



GfG Instrumentation

Worldwide manufacturer of gas detection solutions



TR 1001: G450 and G460 Multi-sensor Gas Detectors

Technician level training course

January 23, 2013

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GfG Instrumentation

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**G450 / G460
Advanced / Technician Training**



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Service e-mail: service@gfg-inc.com

Internet: www.gfg-inc.com

Technical documentation and download site:
www.goodforgas.com



Overview of G450 / G460 Features



G450 Confined Space Gas Detector

- **One to four sensors**
- **Full 3-year warranty on all sensors**
- **Optional 6-year warranty on all sensors**
- **O2 sensor rated for continuous use in – 30°C temperatures**
- **Interchangeable rechargeable (NiMH) or alkaline battery packs last 25 hours per charge**
- **Super durable IP-67 water resistant design**
 - **Only \$695.00 USD list price (alkaline)**
 - **Only \$745.00 USD list price (rechargeable)**



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Slide 3

G460 Multi-gas Monitor

- **Up to SEVEN channels detection**
- **Comprehensive range of interchangeable smart sensors:**
 - **LEL, O2, CO, H2S: 3-year warranty**
 - **Infrared combustible gas: 3-year warranty**
 - **Infrared CO2: 3-year warranty**
 - **Most other substance-specific EC toxic: 2-year warranty**
 - **PID lamp: 1-year warranty**



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G450 / G460 Optional 6-year Sensor Warranty

- 3-year warranty on O₂, LEL, CO and H₂S sensors still standard
- Standard lifetime warranty on instrument
- 6-year sensor warranty option available for additional \$250.00 at time of purchase

G450 Confined Space Gas Detector Six-year Extended Sensor Warranty Program



GfG instrumentation offers the longest sensor warranty in the history of gas detection!

GfG instrumentation gas detectors offer the best features and performance, at the lowest cost of ownership of any atmospheric monitors on the market today. GfG instruments carry a lifetime warranty on the instrument itself. The standard G450 sensor warranty is a full 3-years from the date of purchase. The extended sensor warranty option provides coverage for all four sensors (O₂, LEL, CO and H₂S) for a full 6-years from the date of purchase.

Other manufacturers charge up to \$270.00 for a set of four sensors. To make it worse, most manufacturers only warrant the sensors for 2-years from purchase. Customers may have to replace all four sensors three or four times over the life of the instrument. A single set of replacement sensors is often more expensive than a brand new instrument. GfG thinks that's wrong!

- Standard 3-year warranty on all four sensors
- Standard lifetime warranty on the instrument

Most of the components in a GfG instrument never need to be replaced, and carry a lifetime warranty for as long as you own the product. The only exceptions are the battery packs, filters and sensors.

- Optional 6-year extended sensor warranty
- How does the extended sensor warranty work?
- How much can I save?

The optional extended warranty provides sensor warranty coverage for a full 6-years. The option is available for an additional \$250.00 at the time the instrument is purchased.

Sensors that fail under warranty will be replaced with a brand new sensor at no charge.

GfG instruments are designed for durability. How much you save depends on how long you own and keep your GfG instrument in service. The list price of a rechargeable four-gas G450 is \$745.00. With the extended warranty option, the six-year cost of ownership is only \$995.00. This is less than the three-year cost of ownership for most other confined space gas detectors.

Yes. When it's finally time to replace the sensors, you can buy and replace them one at a time, or you can purchase a complete set of all four sensors for \$400.00. Replacement sensors carry the same standard three year warranty as the original sensors.



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 Ver. 1.1.008.0.003

G450 / G460 Optional 6-year Sensor Warranty

Cost of Ownership									
Product	MSA Altair 4X		ISC MX4		BW Quattro		X-am 2000		GfG G450
List price of rechargeable 4 channel instrument	\$915.00		\$695.00		\$745.00		\$795.00		\$745.00
Standard sensor warranty & price									
LEL	3-year	\$210	2-year	\$220	2-year	\$185	3-year	\$175	\$100*
Oxygen	3-year	\$180	2-year	\$165	2-year	\$135	3-year	\$145	\$100*
CO	NA	NA	2-year	\$275	2-year	\$200	5-year	\$145	\$100*
H ₂ S	NA	NA	2-year	\$275	2-year	\$150	5-year	\$145	\$100*
COSH	3-year	\$210	NA	NA	NA	NA	NA	NA	NA
Instrument price Pricing*	\$915.00		\$695.00		\$745.00		\$805.00		\$745.00
Three year cost of ownership	\$915.00		Between \$860.00 and \$1,630.00**		Between \$880.00 and \$1,415.00***		\$805.00		\$745.00
Extended warranty option:	Yes		No		No		Yes		
How long?	1-year additional		NA		NA		3-year additional		
How much?	\$315.00		NA		NA		\$250.00		
Total cost of ownership with extended warranty	\$1,230.00 (4-years)		NA		NA		\$980.00 (5-year)***		\$995.00 (6-years)
Total six year cost of ownership	\$1,515.00 (6-years)		Between \$1,795.00 and \$2,565.00 (6-years)		Between \$1,550.00 and \$2,085.00 (6-years)		Between \$980.00 and \$1,475.00 (6-years)		\$995.00 (6-years)



Easy to use!

- *Basic operation is extremely simple*
- *Single on-off button all that is needed for most day to day use*
- *Every instrument shipped complete with operations manual*



G460

Multi-gas Detector

Operations Manual



GfG Instrumentation

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Slide 7



Three color "Traffic Signal" display

- *Back lit three-color full graphics LCD*
- *Top mounted display with wrap around (360°) LED alarm indicator*
- *LCD includes flip and zoom functions*



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Slide 8



Rugged design

- *Rugged, double shot molded housing includes integral rubberized boot*
- *Durable high tension steel alligator belt clip*



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G460 Multi-gas Monitor

- *Standard G460 housing color now "GfG Blue"*
- *Optionally still available in "GfG Black"*



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Slide 10

G450 / G460 Multi-Gas Detector

- **Interchangeable rechargeable (NiMH) or alkaline battery packs last up to 25 hours per charge**
- **Top-mounted, three color, full graphics LCD**
- **Durable IP-67 water resistant design**
- **O2 sensor rated for continuous use in -30°C temperatures**



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G450 / G460 battery packs

- **Interchangeable rechargeable (NiMH) and alkaline battery packs last up to 25 hours**
- **NiMH batteries provide excellent cycle life and low temperature performance**
- **NiMH battery packs warranted for 2-years**
- **Typical run-time after two years for properly maintained NiMH battery packs is usually around 16 hours**

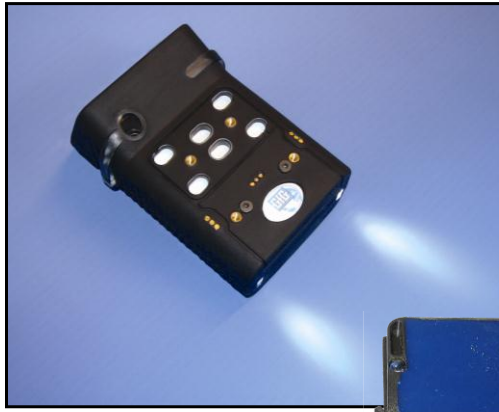


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Rechargeable battery pack



- Available with optional built-in flashlight LEDs

LED location

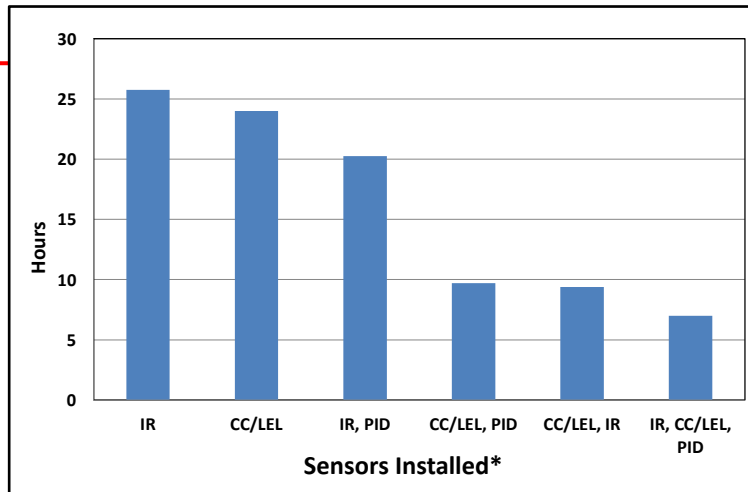


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Expected G450 / G460 run times



