

FurnaceDoctor®-Pro

V2.0

USER MANUAL

Revision Number 003



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TABLE OF CONTENTS

1	<i>SAFETY</i>	6
2	<i>THEORY</i>	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	<i>OPERATIONS</i>	12
3.1	Precautions Before Operations:.....	12
3.2	User Manual Specifics	12
3.3	Sample Gas	13
3.4	Particles.....	13
3.5	Humidity	13
3.6	Liquids.....	14
3.7	Entrained Oil.....	14
3.8	Gas Sampling Ports	14
4	<i>INITIALIZING THE ANALYZER</i>	16
4.1	Connecting the Gas Lines.....	16
4.2	Default Display	19
5	<i>THE MENU SYSTEM</i>	20
5.1	Accessing the Main Menu Screen	20
5.2	Main Menu Available Options	21
6	<i>I/R Gas Values</i>	22
6.1	Selecting the Dew point, Calculation Modes	22
6.2	Furnace Mode Selection.....	23
6.3	Generator Mode Selection	25
6.4	ENDO and EXO Selection	26
6.6	Data Logging Preparation	27
6.7	Enter Log I.D.	28
6.8	Enter Log File Name	29
6.9	Enter Data Log Interval.....	30

6.10	Enter Additional Comments.....	32
6.11	Insert USB Stick	35
6.12	Start Data Logging	36
6.13	Stop Data Logging	38
7	View Chart Icon	40
7.1	Stand Alone Chart Viewer	40
7.2	Viewing Log Files.....	41
8	CALIBRATION.....	42
8.1	Gas Requirements.....	42
8.2	Calibration: Span Gas Verification	43
8.3	To Begin Calibration	44
8.4	Starting Calibration	48
8.5	Zero Calibration	48
8.6	Span Calibration	52
8.7	Restoring Factory Calibration	55
9	PROCESS CALCULATOR.....	57
9.1	Accessing the Process Calculator	57
9.2	Calculation Method Set to: Options.....	61
10	UTILITIES.....	62
10.1	Utilities Configurable Options.....	62
10.2	Date and Time.....	63
10.3	Configure I/R Screen.....	65
10.4	Configure I/R Screen, Page 1 Options Include	66
10.5	Carrier Gas Selection Options	67
10.6	Please Select Carrier Gas	67
10.7	Configure I/R Screen, Page 2 Options Include	69
10.8	Generator Mode Process Temperature	70
10.9	Gas Generator Selection	71
10.10	Configure I/R Screen, Page 3 Options Include	73
11	BATTERY CHARGER	74
11.1	What’s Included?	74
11.2	Charging	74
12	ETHERNET SETUP	75

12.1 Accessing the Ethernet Setup.....75

13 VNC Viewer 78

13.1 What is VNC Viewer?.....78

13.2 Example.....78

14 General Maintenance 80

14.1 Inspecting and Replacing the Filter80

15 TROUBLESHOOTING..... 86

15.1 How Can I Use the FurnaceDoctor®-Pro to Troubleshoot the Furnace?.....86

15.2 How Do I Interpret the Gas Values?87

16 Frequently Asked Questions (FAQs)..... 89

17 EQUIPMENT RATINGS 91

18 SPARE PARTS 93

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)

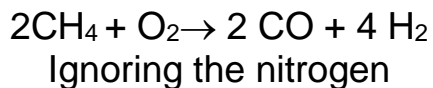
These ratios are typical whether you are producing gas by means of an endothermic generator or using prepared gasses such as nitrogen and

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:

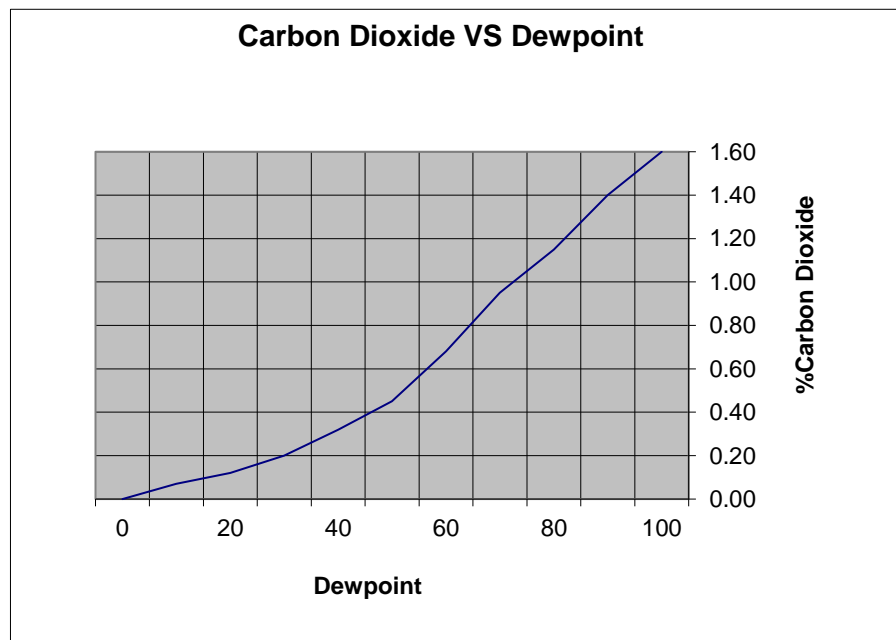
- The catalyst must be clean, and free from soot. If soot is present, the efficiency of the above reactions goes down.
- You must have adequate temperature to keep the rate of the reactions high enough.

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.

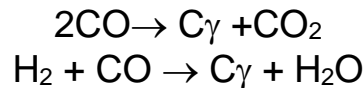


To obtain the desired dew point, adjustments are made to either your oxygen probe control system, or the generator carburetor.

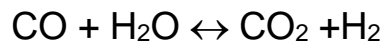
2.5 How Will the FurnaceDoctor®-Pro Help Me with My Furnace Atmosphere?

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 H₂ and O₂ 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 CO₂ is a much more accurate means of determining equilibrium carbon.

One potential problem is when CH₄ 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

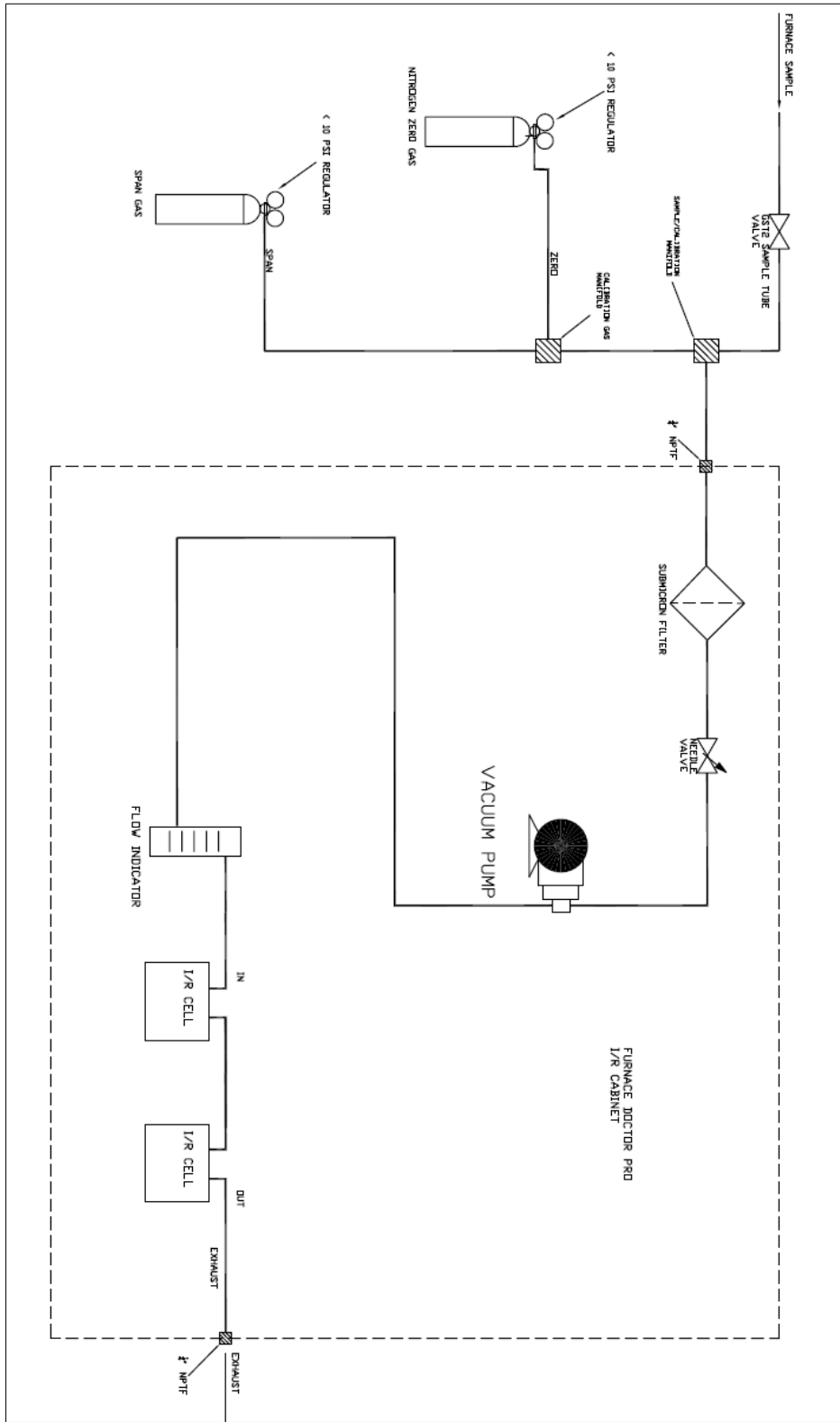
The sample gas must be free of any contamination.

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

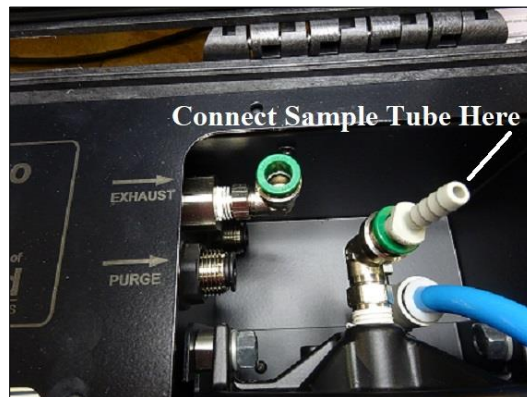
***** **CAUTION** *****

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.



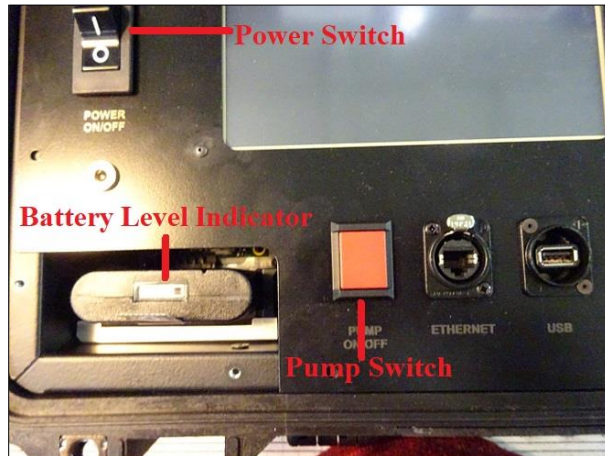
Sample Tube Connection



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.

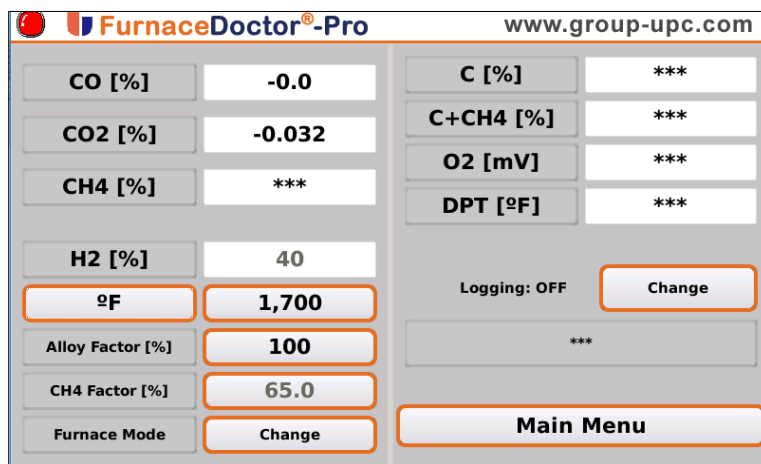
Your FurnaceDoctor®-Pro is equipped with a battery monitor. When a battery level monitor is low, it is time to charge your FurnaceDoctor®-Pro.



