen, Page 3 Options Include

Touch the Page 3 tab of the Configure I/R Screen Menu. After you have configured the I/R Screen, touch OK and you will be taken to the main menu.

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Page 1 | Page 2 | **Page 3**

☒ Show H2

☒ Show Temperature

☒ Show Alloy Factor

☒ Show Methane Factor

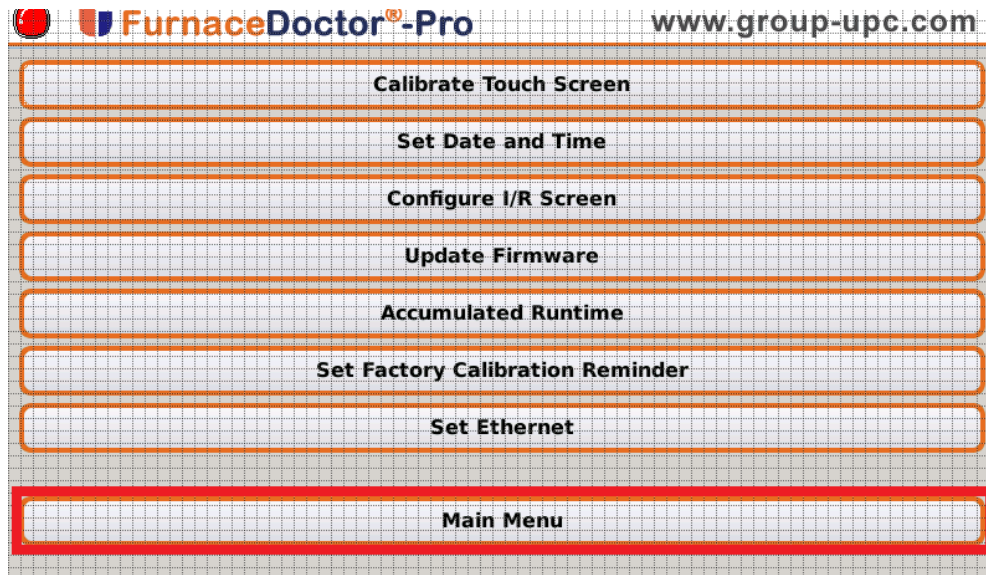
☒ Show Endo/Exo

☒ Show Furnace Mode

Ok **Cancel**

Utilities Configuration, Page 3

Touch the “Main Menu” button to return to the Main Menu.



Utilities Configuration Menu

11 BATTERY CHARGER

11.1 What's Included?

Your FurnaceDoctor®-Pro includes a battery charger - A/C adaptor.





Battery Charger- A/C Adaptor

11.2 Charging

Unit will operate continuously for approximately 6 hours without recharging. A full charge will take approximately 2 hours to complete. It is not necessary to completely discharge the battery before charging.

To charge the unit - Connect the supplied Battery charger - universal A/C adaptor into the “D/C INPUT” port on the top of the Furnace Dr.

Note: Unit is designed to operate with a charged battery or with the A/C adaptor. Using the charger as an AC adapter will not allow the battery to charge as quickly as it would otherwise. It is considered best practice to connect the charger with the unit's power off and fully charge the battery. The unit will not operate with the battery removed.

12 ETHERNET SETUP

12.1 Accessing the Ethernet Setup

From the Default (I/R Gas Values Screen) touch the Main Menu button to Bring up the Main Menu Page.

FurnaceDoctor®-Pro www.group-upc.com

	Value	Offset	Span	Reading
%CO	25.0	0.0	1.0	24.9
%CO2	1.002	0.000	1.000	1.064
%CH4	10.01	0.00	1.00	10.31

Cell Pressure (mb) 985 979 Range: (926-1024)
Cell Temp.(°F) 93.1 88.6 Range: (77-87)