*All configurations include O₂ and CO/H₂S sensors as well as the listed "high power" sensors

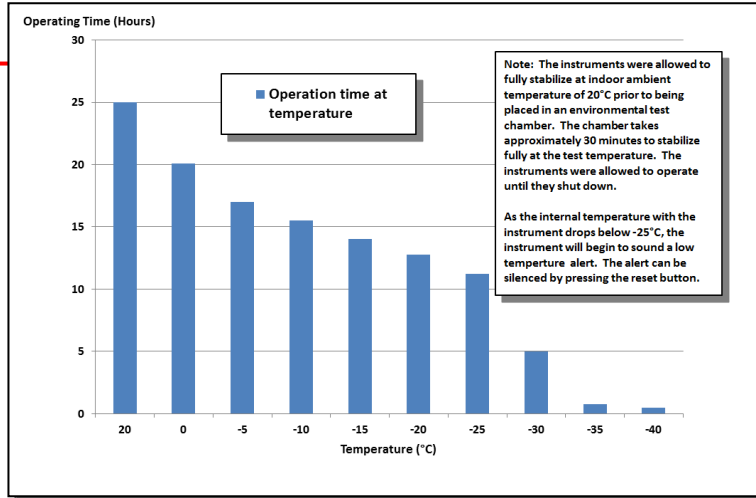


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Expected G450 run times as function of temperature



January 3, 2013

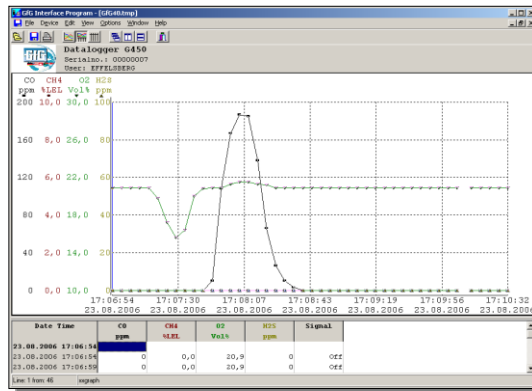
G450 and G460 battery pack maintenance

Slide 15



Datalogging Standard

- **Mode:**
 - Average
 - Peak
 - Instantaneous
- **Interval:**
 - 1 sec. – 60 min.
- **Internal capacity:**
 - 1,890 intervals
 - 63 hours continuous at 2 min. Interval
- **G460:**
 - Built-in expansion slot for 2GB additional data storage capacity



January 3, 2013

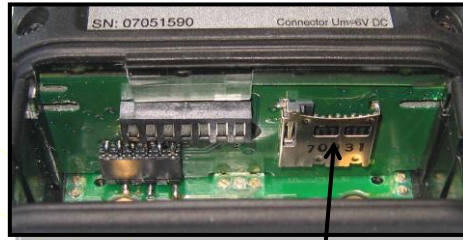
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G460 Optional Extended Datalogging Storage Capacity

- **Built-in slot for optional high capacity extended memory card**



Memory expansion card slot

January 3, 2013

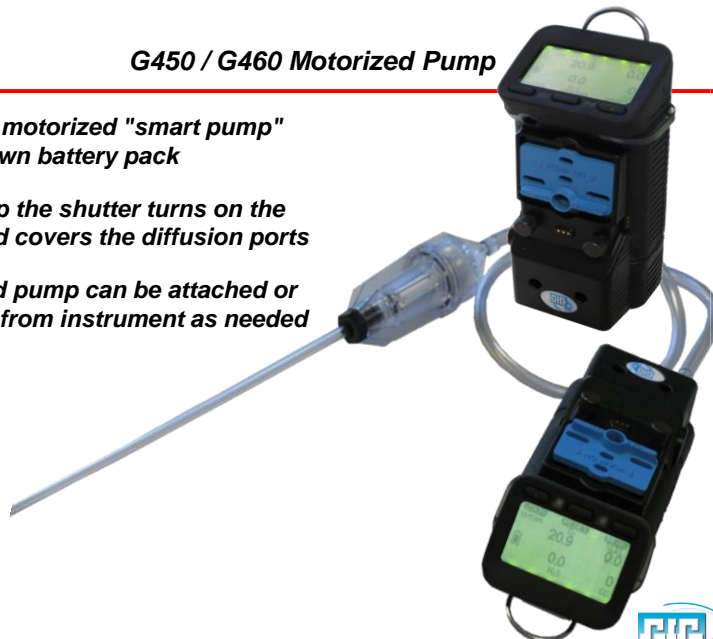
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Slide 17



G450 / G460 Motorized Pump

- **Powerful motorized "smart pump" with its own battery pack**
- **Sliding up the shutter turns on the pump and covers the diffusion ports**
- **Motorized pump can be attached or removed from instrument as needed**



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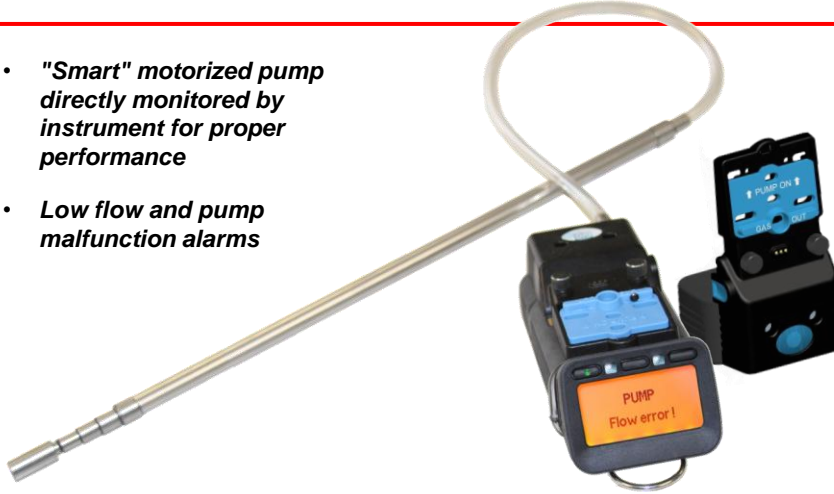
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Slide 18



G450 / G460 Motorized Pump

- *"Smart" motorized pump directly monitored by instrument for proper performance*
- *Low flow and pump malfunction alarms*



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Slide 19



G450 / G460 Drop-in Charger

- *Smart charger includes trickle charge mode to prevent damage to battery pack due to overcharging*
- *Available in single and double versions*
- *Available for use with 12 VDC vehicle charging system*