Battery Level Indicator

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

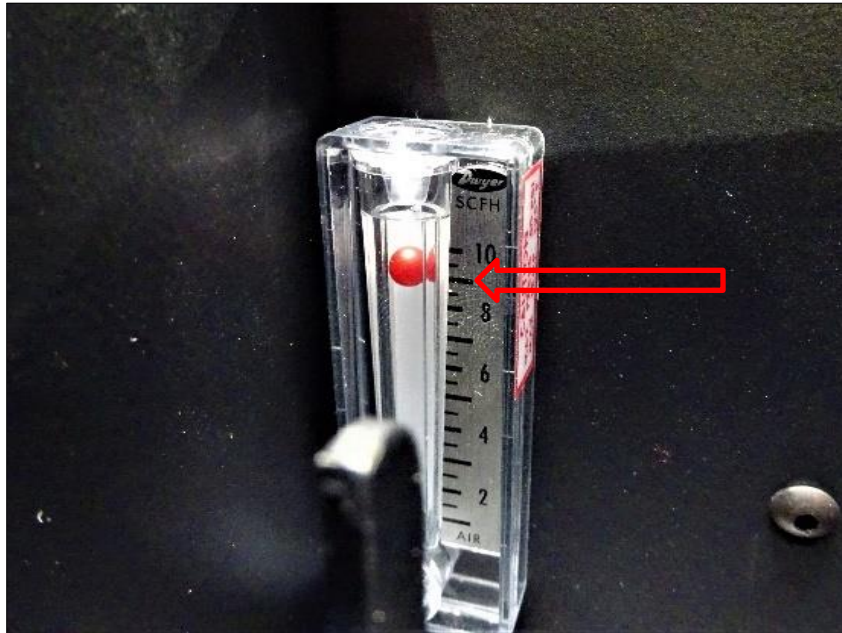
Manual entry fields are in white with orange borders, live and calculated fields are in white. Characteristic Fields are gray.



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.

The screenshot displays the 'I/R Gas Values' screen of the FurnaceDoctor®-Pro instrument. The interface is organized into two columns of data and control elements. The top left corner features the 'FurnaceDoctor®-Pro' logo and the website 'www.group-upc.com'. The data is presented in a grid-like format with labels and values. Several values are highlighted with yellow boxes: CO [%] (25.0), CO₂ [%] (0.954), CH₄ [%] (10.00), O₂ [mV] (1,050), and DPT [°F] (66). The temperature is shown as 1,700 °F. Other parameters include H₂ [%] (40), Alloy Factor [%] (100), and CH₄ Factor [%] (65.0). Control buttons for 'Furnace Mode' and 'Endo Mode' are labeled 'Change'. A 'Logging: OFF' indicator has a 'Change' button next to it. A 'Main Menu' button is located at the bottom right. A '***' separator is visible between the logging and main menu sections.

Parameter	Value
CO [%]	25.0
CO ₂ [%]	0.954
CH ₄ [%]	10.00
H ₂ [%]	40
°F	1,700
Alloy Factor [%]	100
CH ₄ Factor [%]	65.0
Furnace Mode	Change
Endo Mode	Change
C [%]	0.22
C+CH ₄ [%]	0.60
O ₂ [mV]	1,050
DPT [°F]	66
Logging	OFF
Change	Change

Main Menu	

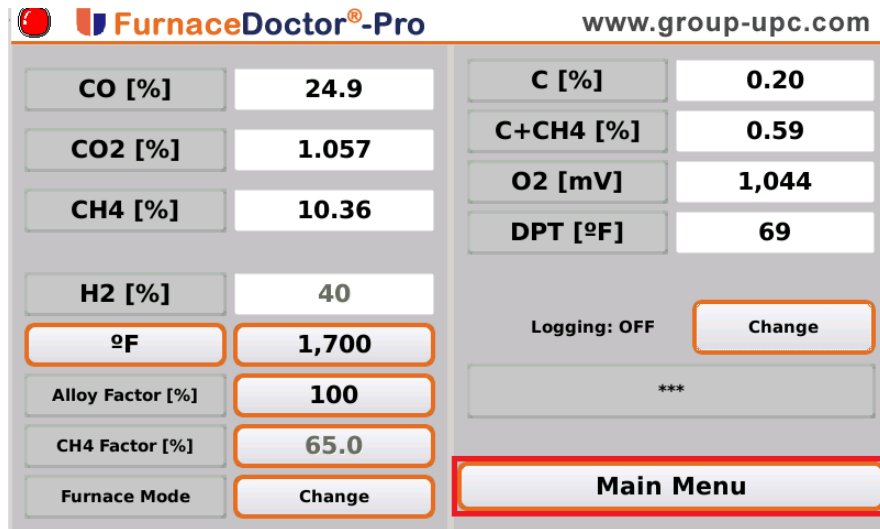
Default Display I/R Gas Values

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.



“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

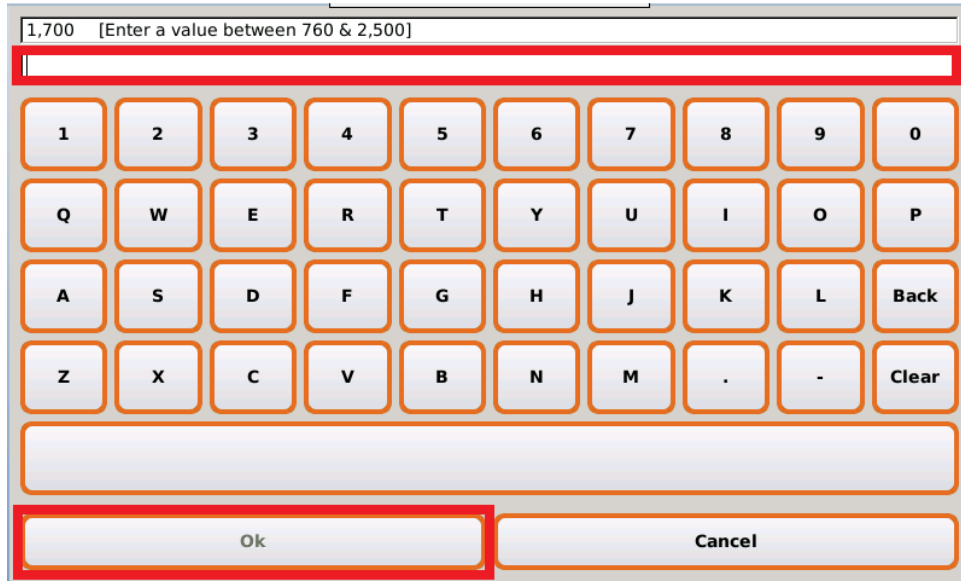
Furnace Mode Selection

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.



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.

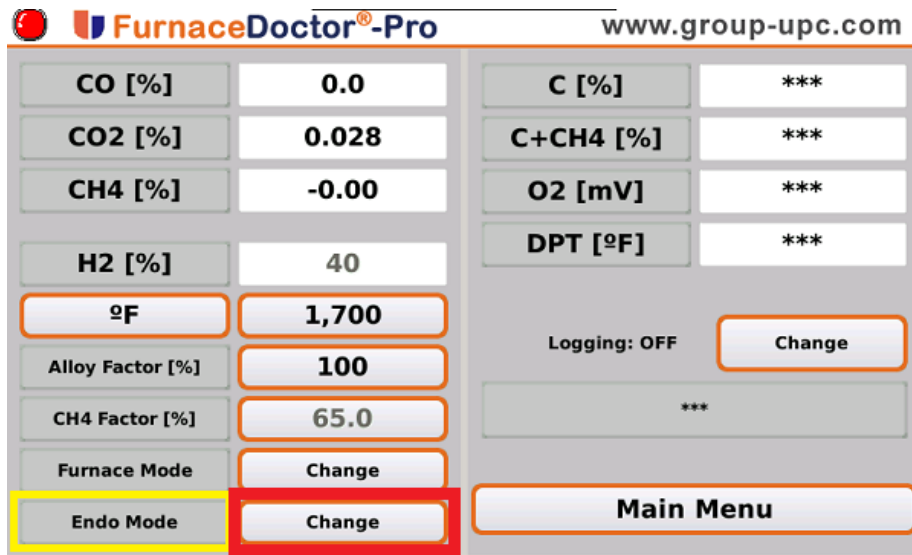
H2 [%]	40
°F	1,680
Alloy Factor [%]	100
CH4 Factor [%]	65.0
Generator Mode	Change

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.

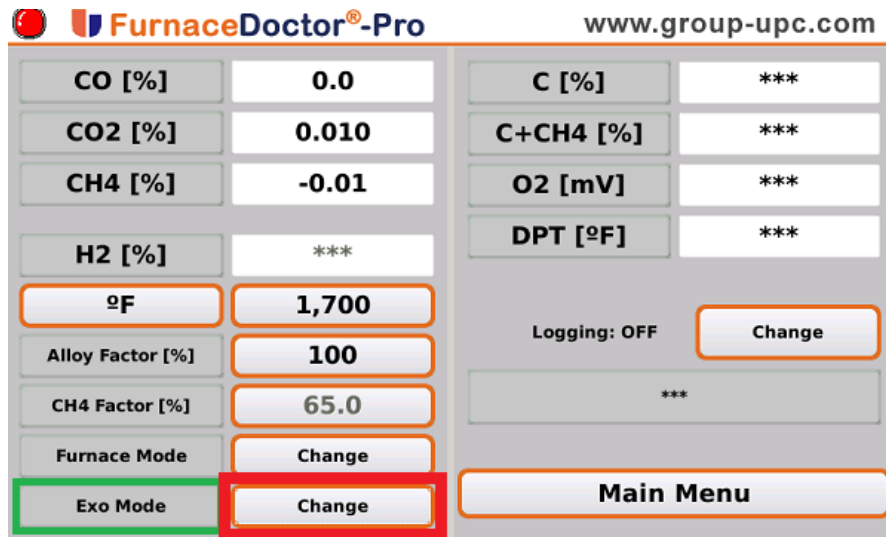
6.4 ENDO and EXO Selection

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.



“ENDO Change”

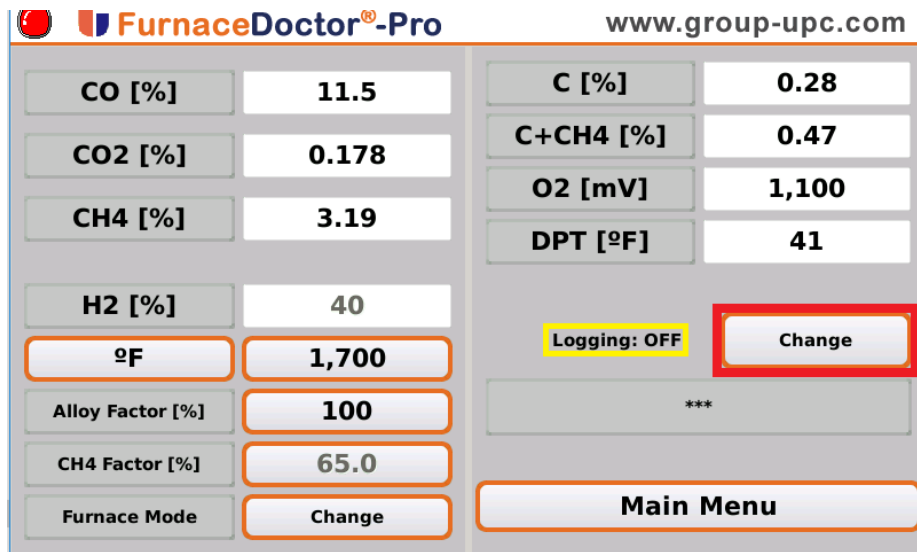
To change from ENDO to EXO touch the Change button to the right of the “ENDO” or “EXO Field”. Touching the change button will switch between the 2 modes.



“EXO Change”

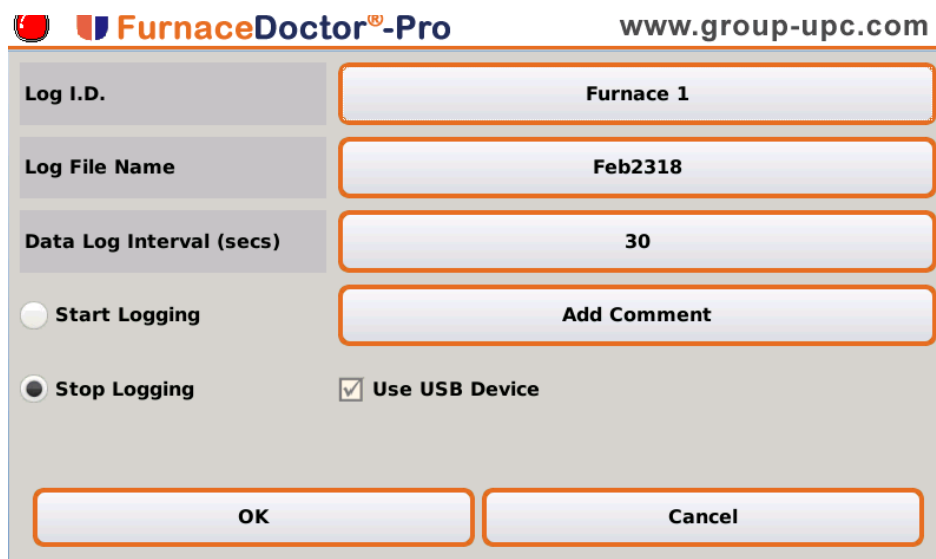
6.6 Data Logging Preparation

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



Logging On/Off Button

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



“Log ID Screen”

6.7 Enter Log I.D.

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

The screenshot shows the main configuration screen of the FurnaceDoctor®-Pro application. At the top, the logo and name 'FurnaceDoctor®-Pro' are on the left, and the website 'www.group-upc.com' is on the right. The screen contains several input fields and controls:

- Log I.D.:** A text field containing 'Furnace 1', highlighted with a yellow border.
- Log File Name:** A text field containing 'Feb2318'.
- Data Log Interval (secs):** A text field containing '30'.
- Start Logging:** A radio button that is currently unselected.
- Stop Logging:** A radio button that is currently selected.
- Use USB Device:** A checked checkbox.
- Add Comment:** A text field.
- OK and Cancel:** Two buttons at the bottom of the screen.