Calibrate
ZERO
SPAN

Last Factory Calibration
07/22/2016
Restore

Due in days
Past Due

Last calibration date: 03/12/2018 **Main Menu**

Accessing Main Menu Screen

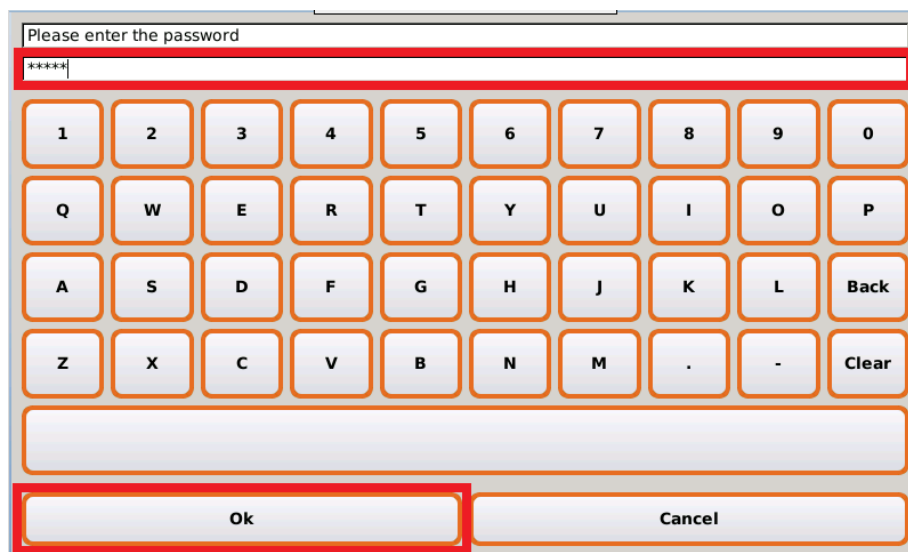


The Main Menu will appear on the Screen. Touch the Utilities Icon to access the Utilities Password Entry Screen.



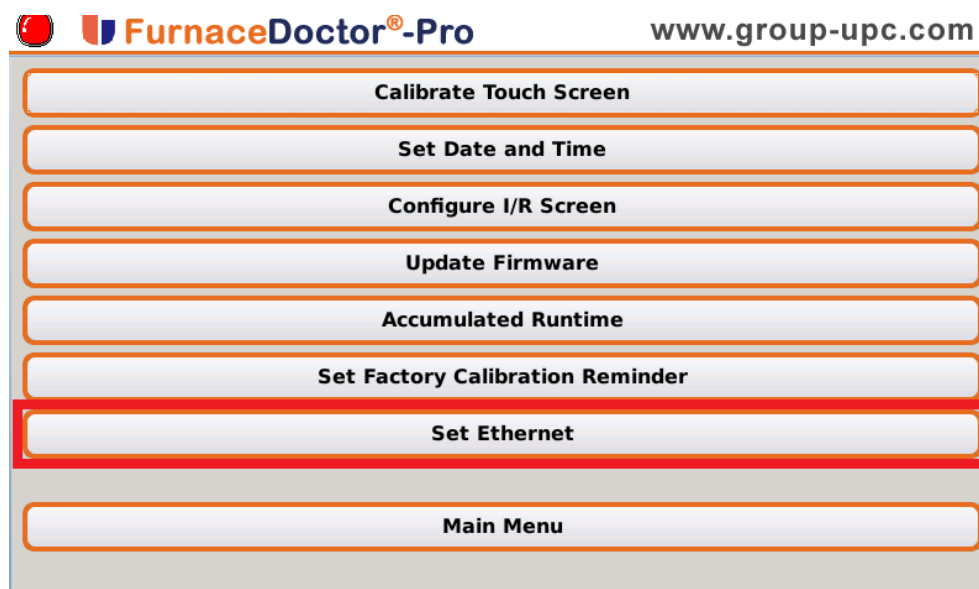
Utilities Icon

The “Utilities” Password request keyboard will open, and you will need to enter the password by typing “45069” into the data entry field to access the various configurable parameters pertaining to system utilities, then Touch “Ok”.



Utilities Password Entry

The “Utilities Parameters” screen will open to the following page displaying the various configurable options available under the “Utilities” Icon.



Touch “Set Ethernet”

The Ethernet Configuration Screen will appear.