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Slide 20



Optional G450 / G460 Drop-in Charger for Pump Equipped Instruments

- *Charger simultaneously charges both pump AND instrument*
- *Available for use with 12 VDC vehicle charging system*



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Slide 21



G450 / G460 Five-Unit Multi-Charger

- *Five instrument multi-charger*



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Slide 22



Five instrument multi-charger



- *Can be substituted in place of standard cradle chargers with orders of 5 or more instruments*



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Slide 23

Other accessories

- *Calibration adapters*
- *Sampling probes*
- *Leather holsters*
- *Calibration kits*



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Slide 24

Use TS-400 Test Station for daily bump check

- **Standalone operation - No PC required!**
- **Automatic bump-test only**
- **Success / failure indication after each test**
- **Economic use of test gas**
- **Easy collection of unit test and logged data**



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Slide 25



Use DS400 Docking Station for daily bump check and / or periodic calibration

- **Standalone operation:**
- **No PC required**
- **Automatic bump-test**
- **Automatic span calibration**
- **Success / failure indication after each test**
- **Economic use of test gas**
- **Easy collection of unit test and logged data**
- **Reduced maintenance cost**



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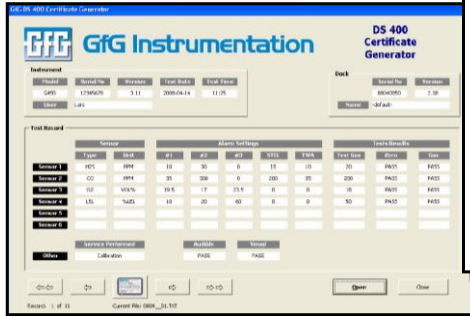
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Slide 26



Comprehensive Test Reports

- Easy to generate custom test reports



DS400
Instrument Service Report

Date/Time	Identification	Details	Test	Sensor	Test	Zero	Gas
2009-04-29 14:01	Instrument User	G450 SN20034434 version 3.13 DS400 SN20023101 version 2.14 DOR W	Bump CO LEL LEL Audible Visual	H2S CO CO CO CO CO CO	25PPM 100PPM 19VOL 19VOL 15VOL 15VOL	PASS PASS PASS PASS PASS PASS PASS	PASS PASS PASS PASS PASS PASS PASS
2009-04-29 14:07	Instrument User	G450 SN20034436 version 3.13 DS400 SN20023101 version 2.14 TERRY J	CAL CO CO CO LEL LEL Audible Visual	H2S CO CO CO CO CO CO CO	25PPM 100PPM 19VOL 19VOL 15VOL 15VOL	PASS PASS PASS PASS PASS PASS PASS PASS	PASS PASS PASS PASS PASS PASS PASS PASS
2009-04-29 14:09	Instrument User	G450 SN20034436 version 3.13 DS400 SN20023101 version 2.14 TERRY J	Bump CO CO CO LEL LEL Audible Visual	H2S CO CO CO CO CO CO CO	25PPM 100PPM 19VOL 19VOL 15VOL 15VOL	PASS PASS PASS PASS PASS PASS PASS PASS	PASS PASS PASS PASS PASS PASS PASS PASS
2009-04-29 14:13	Instrument User	G450 SN20034436 version 3.13 DS400 SN20023101 version 2.14 TERRY B	CAL CO CO CO LEL LEL Audible Visual	H2S CO CO CO CO CO CO CO	25PPM 100PPM 19VOL 19VOL 15VOL 15VOL	PASS PASS PASS PASS PASS PASS PASS PASS	PASS PASS PASS PASS PASS PASS PASS PASS
2009-04-29 14:15	Instrument User	G450 SN20034436 version 3.13 DS400 SN20023101 version 2.14 TERRY B	Bump CO CO CO LEL LEL Audible Visual	H2S CO CO CO CO CO CO CO	25PPM 100PPM 19VOL 19VOL 15VOL 15VOL	PASS PASS PASS PASS PASS PASS PASS PASS	PASS PASS PASS PASS PASS PASS PASS PASS
2009-04-29 14:19	Instrument User	G450 SN20034438 version 3.13 DS400 SN20023101 version 2.14 JORDAN M	CAL CO CO CO LEL LEL Audible Visual	H2S CO CO CO CO CO CO CO	25PPM 100PPM 19VOL 19VOL 15VOL 15VOL	PASS PASS PASS PASS PASS PASS PASS PASS	PASS PASS PASS PASS PASS PASS PASS PASS
2009-04-29 14:20	Instrument User	G450 SN20034438 version 3.13 DS400 SN20023101 version 2.14 JORDAN M	Bump CO CO CO LEL LEL Audible Visual	H2S CO CO CO CO CO CO CO	25PPM 100PPM 19VOL 19VOL 15VOL 15VOL	PASS PASS PASS PASS PASS PASS PASS PASS	PASS PASS PASS PASS PASS PASS PASS PASS
2009-04-29 14:24	Instrument User	G450 SN20034449 version 3.13 DS400 SN20023101 version 2.14 RANDY H	CAL CO CO CO LEL LEL Audible Visual	H2S CO CO CO CO CO CO CO	25PPM 100PPM 19VOL 19VOL 15VOL 15VOL	PASS PASS PASS PASS PASS PASS PASS PASS	PASS PASS PASS PASS PASS PASS PASS PASS
2009-04-29 14:47	Instrument User	G450 SN20034453 version 3.13 DS400 SN20023101 version 2.14 DAVE G	Bump CO CO CO LEL LEL Audible Visual	H2S CO CO CO CO CO CO CO	25PPM 100PPM 19VOL 19VOL 15VOL 15VOL	PASS PASS PASS PASS PASS PASS PASS PASS	PASS PASS PASS PASS PASS PASS PASS PASS

Page 1 of 8

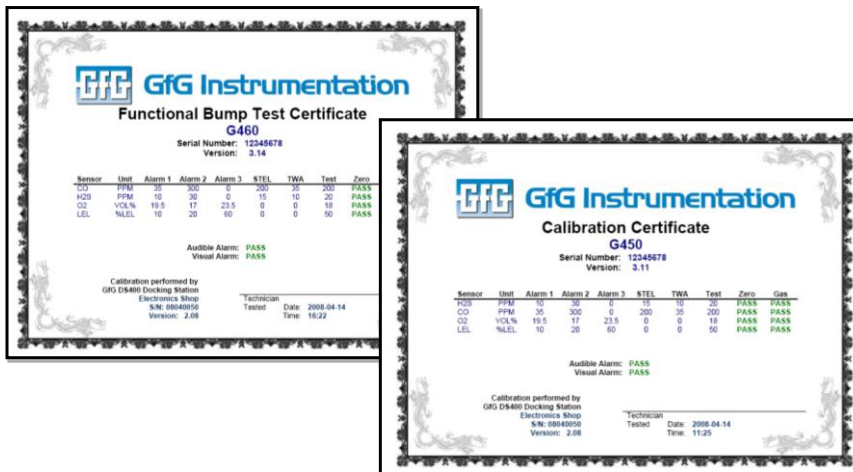
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Slide 27



Automatically generate calibration and bump test certificates



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Slide 28



Accessories included with every instrument

- **Instrument with CO, H₂S, LEL and O₂ sensors (installed)**
- **Operations manual**
- **Battery pack (installed)**
 - **Rechargeable NiMH or**
 - **Alkaline**
- **Charging cradle (when instrument has rechargeable battery pack)**
- **110 VAC wall-cube power source**
- **Calibration adapter**