“Log ID Field”

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

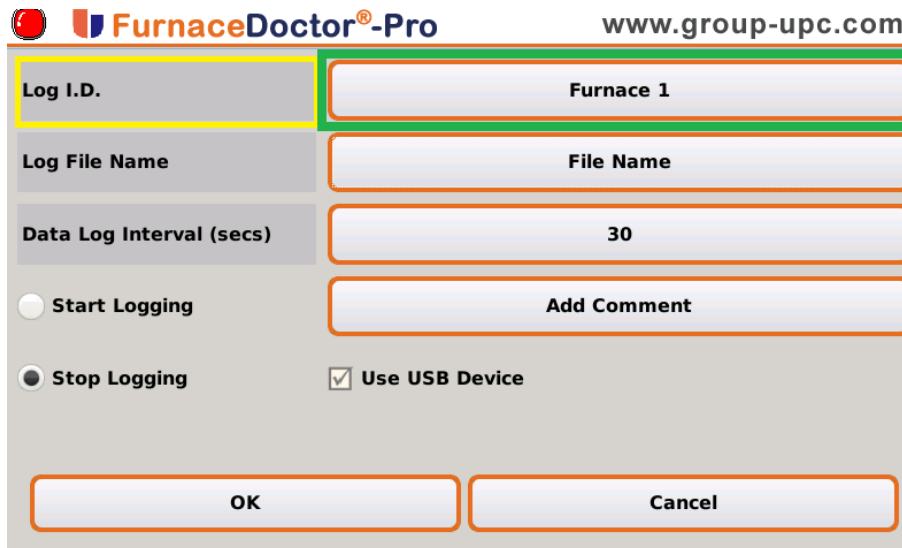
For example; you may identify the log file by typing “Furnace 1” in the second line of the keyboard screen, then touch Ok in the bottom left corner of the screen.

The screenshot shows a dedicated keyboard interface for entering the Log I.D. The top of the screen has a title bar that says 'Log I.D. Entry'. Below the title bar is a text input field containing the text 'Furnace 1'. The keyboard consists of several rows of buttons:

- Row 1: Numbers 1 through 0.
- Row 2: Letters Q through P.
- Row 3: Letters A through L, followed by a 'Back' button.
- Row 4: Letters Z through M, followed by a period/underscore button and a 'Clear' button.
- Below the keyboard is a large empty text field.
- At the bottom are two buttons: 'Ok' and 'Cancel'.

“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



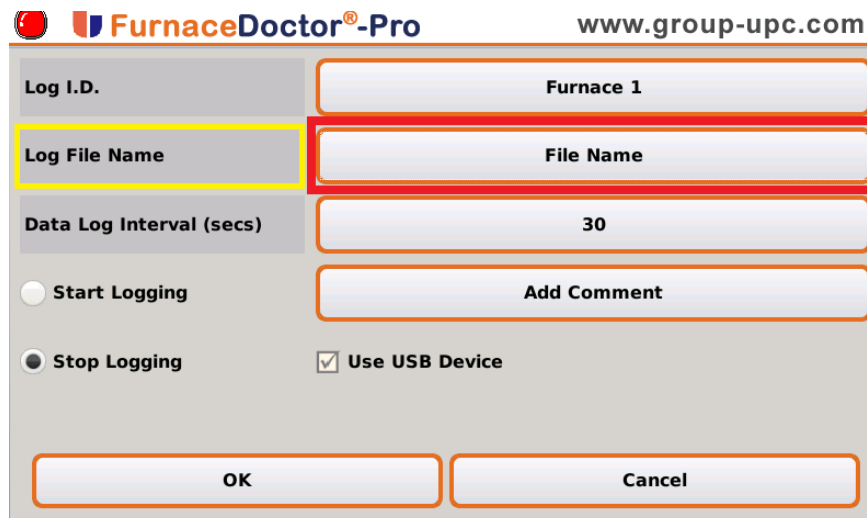
The screenshot shows the FurnaceDoctor®-Pro interface with the following fields and controls:

- Log I.D.:** A text field containing "Furnace 1", highlighted with a yellow border.
- Log File Name:** A text field containing "File Name", highlighted with a green border.
- Data Log Interval (secs):** A text field containing "30".
- Start Logging:** A radio button.
- Stop Logging:** A radio button.
- Use USB Device:** A checked checkbox.
- Add Comment:** A text field.
- OK** and **Cancel** buttons at the bottom.

"Furnace 1 Entry"

6.8 Enter Log File Name

Touch the "Log File Name" field button.



The screenshot shows the FurnaceDoctor®-Pro interface with the following fields and controls:

- Log I.D.:** A text field containing "Furnace 1".
- Log File Name:** A text field containing "File Name", highlighted with a yellow border.
- Data Log Interval (secs):** A text field containing "30".
- Start Logging:** A radio button.
- Stop Logging:** A radio button.
- Use USB Device:** A checked checkbox.
- Add Comment:** A text field.
- OK** and **Cancel** buttons at the bottom.

"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.

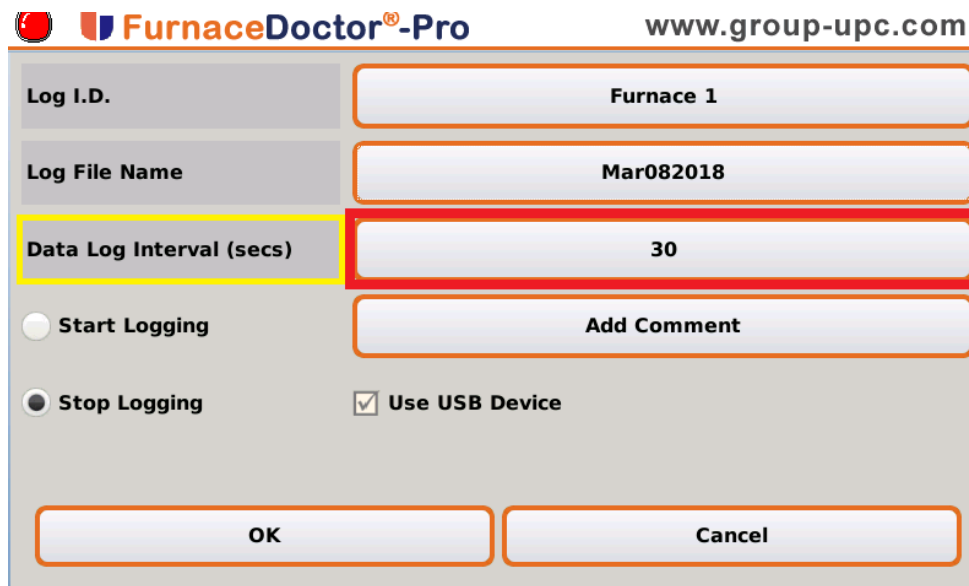


The screenshot displays a 'File Name' entry screen. At the top, there is a text field containing 'Mar082018'. Below this is a full QWERTY keyboard with orange borders around each key. At the bottom of the screen, there are two buttons: 'Ok' on the left and 'Cancel' on the right. The 'Ok' button is highlighted with a red rectangular border.

“Log File Name Entry”

6.9 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.



The screenshot shows the 'Data Log Interval Selection' screen. At the top, there is a logo for 'FurnaceDoctor®-Pro' and the website 'www.group-upc.com'. Below this are several fields and controls: 'Log I.D.' with the value 'Furnace 1', 'Log File Name' with the value 'Mar082018', and 'Data Log Interval (secs)' with the value '30'. The 'Data Log Interval (secs)' field and its value are highlighted with a red rectangular border. There are also radio buttons for 'Start Logging' and 'Stop Logging', a checkbox for 'Use USB Device', and an 'Add Comment' button. At the bottom, there are two buttons: 'OK' and 'Cancel'.

“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”.

The image shows a digital keypad interface for entering a data log interval. At the top, there is a text input field with the placeholder text "30 [Enter a value between 30 & 3,600]". Below this, the number "60" is entered into the field. The keypad consists of four rows of buttons: the first row contains digits 1-0; the second row contains letters Q-P; the third row contains letters A-L and a "Back" button; the fourth row contains letters Z-M, a period, a hyphen, and a "Clear" button. Below the keypad is a large empty rectangular area. At the bottom of the screen, there are two buttons: "Ok" and "Cancel". The "Ok" button is highlighted with a red border.

“Data Interval” Entry Screen

6.10 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.

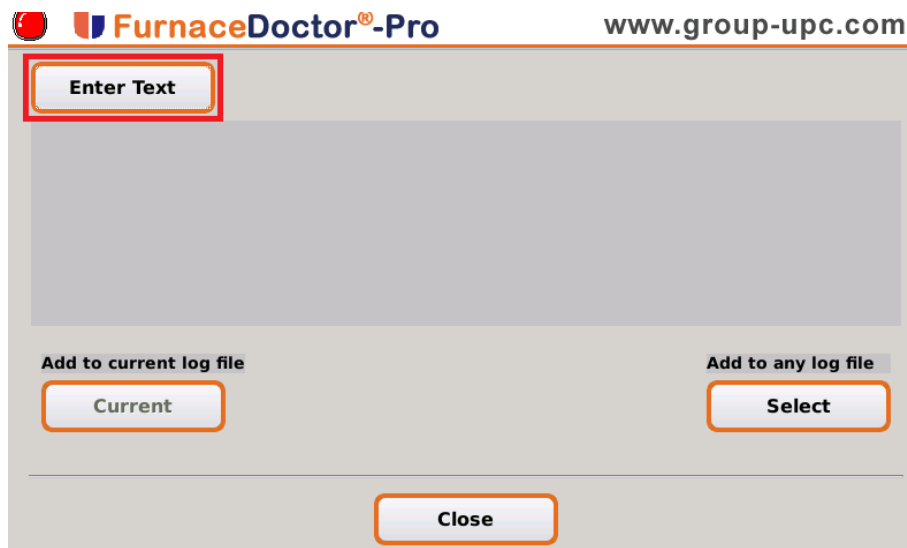


The screenshot shows the FurnaceDoctor®-Pro settings interface. At the top, there is a logo and the text "FurnaceDoctor®-Pro" and "www.group-upc.com". Below this, there are several input fields and controls:

- Log I.D.:** A text field containing "Furnace 1".
- Log File Name:** A text field containing "Mar082018".
- Data Log Interval (secs):** A text field containing "60".
- Start Logging:** A radio button that is currently unselected.
- Stop Logging:** A radio button that is currently selected.
- Use USB Device:** A checked checkbox.
- Add Comment:** A button highlighted with a red box, indicating it is the focus of the instruction.
- OK:** A button at the bottom left.
- Cancel:** A button at the bottom right.

“Add Comment” Button

Touch the “Enter Text” button.

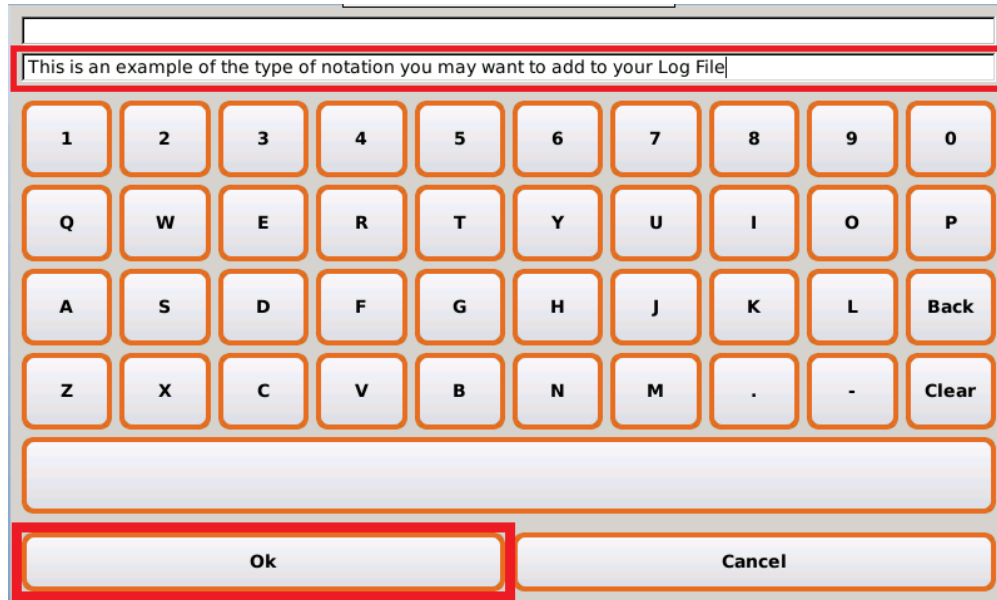


The screenshot shows the "Enter Text" dialog box. At the top, there is a logo and the text "FurnaceDoctor®-Pro" and "www.group-upc.com". Below this, there is a large text input area. At the bottom, there are two buttons for adding the text to a log file:

- Add to current log file:** A button labeled "Current".
- Add to any log file:** A button labeled "Select".
- Close:** A button at the bottom center.

“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.