The image shows the Ethernet Configuration screen. At the top, there are two icons: a blue circle with a white plus sign and a blue circle with a white minus sign. Below these is a table-like structure with five rows. The first row is 'Interface' with the value 'eth0'. The second row is 'Use DHCP' with the value 'No'. The third row is 'IP Address' with the value '192.168.30.90'. The fourth row is 'Network Mask' with the value '255.255.255.0'. The fifth row is 'Gateway' with the value '192.168.30.1'. At the bottom of the screen, there are two buttons: 'OK' and 'Close'.

Ethernet Configuration Screen

13 VNC Viewer

13.1 What is VNC Viewer?

VNC viewer software comes with your FURNACEDOCTOR®-PRO on the included Flash drive.

13.2 Example

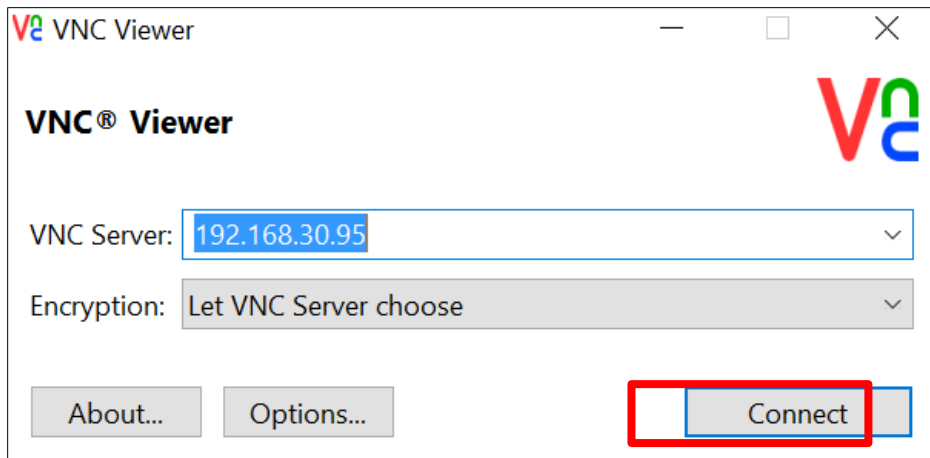
The instrument's network settings are entered in the Configuration Menu / Network Settings. An example of the settings for a network is shown below. Your settings will be different.

NETWORK SETTINGS	
Interface	eth0
Use DHCP	No
IP Address	192.168.30.95
Network Mask	255.255.0.0
Gateway	192.168.0.1

Network Settings Example

Using the information from your IT support team to fill in the IP ADDRESS and GATEWAY addresses. The other settings can stay as shown.

Install VNC Viewer (<http://www.realvnc.com/download/>) and run this. It will ask you for the IP address of the instrument. Then click on connect.



VNC Viewer, Select Connect

If it connects to the instrument it will almost immediately ask for the password. The password is:

x11vncpwd

This allows for remote access each FURNACEDOCTOR®-PRO V2.0 and is helpful for grabbing screen shots of the instrument for documentation. All of the screen shots for this document were captured using this VNC. You can pull up previous log files and screen capture trend charts from running processes or archived jobs. Remember that this is just like pressing the buttons on the instrument so let your operators know when you are accessing the instrument remotely.