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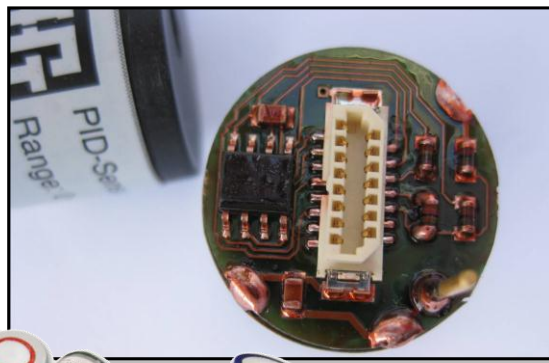
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Slide 29



Traditional Electrochemical Toxic Gas Sensors

- **More types of sensors available every year**
- **Toxic gas sensors designed to detect target gases at ever lower concentrations**



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Slide 30



G460 Interchangeable Plug-and-Play Smart Sensors

- Available sensors include:

- O_2
- Catalytic LEL
- Infrared LEL
- Infrared CO_2
- CO
- H_2S
- COSH
- PID
- SO_2
- Cl_2
- ClO_2
- NH_3
- H_2
- PH_3
- HCN
- NO
- NO_2
- HCL
- HF
- EtO
- O_3
- $COCl_2$
- HBr
- THT
- and more!

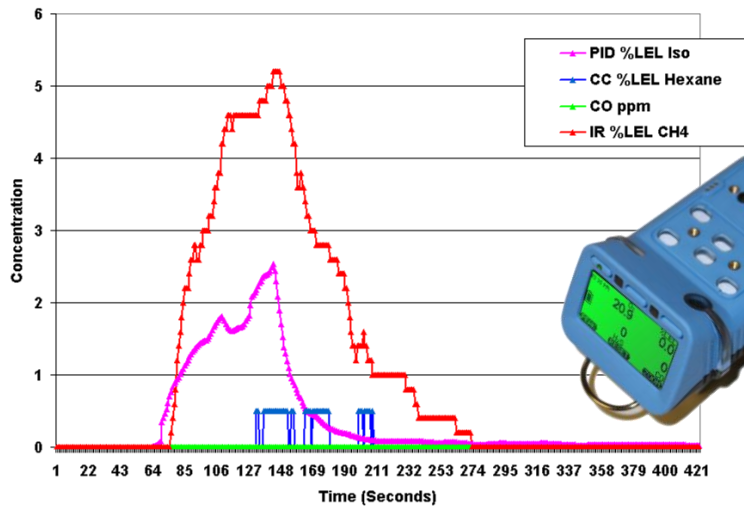


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Slide 31

G460 has the flexibility to support the right sensor technology for the job!



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Slide 32

GfG wins hands down when it comes to features AND three year cost of ownership!



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Slide 33

Sales Support:
www.Goodforgas.com

- **Data sheets**
- **Price lists**
- **Manuals**
- **Application Notes**
- **Product images**
- **Print ads**
- **...and more!**

Multi-Sensor Atmospheric Monitor

Confined Space performance

Specific VOCs

Supplier Of Gas Detection Solutions

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Choosing the best detection technologies for measuring combustible gas and VOC vapors

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Slide 34

G450 / G460 Basic Operation



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Slide 35



Basic operation

- *Basic operation is extremely simple*
- *Single on-off button all that is needed for most day to day use*

Read and understand the operations manual before use!

G460

Multi-gas Detector

Operations Manual



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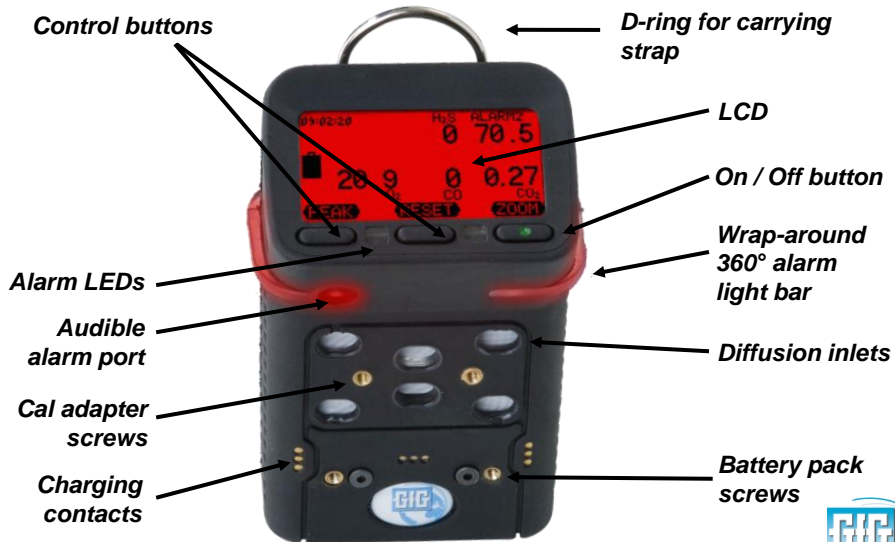
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Slide 36



External features and controls



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Slide 37



Battery Pack Location



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Slide 38



Turning the instrument on

- *Verify proper performance by performing bump test before each day's use*
- *Make sure instrument located in fresh air before turning on*
- *Press the right hand button to turn on*



On / Off button
(one with green
indented dot)



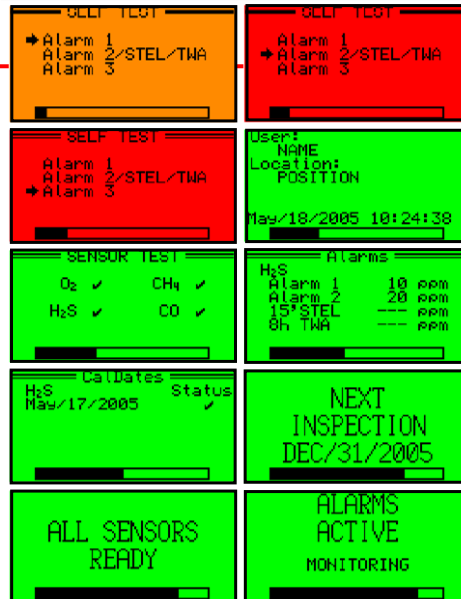
Verifying firmware version

- *The first screen in the start-up sequence shows the software version (firmware) currently installed*



Startup sequence

- After turning on instrument will display sequence of screens
 - Status of sensors
 - Alarm settings
 - Calibration and bump test due dates
- Audible and visual alarms will briefly activate
- Count-down indicates when G460 ready to use
- Instrument will display alarm notification if bump test or calibration is overdue



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Slide 41

Instrument start up

- If the instrument displays a “Bump test” or “Calibration” warning during startup, press “NEXT” to acknowledge and continue
 - Do not use the instrument to monitor for gas until the required procedure is completed!
- Check battery status when startup is complete
- Verify that the readings stabilize at fresh air values (20.9% O₂, 0% LEL, 0 ppm toxic gas) and perform a fresh air Autocal adjustment if needed
- Use the Docking Station or manually perform the required Bump Test or Calibration procedure



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Slide 42



"Bump test" and "Calibration" overdue alarms

- *The audible and LED alarms are activated and a warning message indicates the "Bump test" or "Calibration" due date has been exceeded*
- *The warnings can be acknowledged by pressing the "NEXT" button, in which case the instrument continues the startup sequence*
- *The alarms will continue to be displayed every time the instrument is turned on until they are cleared*
- *The "Bump test" overdue alarm can only be cleared by using a Docking Station*
- *The "Calibration" alarm can be cleared either by using a Docking Station, or performing a full manual calibration on the instrument*