FurnaceDoctor®-Pro www.group-upc.com

Log I.D.	Furnace 1
Log File Name	Mar082018
Data Log Interval (secs)	60
<input type="radio"/> Start Logging	Add Comment
<input checked="" type="radio"/> Stop Logging	<input checked="" type="checkbox"/> Use USB Device

Data Log I.D. Reflected Changes

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

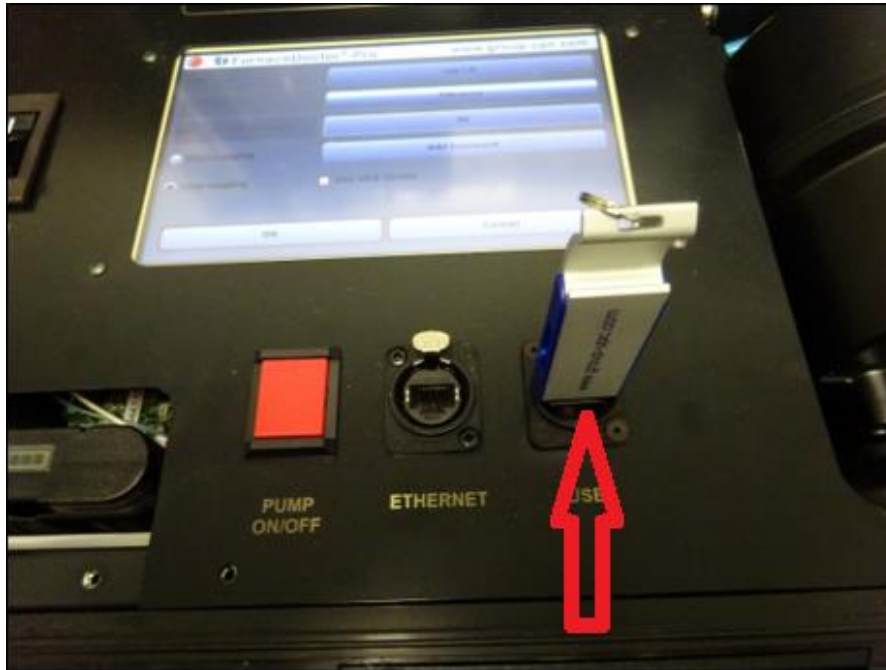
FurnaceDoctor®-Pro www.group-upc.com

CO [%]	4.3	C [%]	0.13
CO2 [%]	0.055	C+CH4 [%]	0.22
CH4 [%]	0.57	O2 [mV]	1,109
H2 [%]	40	DPT [°F]	36
°F	1,700	Logging: OFF	<input type="button" value="Change"/>
Alloy Factor [%]	100	***	
CH4 Factor [%]	65.0	<input type="button" value="Main Menu"/>	
Furnace Mode	<input type="button" value="Change"/>		

Default Screen

6.11 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)

6.12 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.

FurnaceDoctor®-Pro		www.group-upc.com	
CO [%]	24.9	C [%]	0.20
CO2 [%]	1.079	C+CH4 [%]	0.58
CH4 [%]	10.35	O2 [mV]	1,043
H2 [%]	40	DPT [°F]	70
°F	1,700	Logging: OFF	Change
Alloy Factor [%]	100	***	
CH4 Factor [%]	65.0	Main Menu	
Furnace Mode	Change		

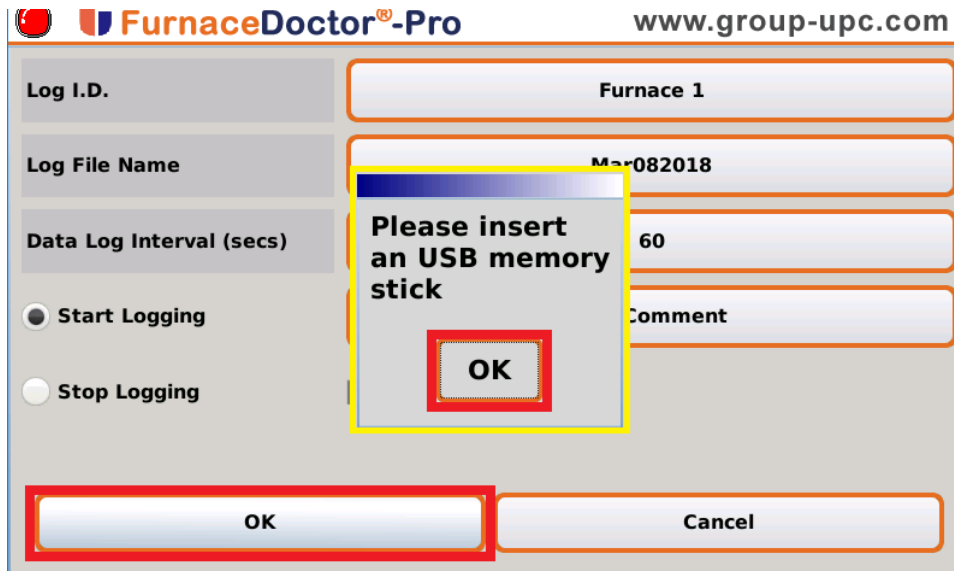
“Default Screen” = I/R Gas Values

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.

FurnaceDoctor®-Pro		www.group-upc.com	
Log I.D.	Furnace 1		
Log File Name	Mar082018		
Data Log Interval (secs)	60		
<input checked="" type="radio"/> Start Logging	Add Comment		
<input type="radio"/> Stop Logging	<input checked="" type="checkbox"/> Use USB Device		
OK	Cancel		

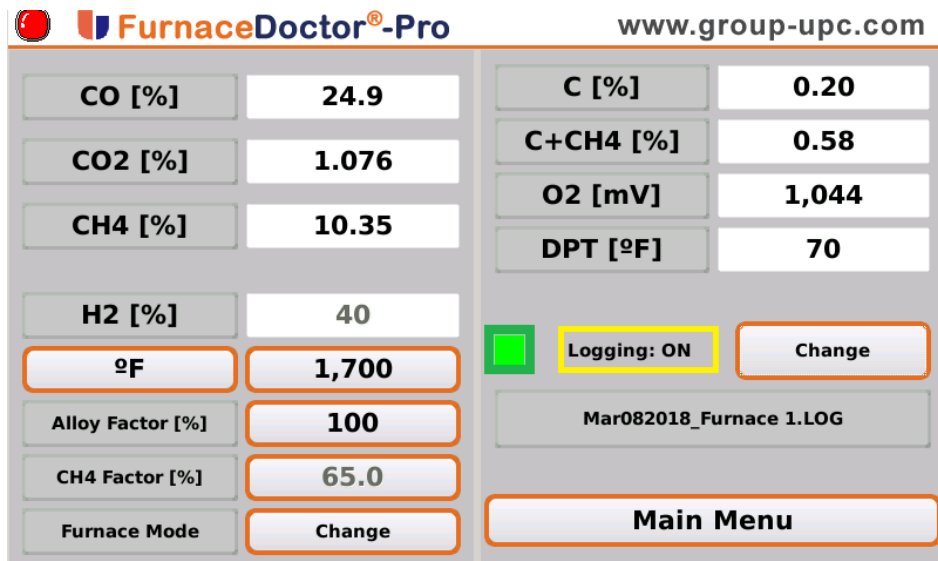
Touch the “Use USB Device” Button

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

6.13 Stop Data Logging

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

The screenshot shows the FurnaceDoctor®-Pro interface with the following data and controls:

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

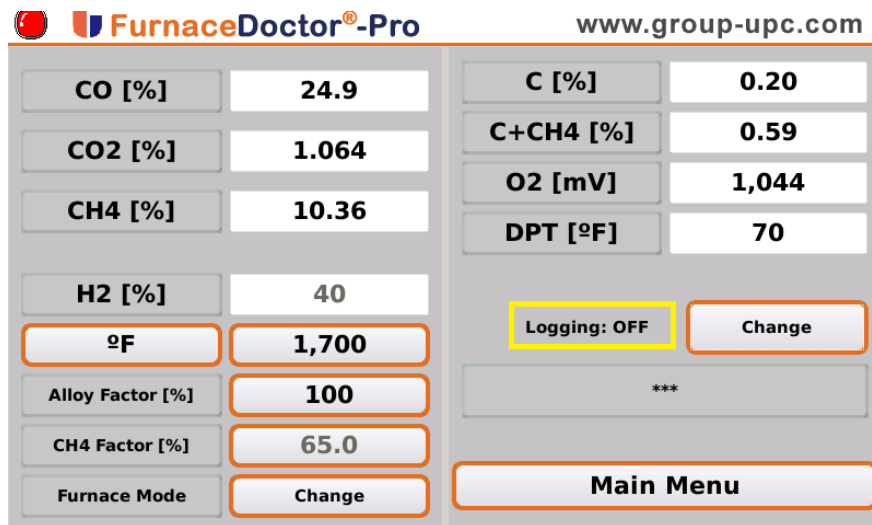
The following screen will be displayed. Touch on the circle to the left of “Stop Logging” and then touch OK.

The screenshot shows the FurnaceDoctor®-Pro interface with the following data and controls:

FurnaceDoctor®-Pro		www.group-upc.com	
Log I.D.	Furnace 1		
Log File Name	Mar082018		
Data Log Interval (secs)	60		
<input type="radio"/> Start Logging	Add Comment		
<input checked="" type="radio"/> Stop Logging	<input checked="" type="checkbox"/> 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 interface with the following data and controls:

FurnaceDoctor®-Pro		www.group-upc.com	
CO [%]	24.9	C [%]	0.20
CO2 [%]	1.064	C+CH4 [%]	0.59
CH4 [%]	10.36	O2 [mV]	1,044
H2 [%]	40	DPT [°F]	70
°F	1,700	Logging: OFF	Change
Alloy Factor [%]	100	***	
CH4 Factor [%]	65.0	Main Menu	
Furnace Mode	Change		

“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.

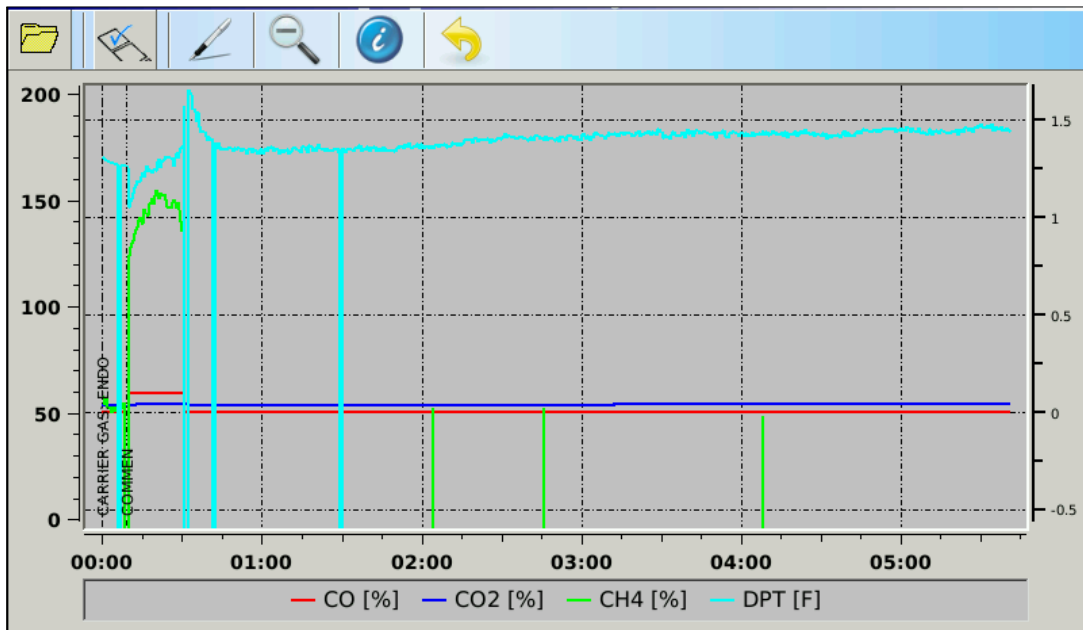
7 View Chart Icon

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

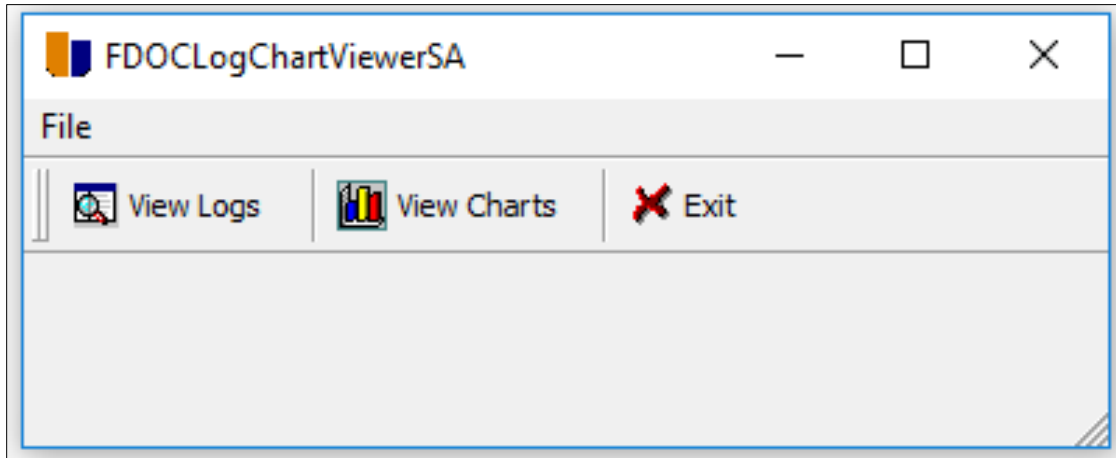
Data saved will include time, date, Log Id, CO, CO2, CH4, and user entered temperature. Expected O2mv, dew point, %Carbon, will be determined in the “Configure I/R Screen”. The checked items will be data logged. (See Utilities).