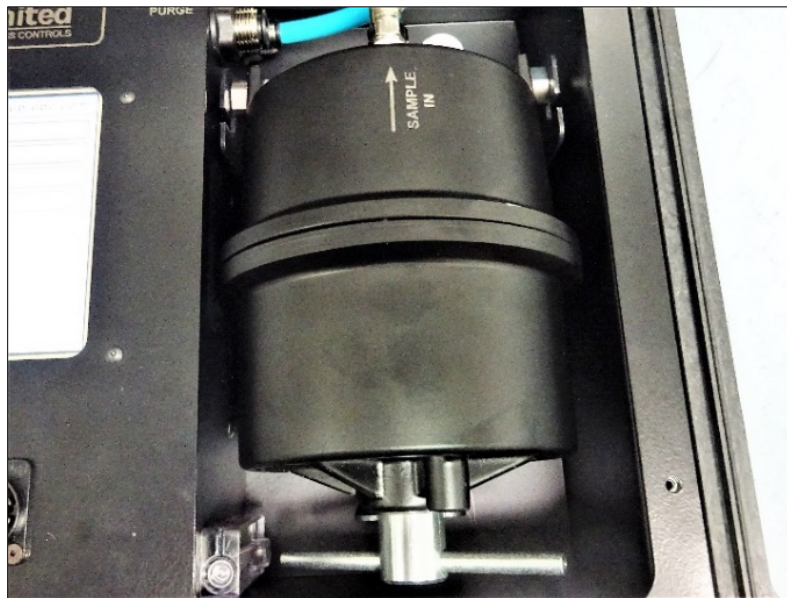
Another advantage of this feature is you are using your mouse scroll to page through screens and selection lists. This is much faster than using the touchscreen scroll. Adding or changing recipes on the instrument is much faster for example through a VNC connection.



14 General Maintenance

14.1 Inspecting and Replacing the Filter

Remove the Filter Housing by lifting it upright as shown below.



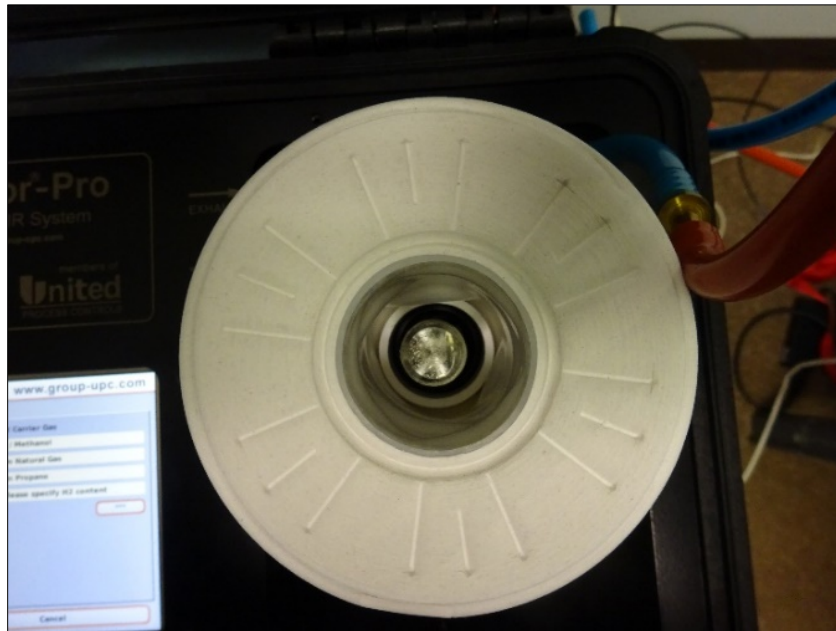
Filter Location



Upright Filter



Remove the filter from the Filter Housing by Turning the T-Handle in a counter clock wise direction until the Filter Cap disengages from the housing, then remove the filter for inspection.



Filter View in Housing



Top View of Filter



Fully Inspect the Filter for any signs of discoloration, then replace the Filter paying attention to the filter orientation during replacement and ensure that the Filter O-ring remains in its proper position during reinstallation.



Manufacturer's Recommendation



Filter O-ring Location

Below is a pictorial representation of filter elements in various stages of contamination, all 4 of these filter elements should be replaced, the filter bowl should be cleaned out to prevent further contamination, and a new filter element should be installed.



Filters in various stages of contamination

The following photo illustrates the appearance of a filter element that has been in use for a few months, the filter is “sooting up” and should be replaced prior to use.



Typical after a few months use.



The yellowish tint in this filter indicates contamination due to dirty natural gas and should be replaced before use.



Filter “Dirty Natural Gas”

The multiple indentations seen on the next filter are indicative that the filter has been removed and replaced several times, this filter element should be replaced before use.



Multiple Indentations from Filter Housing

This final contaminated filter element is in horrible condition and is way overdue for replacement. This filter element cannot do its job properly and due to internal component and cell contamination, it resulted in very costly repairs.