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Slide 43

Turning the instrument off

- *Press and hold down the right hand "Zoom" button for 5 seconds to turn off*
- *LCD will count down (3...2...1)*
- *Release button when steady tone indicates shut-down is complete*



On / Off ("Zoom") button



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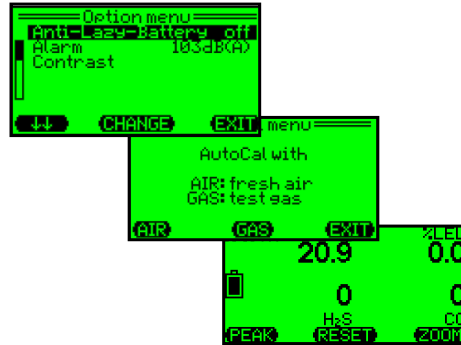
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Slide 44

Function of buttons



- The “name” and function of the control buttons change depending on what you are doing or seeing on the display



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Slide 45



LCD features

- Pressing any button will causes display backlight to be activated
- Press the “Zoom” button once to magnify readings, press “Zoom” again to see next gas
- Pressing “Peak” and “Zoom” at same time will “flip” display



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Slide 46



LCD features

- Pressing “Reset” and “Zoom” at same time puts instrument directly into “AutoCal” mode

AIR	- AutoCal® with fresh air
GAS	- AutoCal® with test gas
EXIT	- Back to main menu



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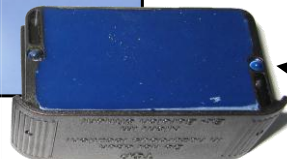
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Slide 47



Rechargeable battery pack

- Available with optional built-in flashlight LEDs



LED
location

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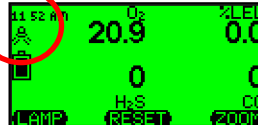
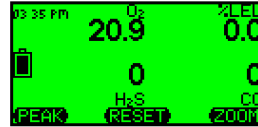
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Slide 48



To turn on LED flashlight

- From normal operation:
 - Press and hold "Peak" until the soft key changes name to "Lamp" and lamp icon shows in display
 - LEDs will remain lit for 60 seconds, then turn off
 - Press "Lamp" to turn off sooner



Instrument readings and alarms

- LEL:
 - Readings in 0.5% LEL increments
- H₂S:
 - Standard H₂S sensor:
 - Readings in 0.1 ppm increments
 - COSH sensor:
 - H₂S readings in 0.2 ppm increments
- CO:
 - Readings in 1.0 ppm increments
- O₂:
 - Readings in 0.1% volume increments



G450 / G460 alarms

Alarm Type	Sensors	Number of Alarms	Description
Instantaneous Value (AL)	Oxygen	3	An instantaneous alarm is activated immediately if the gas concentration exceeds or falls below a pre-set threshold. The alarm values are adjustable.
	Combustible gases	3	
	Toxic gases	2	
Short Term Value (STEL)	Toxic gases	1	The short-term value (STEL) is the average concentration over a short period of time (e.g. 15 minutes). The STEL alarm is not latching; it resets automatically as soon as the concentration falls below the threshold.
Long Term Value (TWA)	Toxic gases	1	The long-term value (TWA) refers to an 8-hour shift and calculates the average concentration. The TWA alarm cannot be reset. It is only de-activated if the detector is switched off.

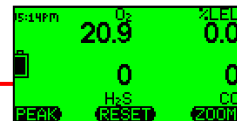


Effects of O₂ concentration on combustible gas readings

- LEL readings may be affected if levels of O₂ are higher or lower than fresh air
- The standard catalytic LEL sensor requires a minimum level of 10% oxygen to read LEL
- If the O₂ concentration is too low the LEL reading will be replaced with question marks



Readings in fresh air



Readings in O₂ deficient air



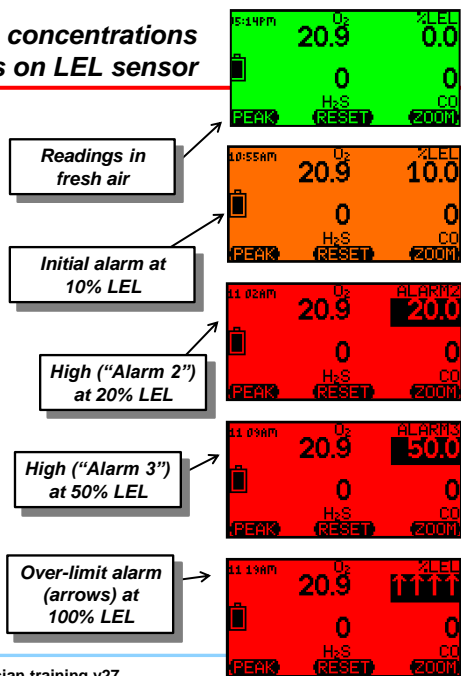
Readings when O₂ too low for LEL sensor



Effects of high concentrations of gas on LEL sensor

• **Additional concerns when using standard catalytic LEL sensors:**

- **Work is not permitted in areas where the concentration of gas exceeds safety limits!**
- **If the explosive gas concentration is too high there may not be enough oxygen for the LEL sensor to detect properly**
- **Concentrations above 100% LEL can damage the LEL sensor**

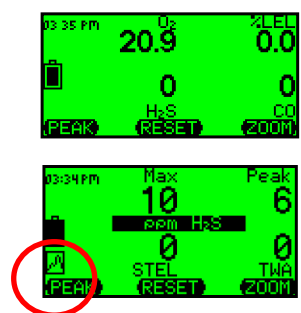


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Peak Reading Mode

- **Main screen shows the current gas concentrations**
- **Press "Peak" once put instrument into "Peak" reading mode**
- **Icon in display indicates when in peak reading mode**
- **Press "Reset" to clear the peak readings**
- **Press "Peak" to return to normal operation**
- **Note: after 15 minutes G450 returns to normal gas reading screen**



January 23, 2013

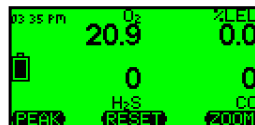
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Slide 54



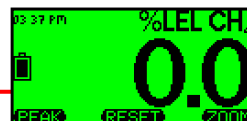
Clearing "Peak Mode" readings

- "Peak Hold" function shows most significant values **ONLY** between the time "Peak" button is first pushed and the next time it is pushed to clear the "Peak" readings
- Pushing "Peak" again clears the displayed "Peak Mode" readings and returns instrument to normal operation
- Clearing "Peak Hold" readings **DOES NOT** clear or reset the Max, STEL or TWA readings in the instrument memory



Viewing Peak, STEL and TWA readings for entire monitoring interval

- The instrument can also display Peak, STEL and TWA readings for the entire monitoring interval (the period of time that the instrument has been turned on)
- Press "Zoom" to make numbers larger, then press and hold "Zoom" for approximately 2 seconds (till instrument beeps)
- Display will now show Max, STEL, TWA for toxic sensors; Max combustible gas, and Min O₂
- Press "Zoom" to advance from one sensor to the next



G450 / G460 battery packs

- *Interchangeable rechargeable (NiMH) and alkaline battery packs last up to 25 hours*
- *NiMH batteries provide excellent cycle life and low temperature performance*
- *NiMH battery packs warranted for 2-years*
- *Typical run-time after two years for properly maintained NiMH battery packs is usually around 16 hours*



January 23, 2013

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Slide 57



G450 / G460 Drop-in Charger

- *Smart charger includes trickle charge mode to prevent damage to battery pack due to overcharging*
- *Available in single and double versions*
- *Available for use with 12 VDC vehicle charging system*