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

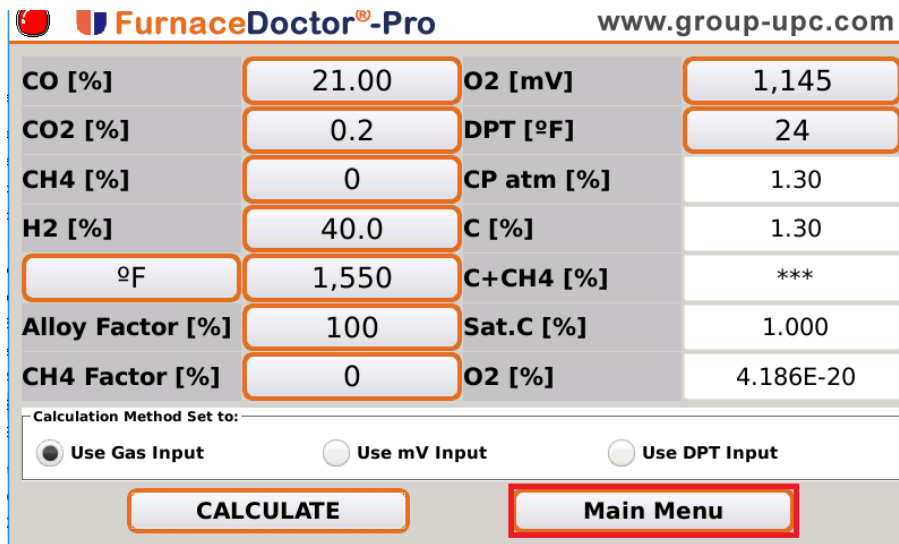
Connect the span bottle to the instrument and check the analyzer span on a weekly basis. If the instrument measures the span bottle within 2% of the analyzed values on the bottle, it is not necessary to calibrate the instrument.

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.



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

Last calibration date: 03/08/2018 Main Menu

“Calibration Screen”

Airgas
an Air Liquide company

Airgas Great Lakes region
 Airgas USA, LLC
 1290 Combermere Dr.
 Troy, MI 48083
 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
 Reference Number: 32-401043753-1
 Cylinder Volume: 138.7 CF
 Cylinder Pressure: 2015 PSIG
 Valve Outlet: 350

Expiration Date: Jan 10, 2026

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

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	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)

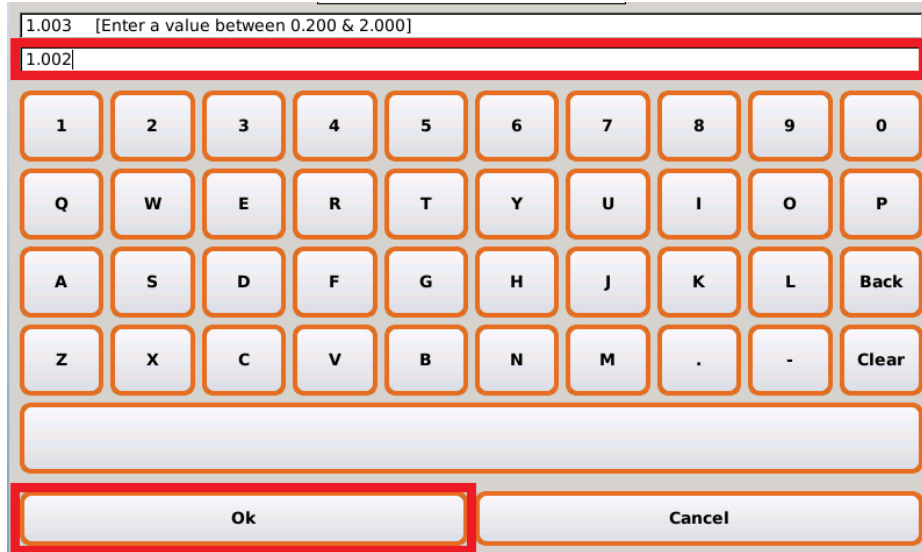
Calibrate <input type="button" value="ZERO"/> <input type="button" value="SPAN"/>	Last Factory Calibration <input type="button" value="07/22/2016"/> <input type="button" value="Restore"/>	Due in days <input type="button" value="Past Due"/>
--	--	---

Last calibration date: 03/08/2018

%CO₂ Value Entry Button

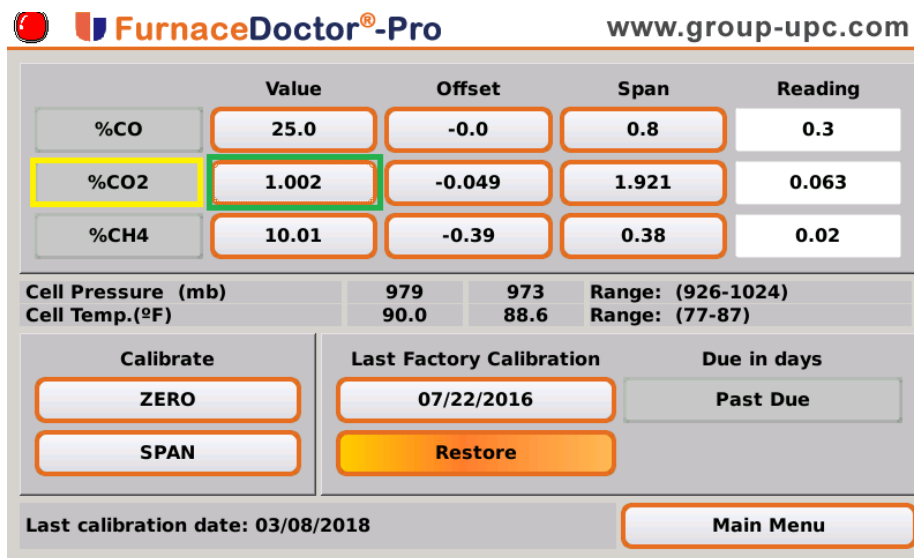
The %CO, %CO₂, and %CH₄ "Value Fields can be manually changed by touching the orange buttons under the "Value" field next to the corresponding gas type but must be changed one at a time. For demonstration purposes, we will focus on the %CO₂ number.

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



%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.



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

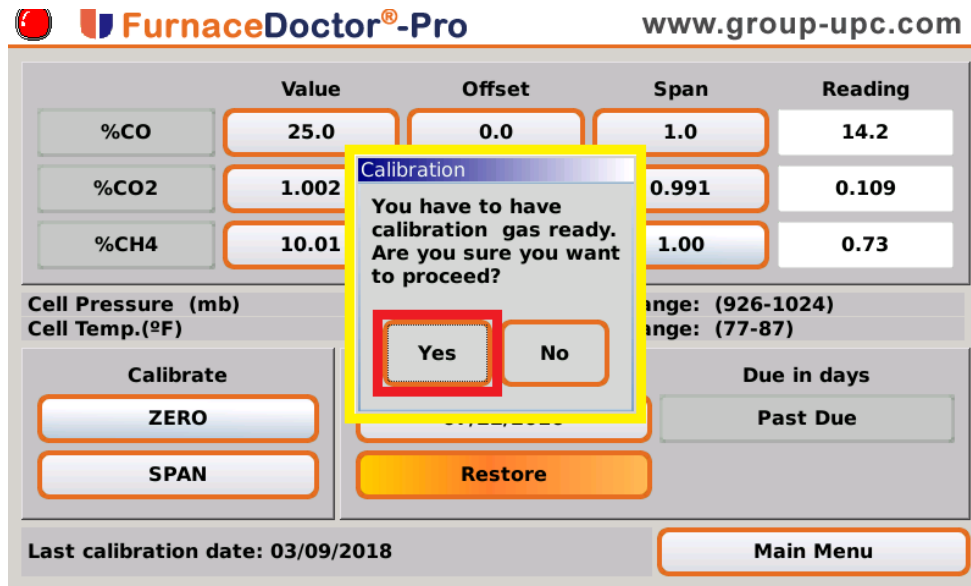
Cell Pressure (mb)	979	973	Range: (926-1024)
Cell Temp.(°F)	89.9	87.0	Range: (77-87)

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

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

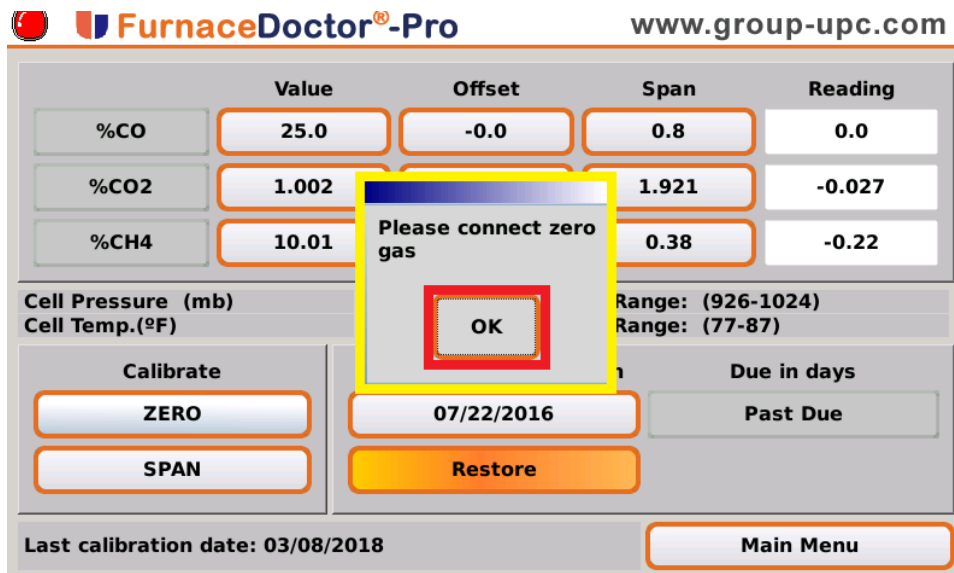
Touch Zero Button

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.



Calibration Gas Ready

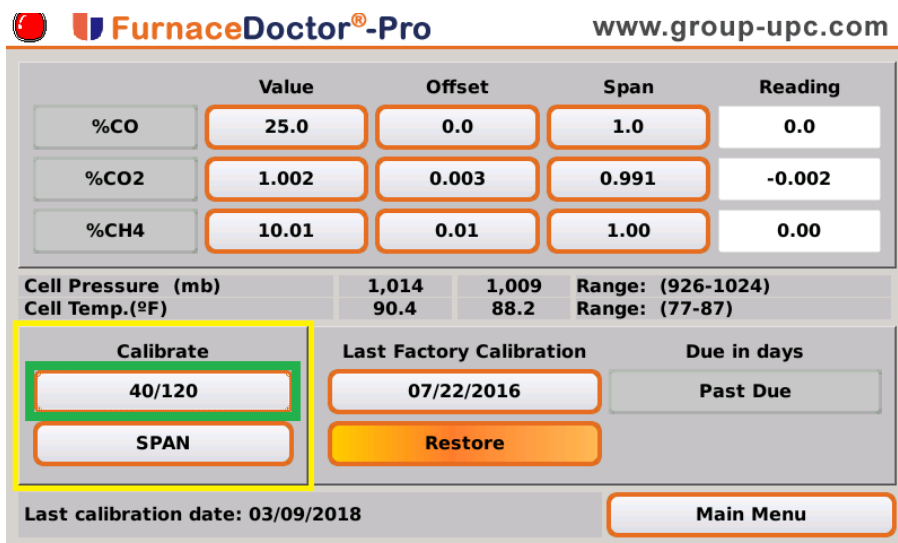
You will receive another prompt, reminding you to connect zero gas.



Connect Zero Gas Prompt

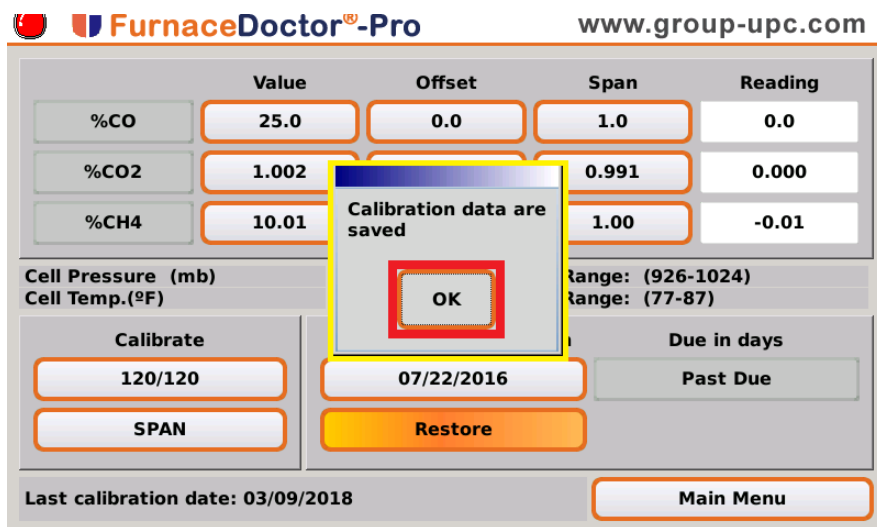
Verify that the Nitrogen (Zero Gas) has been connected to the Gas Analyzer’s “Sample In” Port and gas flow has been properly adjusted to mid-scale indication on the flow meter, press OK to start the calibration.

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.




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.



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.

 **FurnaceDoctor®-Pro** www.group-upc.com

	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)	1,016	1,011	Range: (926-1024)
Cell Temp.(°F)	93.8	89.2	Range: (77-87)

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

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.

FurnaceDoctor®-Pro www.group-upc.com

	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
 Due in days: Past Due

Restore

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.