Filter Element is Horrible

15 TROUBLESHOOTING

15.1 How Can I Use the FurnaceDoctor®-Pro to Troubleshoot the Furnace?

Carbon is computed using actual gas values, so it is more accurate than the assumptions made by the probe.

Compare the %C calculated by the FurnaceDoctor®-Pro to %C displayed on the Carbon Control instrument.

Your carbon controller is set up with some assumptions about the content of the furnace atmosphere. Most controllers assume a CO of 20% as the default value. The FurnaceDoctor®-Pro can precisely measure the actual CO and allow for adjustment of this “factor” to the correct %CO.

Observe the probe millivolts as computed by the FurnaceDoctor®-Pro and displayed by the carbon controller. These should be within 1-2 % of each other. If not, and you have entered the process temperature into the FurnaceDoctor®-Pro correctly, you probably have a problem with the probe or the controller.



First check the millivolt reading at the back of the probe with a meter to eliminate any possible instrument problems.

Next be sure that the probe is free of soot by burning the probe off. If the numbers still do not agree, perform an impedance test on the probe to help determine the electrode condition. You will also want to check to see how fast the probe recovers after this test. Recovery time should be in seconds, not minutes.

Finally disconnect the probes reference air tube and see if the millivolts reading on the controller changes; if it does, you have a leak in the probe substrate.

If you change the probe or if you are sure that the probe is ok, check to be sure you are obtaining a good sample at the FurnaceDoctor®-Pro. Sample ports are frequently the cause of the problem.

A good non-metallic sample probe helps solve this. One trick is to use the probe burn-off port to obtain a sample. This has a few problems associated with it. In furnaces running high methane contents, the methane will crack near the alloy surface of the probe creating a local reaction not representative of the overall furnace atmosphere.

15.2 How Do I Interpret the Gas Values?

CO: For most atmospheres should be around 18-20%. If it is lower than 18% then observe the following:

- Check generator for proper operation.
- If you are using nitrogen methanol, check the ratio of nitrogen to methanol.
- Inspect the atmosphere sparger to verify that it is in good condition.
- If you are using nitrogen as the carrier gas for the ethanol, be sure that the methanol does not have nitrogen bubbles in it.
- If you are using ammonia, the ammonia additions will dilute the %CO in the furnace. Remember there is only room for 100% of the gas in the furnace.
- Check for leaks. This can be confirmed by a high CO₂. Air leaks typically cause the control system to add more natural gas to the furnace.
- If you are asking for a high carbon potential, high methane content, may also dilute atmosphere mix. High surface area loads will be able to draw more carbon out of the atmosphere. Typically, the methane content will go up because of this.

CO₂: This number can be anywhere between 0.05% to 1% and is dependent on temperature and gas composition. It tracks inversely to carbon potential. At 1600°F a 0.4%CO will be about 0.62% CO₂ (assuming 20% CO). To achieve a 0.4% carbon at 1750 °F, CO₂ will be around 0.25.

If the carbon potential is lower than expected, the CO₂ should be higher than expected.

- Check for air leaks.
- Check for burner tube leaks.



- Check for furnace fan water jacket leaks.
- Check generator or nitrogen methanol system.
- If the probe system is in agreement with the FurnaceDoctor®-Pro, be sure there is adequate carrier gas flow, and adequate enriching gas flow.
- Is carbon controller turning on the natural gas when it should?
- If there is a manually adjusted flowmeter for the enriching gas make sure this is fully opened.

CH₄: Most batch furnaces will operate with a CH₄ content ranging from .1% to 4-5%. At the start of the cycle this number is higher than when the atmosphere and the work approach equilibrium with each other. Continuous furnaces performing carburizing will usually operate at higher methane levels. In fact, in some belt furnace applications this is necessary for the process to work!

High free methane (CH₄) content is usually a bi-product of the control system calling for too much natural gas due to an air leak, a defect in the Oxygen sensor, or a crack in the radiant tube.