January 23, 2013

G450 / G460 full technician training v27

Slide 58



Optional G450 / G460 Drop-in Charger for Pump Equipped Instruments

- *Charger simultaneously charges both pump AND instrument*
- *Available for use with 12 VDC vehicle charging system*



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Slide 59



G450 / G460 Charging Cycle

- *GfG smart chargers begin the charging cycle in the "fast charging mode", then switch to "trickle charge mode" when the battery is charged to 90% of its full capacity*
- *Completely discharged batteries may require up to 6 hours to reach the trickle charge stage*



Note: *If possible, leave the instrument in the charger for an additional one or two hours after reaching the trickle charge stage to reach 100% of the charge capacity of the battery*

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Slide 60



G450 / G460 Charging Cycle

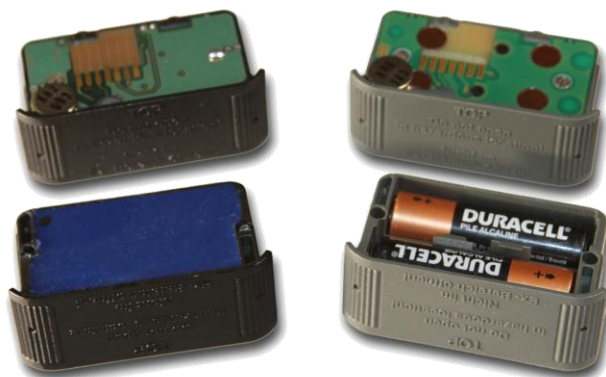
- The green LED in the “single” charger cradle indicates power
- A solid amber LED indicates fast charging
- A flashing amber LED indicates trickle charging
- The instrument display indicates how long the instrument has been in each stage of the cycle



Solid amber indicates fast charging, flashing amber indicates trickle



Changing battery packs



NiMH: Black

Alkaline: Gray



Changing battery packs

- Use the hex wrench tool to loosen and remove the two screws securing the battery pack to front of the instrument housing
- GENTLY remove the battery pack from the instrument

NOTE: USE YOUR FINGERS TO REMOVE THE BATTERY PACK FROM THE INSTRUMENT

NEVER USE A SCREWDRIVER OR OTHER HARD TOOL TO REMOVE THE BATTERY PACK



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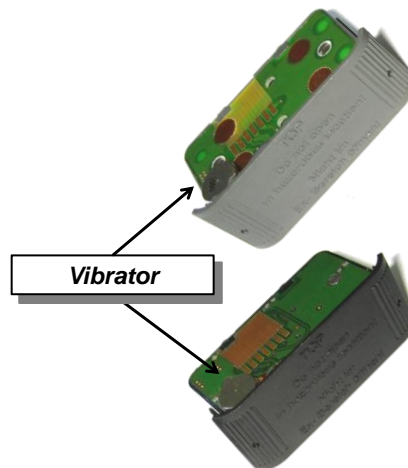
Changing battery packs

- Make sure that the vibrator (the flat disc on the top of the battery pack is) is at the top when the battery pack is reinserted into the instrument

DO NOT FORCE WHEN INSERTING THE PACK INTO THE HOUSING!

- Reinstall and tighten the screws

MAKE SURE SCREWS ARE SECURE BUT DO NOT OVERTIGHTEN!



January 23, 2013

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Slide 64



Voltage depression due to over-charging

- *NIMH batteries do not develop “memories”, however, if they are not exercised they may become “lazy”*
- *Even though the normal amount of power is stored the battery, the peak voltage in “lazy” batteries drops more quickly than usual*
- *Voltage depression is caused by the formation of small crystals of electrolyte on the plates, increasing resistance and lowering the voltage of some individual cells in the battery*
- *To the user it appears the battery is not holding its full charge; to the instrument the rapid drop in voltage indicates that the batteries are about to run out of energy*
- *Exercising the battery by putting it through a deep-discharge cycle can break down the crystals, and improve or restore the run time of the instrument*



January 23, 2013

G450 / G460 full technician training v27

Slide 65

“Anti-lazy battery” deep-discharge cycle

- *Fully charged instruments that fail to operate for the expected time should be exercised by means of the “anti lazy battery” deep discharge cycle*

Note: Instruments that are left on the charger for prolonged periods between use may benefit from being exercised by being deep discharged on a quarterly basis



January 23, 2013

G450 / G460 full technician training v27

Slide 66

Charger cradle hardware compatibility

- G450 and G460 instruments with version 3.41 and higher firmware have enhanced “anti-lazy battery” as well as other features
- GfG recommends updating your instrument firmware to take advantage of these enhanced features
- To take full advantage of the latest anti-lazy battery options it is also necessary to have the latest version charger cradle and power adapter



Cradle serial numbers ending in “D” indicate the latest version

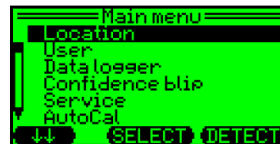
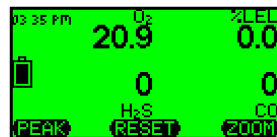
Note: Charger cradle and power adapters sold prior to October, 2011 can be updated at the GfG factory in Ann Arbor to the latest configuration



Power adapter must be equipped with “stereo” type jack with two black stripes

Main menu screen

- Press and hold down “Reset” button until “Main menu” choices appear:
 1. **Location** (use to enter a location name)
 2. **User** (use to enter a user ID number)
 3. **Datalogger** (use to adjust datalog interval)
 4. **Alarm clock** (use to activate a periodic alarm based on the clock time)
 5. **Service** (use to access the “Service Menu”)
 6. **AutoCal®** (use to make either fresh air or span calibration adjustment)
 7. **Options** (use to adjust display contrast, alarm loudness, confidence beep, or activate “Anti Lazy Battery” option)
 8. **Pump** (use to review pump status of motorized pump)



One-time deep discharge cycle for NiMH battery pack

- From "Option Menu" choose "Anti-Lazy-Battery"
- Press "Change" to turn on the one-time deep discharge feature
- Display will show "1X" instead of "Off"
- Press "Exit" to return G450 to normal operation

DO NOT TURN THE INSTRUMENT OFF!

- Allow to run until battery completely drained, then recharge normally, OR
- When down to last 10% of battery place instrument in charger

Do not place in charger until battery icon shows it is down to the last 10% remaining voltage

- Instrument will complete anti-lazy battery deep discharge, then charge normally



Automatic deep discharge cycle

- It is possible to program the instrument so the deep discharge cycle is always automatically activated whenever the instrument is placed in the charger when the battery is below 10% remaining voltage
- From "Options" choose "Anti-Lazy-Battery" then press "Change" to activate the one-time deep discharge cycle (display will show "1X")
- Press "Change" again to choose "Days"
- Anytime the instrument is placed in the charger when there is less than 10% remaining voltage the deep discharge cycle will be activated automatically



Limiting automatic deep discharge cycle to certain days

- Since deep-discharge can take up to 20 hours to complete, it may be advisable to limit automatic deep-discharge to certain days of the week (i.e. enabling the feature for Fridays to give the instrument a full weekend to complete discharging and recharging)
- Press the “down arrow” key to highlight the “Anti-Lazy days” choice, then press “Change”
- The instrument will display the days of the week
- Select the desired days for the automatic activation of this feature, then “Exit” to return to normal operation



Automatic deep discharge cycle

- Pressing “Off” while the instrument is in the charger immediately ends the deep-discharge cycle, and returns the instrument to normal charging