FurnaceDoctor®-Pro www.group-upc.com

	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

Restore

Due in days: Past Due

Last calibration date: 03/09/2018 Main Menu

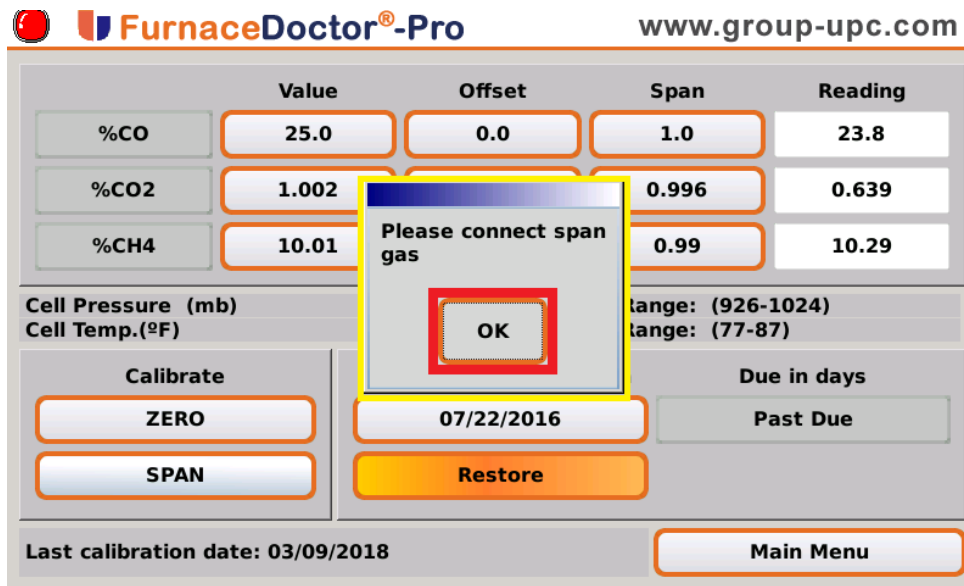
Calibration

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

Yes No

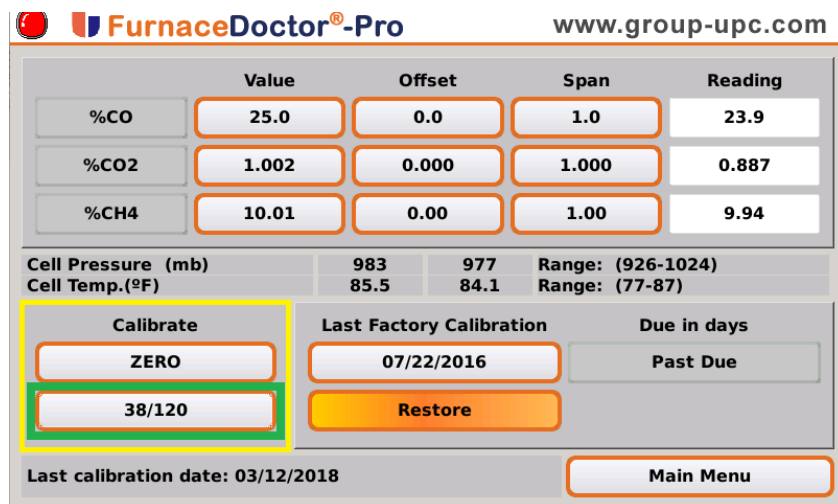
Span Gas Ready?

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.



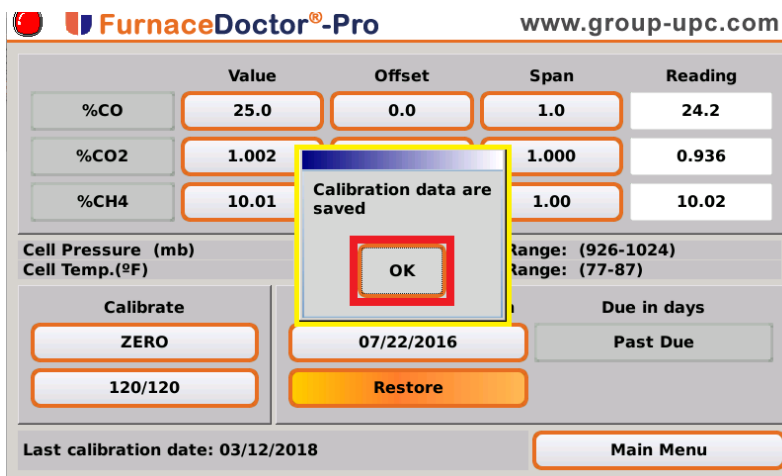
Connect Span Gas Prompt

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



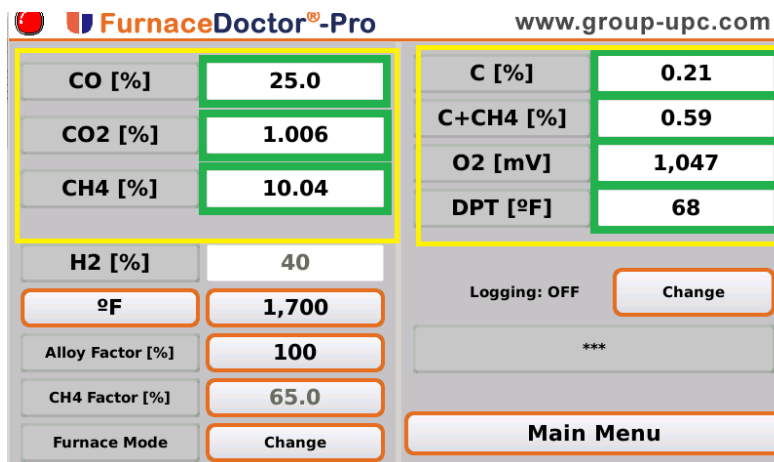
Span Gas Count-up Timer

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.



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).



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 screenshot shows the main calibration interface. At the top, there is a header with the logo and the website address www.group-upc.com. Below this is a table of calibration parameters:

	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

Below the table, there are fields for Cell Pressure (mb) and Cell Temp.(°F) with their respective values and ranges. A 'Calibrate' section contains 'ZERO' and 'SPAN' buttons. A 'Last Factory Calibration' section shows the date '07/22/2016' and a 'Restore' button. A 'Due in days' section shows 'Past Due'. At the bottom, there is a 'Main Menu' button and the text 'Last calibration date: 03/12/2018'.

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

This screenshot shows the same calibration interface as above, but with a confirmation dialog box overlaid. The dialog box has a title bar that says 'Calibration' and contains the text: 'Are you sure that you want to restore factory calibration?'. There are two buttons: 'Yes' and 'No'. The 'Restore' button in the background 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.

The screenshot displays the FurnaceDoctor®-Pro interface. At the top, the logo and website address 'www.group-upc.com' are visible. The main area contains a table of calibration data:

	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

Below the table, there are sections for 'Cell Pressure (mb)', 'Cell Temp.(°F)', and 'Due in days'. A 'Calibrate' section includes 'ZERO' and 'SPAN' buttons. A 'Restore' button is highlighted in orange. A dialog box in the center reads 'Factory calibration has been restored.' with an 'OK' button highlighted in red. At the bottom, there is a 'Main Menu' button and a note: 'Last calibration date: 03/12/2018'.

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.



Main Menu, Process Calculator Icon

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

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

“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.

The screenshot shows the FurnaceDoctor®-Pro interface with the following input fields and values:

Parameter	Value	Parameter	Value
CO [%]	20	O2 [mV]	1,100
CO ₂ [%]	0.2	DPT [°F]	45
CH ₄ [%]	0	CP atm [%]	***
H ₂ [%]	40.0	C [%]	***
Temperature Unit	°F	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

Buttons: **CALCULATE** and **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.

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

“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”.

20 [Enter a value between 1.00 & 50.00]

21

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

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.

FurnaceDoctor®-Pro www.group-upc.com

CO [%]	21.00	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

“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.

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

“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.

The screenshot shows the FurnaceDoctor®-Pro interface with the following data and controls:

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 Method Set to

10 UTILITIES

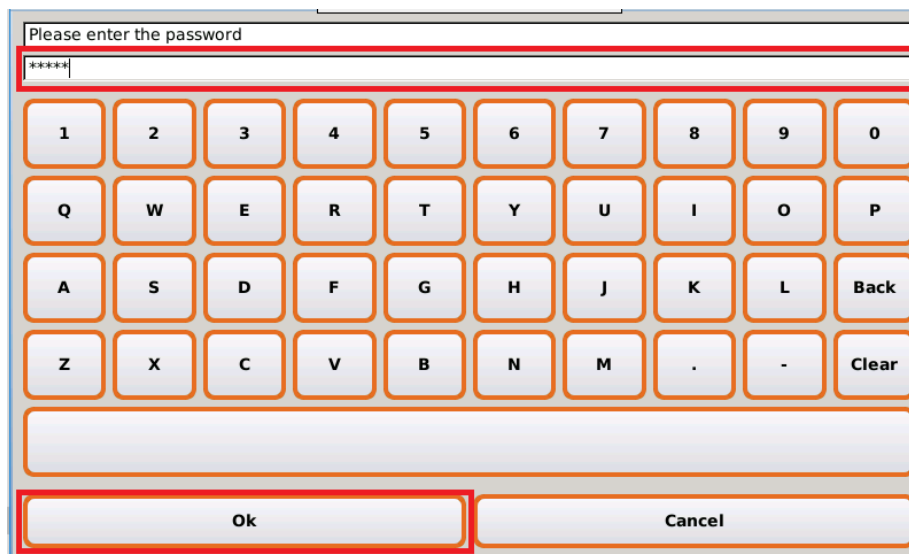
10.1 Utilities Configurable Options

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



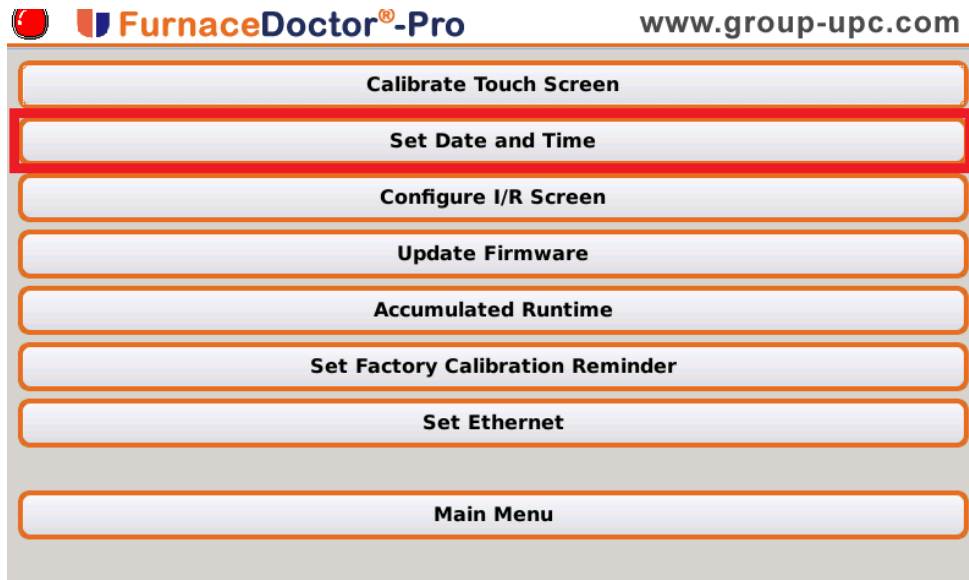
Select “Utilities” Icon

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”.



“Password” Entry

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



“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.

Date: 2018 [Enter a value between 2,000 & 3,000]

Year: 2018

Time: 12

Hour: 12

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

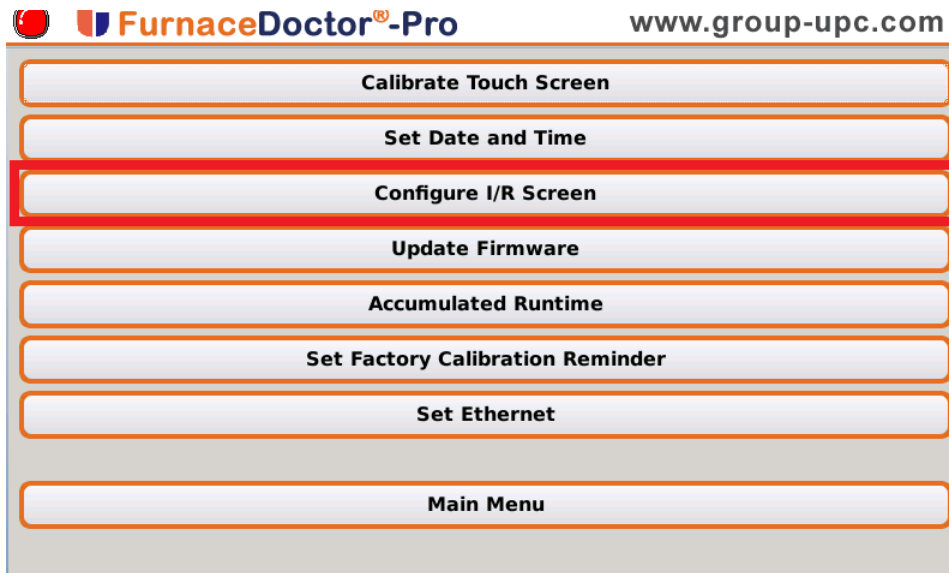
Ok Cancel

“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.