- Check for air leaks.
- Check for burner tube leaks.
- Check for furnace fan water jacket leaks.
- Check generator or nitrogen methanol system
- Be sure that the probe control system is working properly

16 Frequently Asked Questions (FAQs)

When I do a calibration, the correct CO, CO₂, and CH₄ values are displayed, but if I switch back to the IR Gas Value screen, it shows *** for some gases. Why does this happen?**

- There can be a delay in the reading update when switching from the calibration function to the normal display function.
- If a delay occurs, the gas values should display properly within 45 seconds to a minute. In most cases the display usually updates in a few seconds.

Does the %CO change with furnace temperature or Cp in the furnace?

- %CO is not affected by temperature in and of itself but it is typical to have a lower CO at the furnace than the Endo generator. This is due to dilution of the furnace atmosphere by other gasses, during carbon control, and the reactions at the surface of the material during carburizing.
- CO is the principal agent in delivering carbon to the work and higher surface area will result in less CO in the furnace. The speed of this reaction is temperature dependent.
- You also have dilution from enriching gas and dilution air. It is not uncommon for the furnace CO to be measured at around 17-18% while the generator is supplying 20%.



Is CO content in the generator at different dew point and temperature values for the recommend range of the Endo gas generator?

- %CO is a function of generator efficiency and shouldn't change if the generator is stable.

We produce the Endo gas for all of our batch furnaces with one generator. Will %CO be the same in all furnaces?

- The CO probably will not be the same for all furnaces if they are loaded and controlling Carbon – see previous questions.

If the FurnaceDoctor Cp reading is different than the sensor Cp at a constant temperature, does it follow that this difference would be the same at a lower Cp with the same temperature?

- There is no linear correlation based on temperature for differences in Cp as measured by the Furnace Doctor or the sensor. The probe calculation is assuming a fixed %CO that might not be correct for the current load. If the furnace is running high CH₄ there most definitely will be a difference.

When do you use the FurnaceDoctor®-Pro calculation “C+CH₄” instead of “CP atm [%]”?

- The atmospheric Cp calculation is affected only by CO/CO₂ gas composition. The C% equation adds the Cp from the equilibrium calculations and the Cp from the catalytic reactions of methane to the Cp.
- The C+CH₄ should more closely match the probe reading because the probe is sensitive to CH₄ because there is a catalytic reaction caused by the CH₄ and the outer electrode of the probe.
- You will not see any significant difference in the carbon potential if the methane is less than 3%. Using proper alloy factors for the sensor Cp calculation should help match the FurnaceDoctor C+CH₄ carbon calculation.

17 EQUIPMENT RATINGS

Supply Voltage	110-240 VAC
Supply Frequency	50/60 Hz
Power Consumption	3.2/1.8 Amps

Certifications/Compliance



First IR Bench (Normal Range)

	Range	Resolution	Accuracy
CO	0-30%	0.37%	2% of range
CO ₂	0-20%	0.06%	2% of range
CH ₄	0-10%	0.62 %	2% of range



First IR Bench (High CO Range)

	Range	Resolution	Accuracy
CO	0-45%	0.37%	2% of range
CO2	0-20%	0.06%	2% of range
CH4	0-10%	0.62%	2% of range

Second IR Bench (Low CO2 Range)

	Range	Resolution	Accuracy
CO2	0-2%	0.06%	1% of range

Operating Temperature

40°F - 120°F

Relative Humidity

5% - 90% non-condensing

Atmospheres

Suitable for:

Carburizing
Carbonitriding
Carbon Correction
Neutral Hardening
Austempering
Martempering
Precipitation Hardening
Annealing
Normalizing
Stress – Relieving

call UPC if your process is not listed

****NH₃ (ammonia) is strictly prohibited in the sample****

-NH3 filters available upon request-

18 SPARE PARTS

Replacement Battery	T-LITHIUM-BATTERY
Desktop Battery Charger	T-LITHIUM-SMARTCHARGER
Filter Element	T-FIL-04
Filter Housing	T-FIL-03E
Extra Tubing	T-REDTUBE (qty. in feet)
Portable Battery Charger	T-AC-ADAPTOR
Barb Adaptor (for tubing)	T-AD1-TU-BA-0.25



19 CUSTOMER SUPPORT

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