Press “Off” to immediately end deep discharge



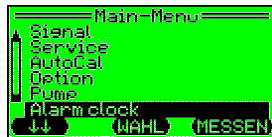
G450/G460 New Firmware V3.44

Addition of a "Clock function"
Example in Measuring mode



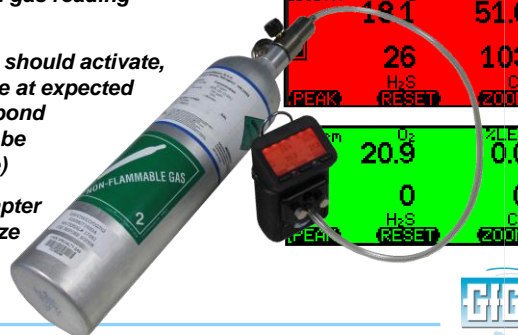
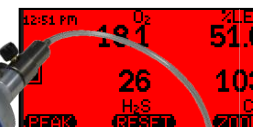
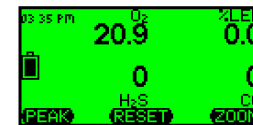
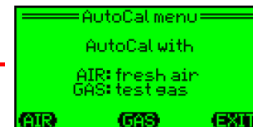
Setting in the main menu under "Alarm clock"

- Selection: OFF, 1x, daily
- Setting the alarm time hrs:mins



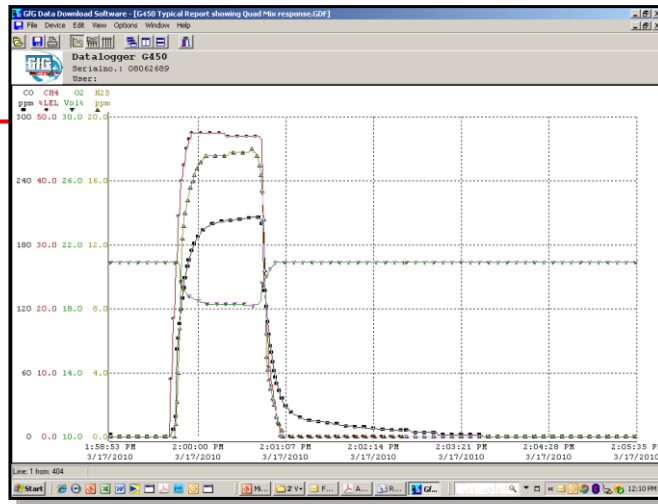
Bump Test (Manual Procedure)

- **Make sure the instrument is located in fresh air, turn on, and allow to warm up**
- **Note readings, and perform fresh air zero if necessary**
- **Attach calibration adapter; instrument will display "AutoCal menu"**
- **Press "Exit" to show normal gas reading screen**
- **Flow gas to sensors; alarms should activate, and readings should stabilize at expected values (if sensors fail to respond properly, instrument should be calibrated before further use)**
- **Turn off gas, remove cal adapter and allow readings to stabilize at fresh air values**



Bump Test

- *Response of sensors to Quad Mix (graphs)*
- *Readings recorded while instrument operated in normal gas reading mode*
- *Simultaneous response to all four gases, as well as match between cal gas concentrations and readings*



January 23, 2013

G450 / G460 full technician training v27

Slide 75



Bump Test

- *Response of sensors to Quad Mix (table)*
- *Readings recorded while instrument operated in normal gas reading mode*
- *When a sensor is in alarm readings are recorded in red*

Date Time	CO ppm	CH4 %LEL	O2 Vol%	H2S ppm	Event	Signal
3/17/2010 1:59:36 PM	0	0.0	20.9	0.0		OFF
3/17/2010 1:59:37 PM	0	0.0	20.9	0.0		OFF
3/17/2010 1:59:38 PM	0	0.0	20.9	0.0		OFF
3/17/2010 1:59:39 PM	2	9.0	20.9	0.0		OFF
3/17/2010 1:59:40 PM	4	9.0	20.9	0.0		OFF
3/17/2010 1:59:41 PM	7	18.5	20.9	0.0		OFF
3/17/2010 1:59:42 PM	11	18.5	20.9	0.0		OFF
3/17/2010 1:59:43 PM	19	27.8	20.9	0.8		OFF
3/17/2010 1:59:44 PM	82	27.8	20.9	2.2		OFF
3/17/2010 1:59:45 PM	92	34.5	20.9	4.0		OFF
3/17/2010 1:59:46 PM	106	34.5	20.7	6.8		OFF
3/17/2010 1:59:47 PM	119	40.0	19.6	9.8		OFF
3/17/2010 1:59:48 PM	130	40.0	19.4	12.4		OFF
3/17/2010 1:59:49 PM	140	42.5	19.2	13.2		OFF
3/17/2010 1:59:50 PM	149	42.5	19.1	14.0		OFF
3/17/2010 1:59:51 PM	153	45.0	19.0	14.2		OFF
3/17/2010 1:59:52 PM	160	45.0	18.9	14.8		OFF
3/17/2010 1:59:53 PM	166	46.5	18.8	15.2		OFF
3/17/2010 1:59:54 PM	171	46.5	18.8	15.6		OFF
3/17/2010 1:59:55 PM	175	47.5	18.7	15.8		OFF
3/17/2010 1:59:56 PM	178	47.5	18.7	16.0		OFF
3/17/2010 1:59:57 PM	181	47.5	18.6	16.4		OFF
3/17/2010 1:59:58 PM	184	47.5	18.6	16.6		OFF
3/17/2010 1:59:59 PM	186	47.5	18.5	16.8		OFF
3/17/2010 2:00:00 PM	188	47.5	18.5	17.0		OFF
3/17/2010 2:00:01 PM	189	47.5	18.5	17.0		OFF
3/17/2010 2:00:02 PM	191	47.5	18.4	17.2		OFF
3/17/2010 2:00:03 PM	193	47.5	18.4	17.2		OFF
3/17/2010 2:00:04 PM	194	47.5	18.4	17.4		OFF

January 23, 2013

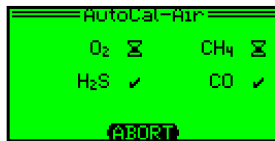
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Slide 76



Manual AutoCal

- **AutoCal allows instrument to be “Fresh air” or “Calibration” (span) adjusted if needed**



- AIR** - AutoCal® with fresh air
- GAS** - AutoCal® with test gas
- EXIT** - Back to main menu



Attach Cal Cap to Enter Fresh Air and Span “AutoCal”

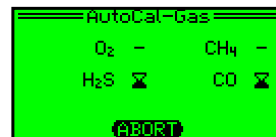
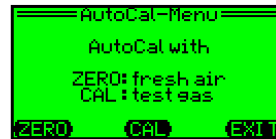


Attach cal cap to unit;
instrument automatically
enters “AutoCal” menu

Choose ZERO or
CAL and apply gas
(if calibrating), e.g.
an H₂S/CO mix.

Adjustment is
automatic

Display shows when
cal adjust has been
successfully
completed

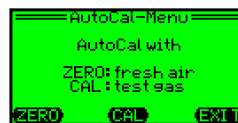


Can also enter "AutoCal" mode by pushing "Reset" and "Zoom" buttons at same time

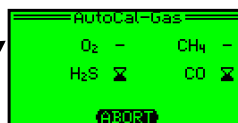


Push "Reset" and "Zoom" at same time; instrument automatically enters "AutoCal" menu

Choose ZERO or CAL and apply gas (if calibrating), e.g. an H₂S/CO mix.