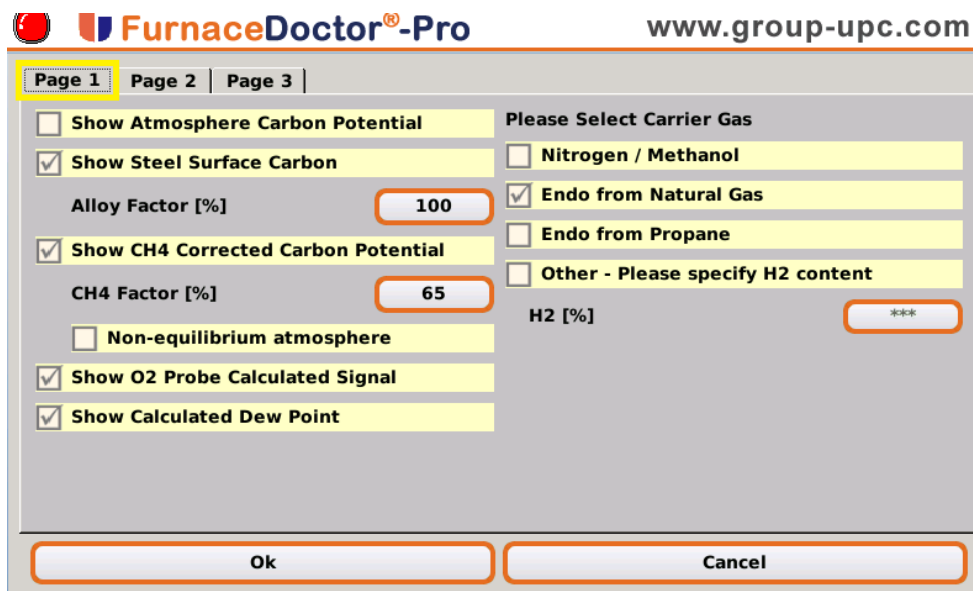
10.3 Configure I/R Screen

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



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.

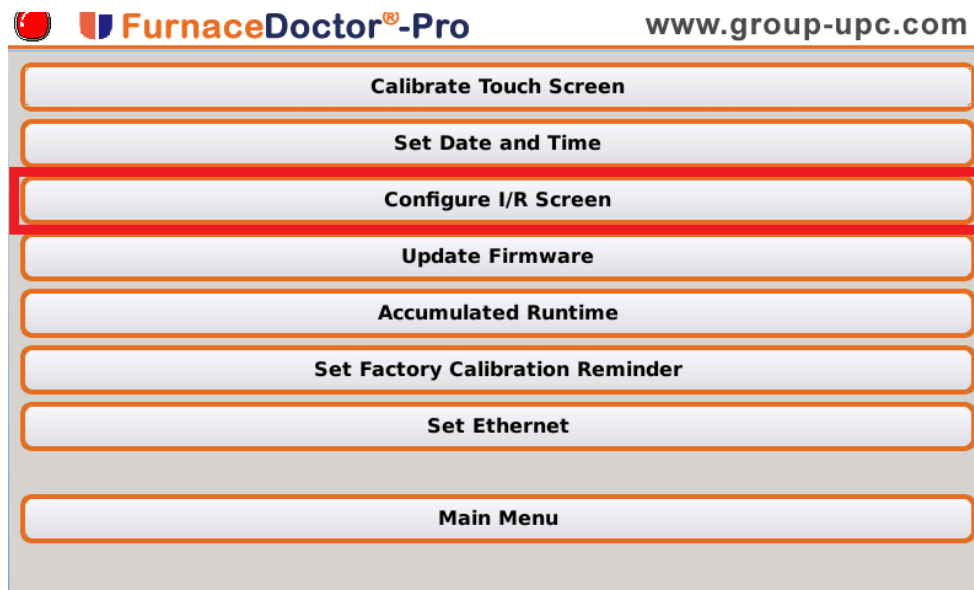
Endo from Natural Gas which will use a 40% H₂ to calculate dew point and carbon potential.

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

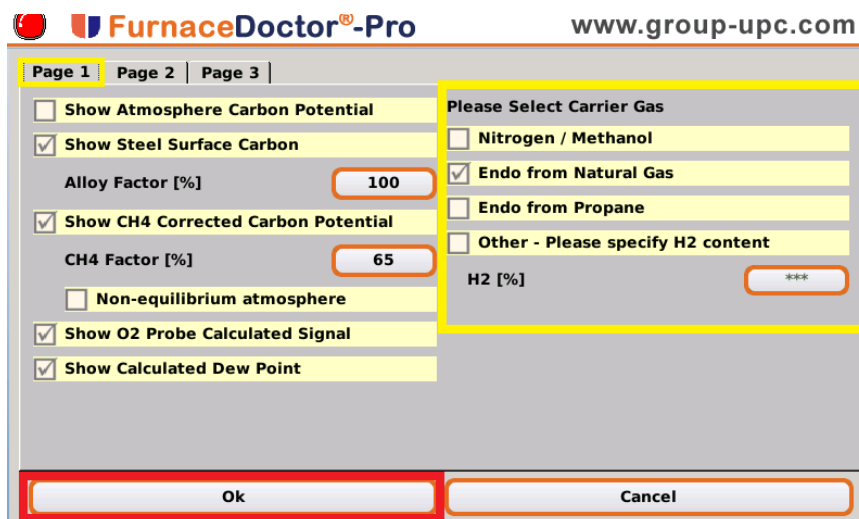
If “Generator Mode” has been selected in Section 6.3, the correct carrier gas for your process must also be selected. Touch the “Configure I/R Screen” button.



Configure I/R Screen

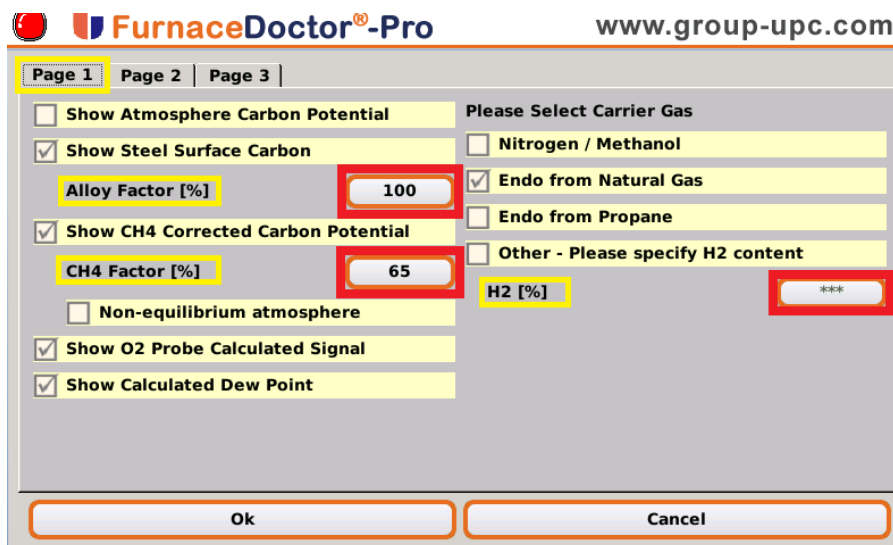
The “Configure I/R Screen” display will immediately open to the Page 1 configuration Page.

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.



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

The default values for these entries are:

Alloy Factor %	100
CH ₄ Factor %	65
H ₂ %	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.



“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.

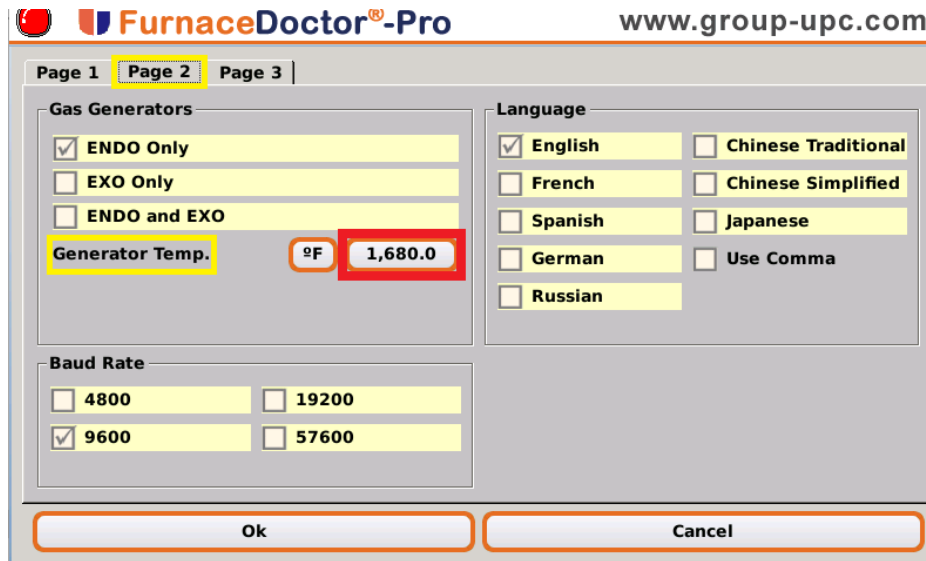
Generator Temp. - Actual generator temperature for Dewpoint calculation.

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.



“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

The screenshot displays the 'FurnaceDoctor®-Pro' software interface. At the top, the logo and 'www.group-upc.com' are visible. Below the logo, there are three tabs: 'Page 1', 'Page 2', and 'Page 3'. The main content area is divided into several sections:

- Gas Generators:** A list of three options: 'ENDO Only' (checked), 'EXO Only' (unchecked), and 'ENDO and EXO' (unchecked). A red box highlights these three options.
- Generator Temp.:** A field with a unit selector set to '°F' and a value of '1680'.
- Language:** A list of language options: 'English' (checked), 'Chinese Traditional' (unchecked), 'French' (unchecked), 'Chinese Simplified' (unchecked), 'Spanish' (unchecked), 'Japanese' (unchecked), 'German' (unchecked), 'Use Comma' (unchecked), and 'Russian' (unchecked).
- Baud Rate:** A list of four options: '4800' (unchecked), '19200' (unchecked), '9600' (checked), and '57600' (unchecked).

At the bottom of the window, there are two buttons: 'Ok' and 'Cancel'.

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

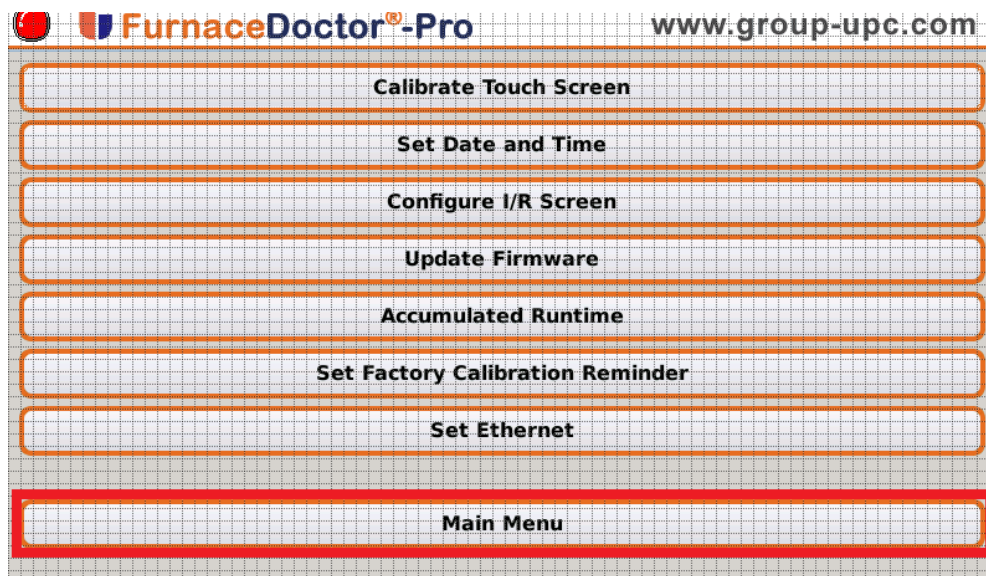
10.10 Configure I/R Screen, Page 3 Options Include

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.



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.

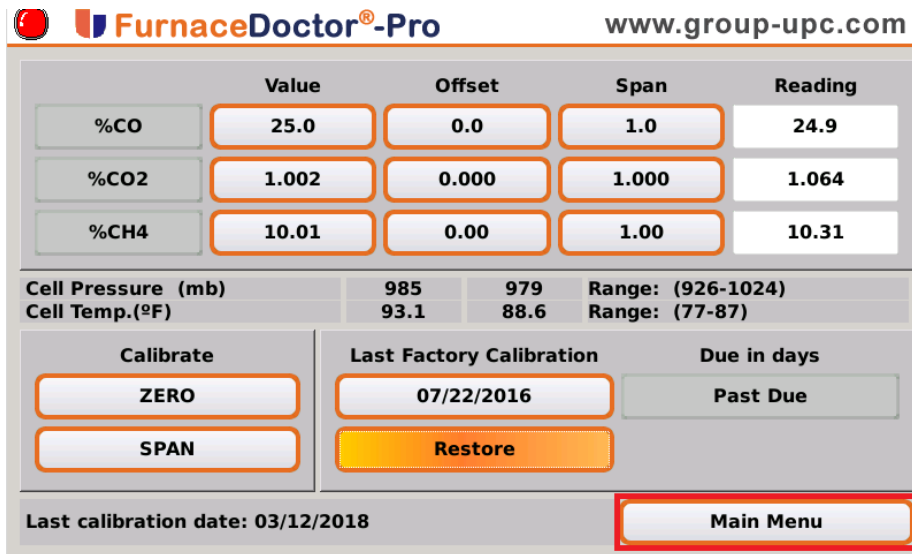
To charge the unit - Connect the supplied Battery charger - universal A/C adaptor into the "D/C INPUT" port on the top of the Furnace Dr.

Note: Unit is designed to operate with a charged battery or with the A/C adaptor. Using the charger as an AC adaptor 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.



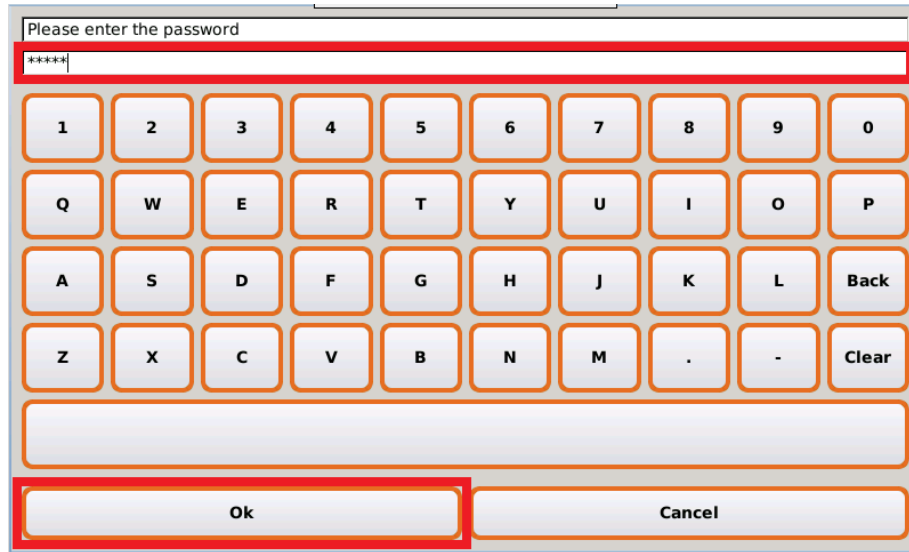
Accessing Main Menu Screen

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”.



Please enter the password

1 2 3 4 5 6 7 8 9 0

Q W E R T Y U I O P

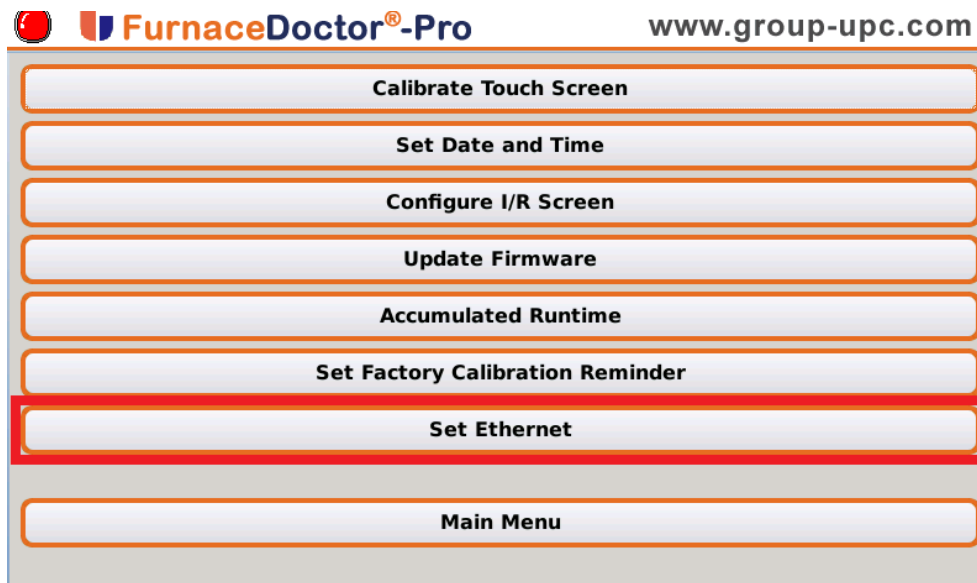
A S D F G H J K L Back


Z X C V B N M . - Clear

Ok Cancel

Utilities Password Entry

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



 **FurnaceDoctor®-Pro** www.group-upc.com

Calibrate Touch Screen

Set Date and Time

Configure I/R Screen

Update Firmware

Accumulated Runtime

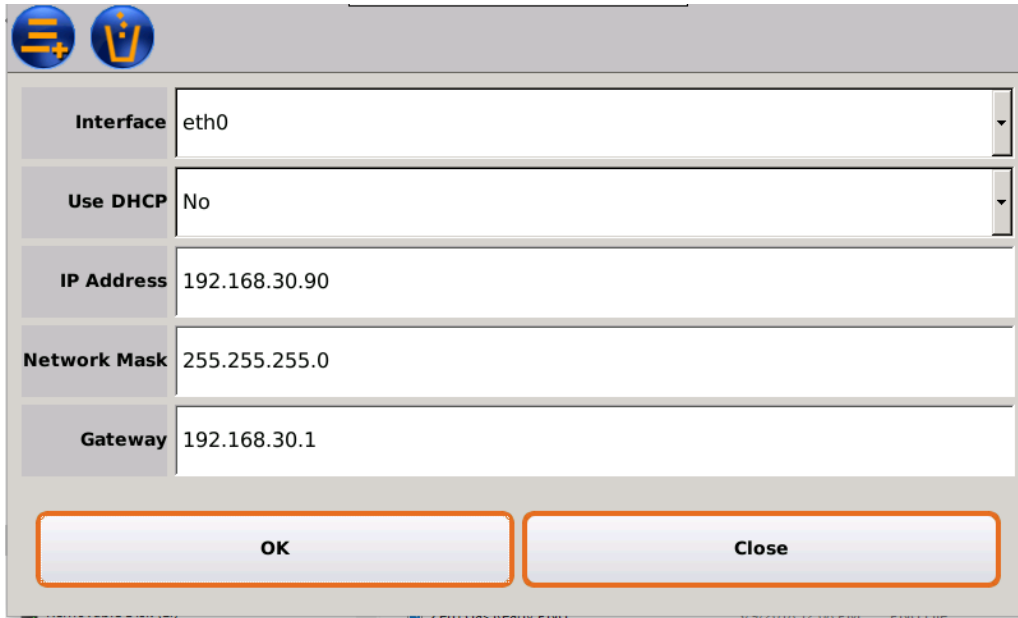
Set Factory Calibration Reminder

Set Ethernet

Main Menu

Touch “Set Ethernet”

The Ethernet Configuration Screen will appear.



The screenshot shows a configuration window with a grey header containing two icons: a blue menu icon and a blue shield icon. Below the header are five rows of configuration fields, each with a grey label on the left and a white input field on the right. The fields are: Interface (eth0), Use DHCP (No), IP Address (192.168.30.90), Network Mask (255.255.255.0), and Gateway (192.168.30.1). At the bottom of the window are two buttons: 'OK' and 'Close', both with orange borders. The background of the window is light grey.

Interface	eth0
Use DHCP	No
IP Address	192.168.30.90
Network Mask	255.255.255.0
Gateway	192.168.30.1

OK Close

Ethernet Configuration Screen

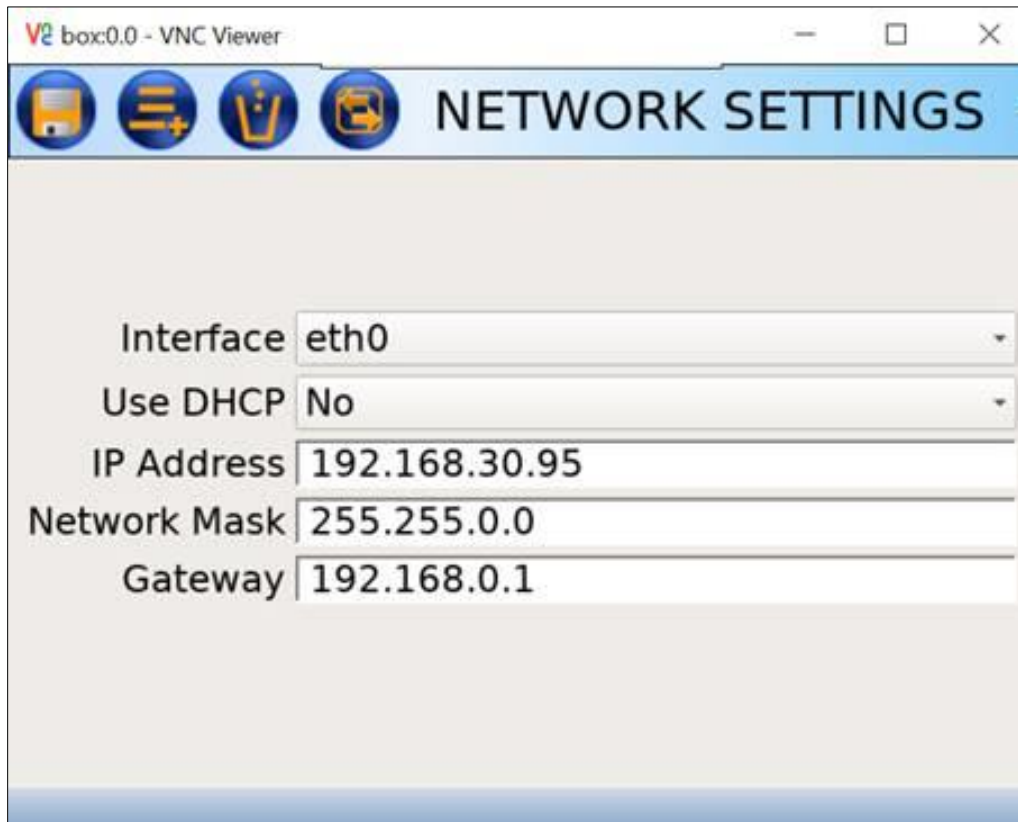
13 VNC Viewer

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.



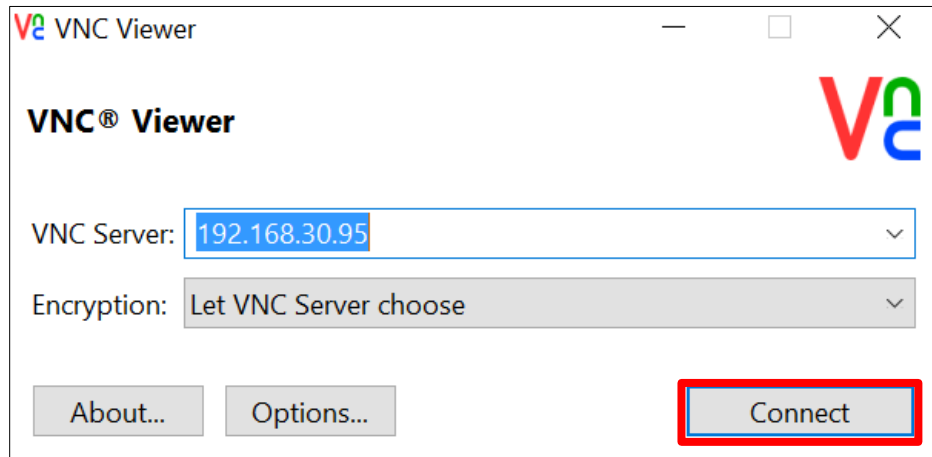
The screenshot shows a VNC Viewer window titled "box:0.0 - VNC Viewer". The window displays a "NETWORK SETTINGS" screen with the following configuration:

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

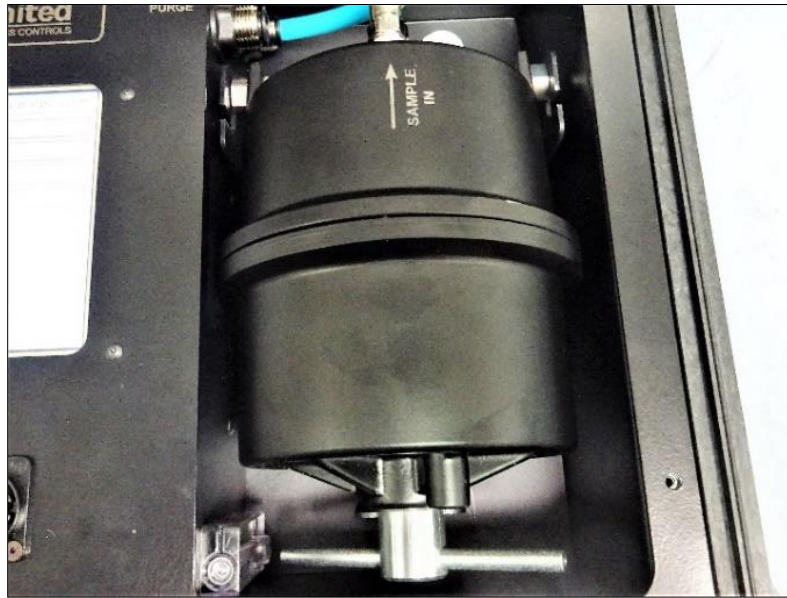
This allows for remote access each FURNACEDOCTOR®-PRO V2.0 and is helpful for grabbing screen shots of the instrument for documentation. All of the screen shots for this document were captured using this VNC. You can pull up previous log files and screen capture trend charts from running processes or 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	CE

First IR Bench (Normal Range)

	Range	Resolution	Accuracy
CO	0-30%	0.37%	2% of range
CO2	0-20%	0.06%	2% of range
CH4	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

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United Process Controls brings together leading brands to the heat treating industry including Atmosphere Engineering, Furnace Control, Marathon Monitors, Process-Electronic, and Waukee Engineering.

We provide prime control solutions through our worldwide sales and services network with easy-to-access local support.

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