Adjustment is automatic



Display shows when AutoCal adjust has been successfully completed



Calibration gas concentrations

- Best to use the default cal gas concentrations
- Default GfG concentrations used to calibrate instrument:
 - 200 ppm CO
 - 20 ppm H₂S
 - 50% LEL methane (CH₄)
- If you use different concentrations you must change instrument settings!



What should you do if you fail AutoCal adjustment?

- AutoCal adjusts all of the sensors that can be adjusted based on the calibration gas being used
- The display will show an "Error" for any sensors that were not successfully adjusted
- The most common reasons for failing AutoCal adjustment are:
 - Forgetting to attach the cal adapter
 - Forgetting to turn on the flow of gas
 - Empty calibration gas cylinder
 - Wrong cylinder / wrong concentration(s) in calibration gas
 - Gas has expired dating and is no longer usable
- Before giving up, check the gas and fittings and try again

```
AutoCal-Menu
AutoCal with
ZERO: fresh air
CAL: test gas
[ZERO] [CAL] [EXIT]
```

```
AutoCal-Gas
O2 - CH4 -
H2S [X] CO [X]
[ABORT]
```

```
AutoCal report
H2S Error
CO OK
O2 OK
CH4 OK
[DETECT]
```



January 23, 2013

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Slide 81

What if you check the gas and fittings but still fail AutoCal adjustment?

- To avoid accidentally using the wrong cal gas, or zeroing the instrument in the presence of contaminants;
- AutoCal has a maximum permitted change in adjustment between one fresh air zero, or one span calibration and the next
- If the change between the zero or span setting exceeds this maximum, the instrument will not properly adjust
- In this case you will need to perform a single-sensor calibration on the sensor or sensors that have failed to calibrate properly



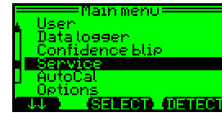
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G450 / G460 full technician training v27

Slide 82

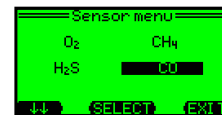
Single sensor calibration procedure (part 1)

- Use single sensor calibration procedure whenever you need to calibrate one sensor at a time
- Press and hold "Reset" button to show the "Main Menu" then chose "Service"
- For "Security Code" use "1100" as the password
- Choose "Sensors" then select the sensor that you intend to calibrate



Make sure to use "1100" as password.

"1100" is a special password that allows a wider maximum calibration adjustment window.



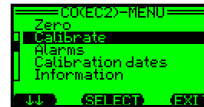
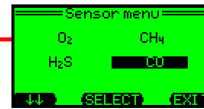
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Slide 83

Single sensor calibration procedure (part 2)

- A screen will show the menu choices for the selected sensor
- If the sensor needs to be fresh air adjusted choose "Zero"
- If the sensor does not need to be fresh air adjusted choose "Calibrate"



January 23, 2013

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Slide 84

Single sensor calibration procedure (part 3)

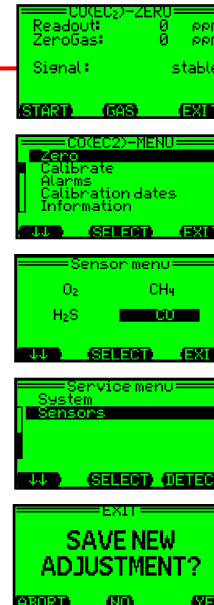
- To perform a fresh air zero:
 - Make sure the sensor is exposed to fresh, contaminant free air
 - Make sure to remove the cal adapter if you are using the surrounding air to adjust the sensor
 - The "Zero" screen will show the current reading
 - Press "Start" to begin the fresh air adjustment
 - An "OK" indicates when the procedure is complete, after which the screen returns to the "Zero" screen

You MUST save the results of the fresh air or calibration adjustment or they will not be saved to the instrument's memory!



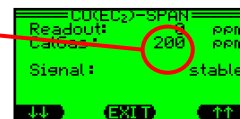
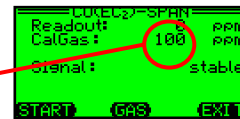
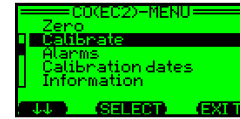
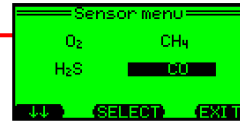
Saving single-sensor "Zero" and "Calibration" results (part 4)

- If you do not deliberately save the results, after a few minutes the instrument will return to normal operation and the results will not be saved!
- Press "Exit" to save the results and return to normal operation
- Each time you press "Exit" you move up one level in the instrument program
- The final screen will ask whether you want to "Save new adjustment?"
- Press "Yes" to update the instrument memory



Single sensor calibration procedure (part 5)

- To perform a span Calibration:
 - Choose the sensor to be calibrated
 - Choose "Calibrate" from the menu
 - Make sure the calibration adapter, calibration gas and regulator are attached to the instrument
 - The "Span" calibration screen shows the "CalGas" concentration that the instrument will use to adjust the sensor
 - Verify the concentration of gas in the cylinder matches the "CalGas" value
 - If needed, you can adjust the "CalGas" value by selecting "Gas" then using the arrow (↑↑ or ↓↓) buttons to change the concentration
 - Press "Exit" after you finish adjusting the "CalGas" concentration



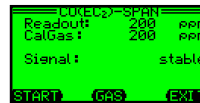
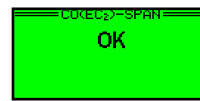
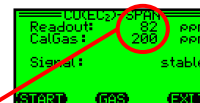
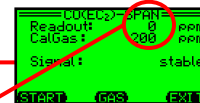
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Slide 87

Single sensor calibration procedure (part 6)

- To perform a span Calibration:
 - The "Readout" shows the current sensor reading
 - Open the regulator valve to begin flowing gas to the sensor
 - The "Readout" number will begin to rise as the sensor responds to the gas
 - Press "Start" to begin the calibration adjustment
 - The "Span" calibration screen will show an hour-glass icon while the sensor is being adjusted, then an "OK" message when the adjustment is complete
 - Press "Exit" to return the instrument to normal operation.
 - Remember to "Save" the new adjustment or the results of the calibration will not be updated to the instrument memory



January 23, 2013

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DS-400 Docking Station for daily bump check and / or periodic calibration



- **Standalone operation:**
 - **No computer required!**
- **Docking station controlled by instrument's control buttons:**
 - **Push "Test" for Bump Test**
 - **Push "Cal" for Auto Cal**
 - **Push "Cancel" to charge only**

January 23, 2013

G450 / G460 full technician training v27

Slide 89



DS-404 Multi-inlet Docking Station for bump check and periodic calibration



- **Inlets for 4 cylinders of gas**
- **Automatic Bump and Cal for 5, 6 and 7 channel instruments**
- **Supports:**
 - **Quad mix (O₂, LEL, CO, H₂S)**
 - **5-mix with SO₂**
 - **5-mix with CO₂**
 - **Isobutylene**
 - **HCN**
 - **NO₂**
 - **And other individual gases**

January 23, 2013

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Slide 90



Using DS400 Docking Station for daily bump check and / or periodic calibration



- **Standalone operation: DS-400 does not require connection to an external computer**
- **Test results and other messages displayed on instrument LCD**

January 23, 2013

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Slide 91



Using DS-400 Docking Station for daily bump check and / or periodic calibration

- **Using DS-400 allows instrument to record "Bump Test" as specific event in instrument's memory**
- **It is possible to set a "Bump Test Due" date in the instrument's memory**
- **Only way to reset next "Bump Test Due" date is by means of DS-400 Docking Station**



January 23, 2013

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Slide 92



Using DS-400 Docking Station for daily bump check and / or periodic calibration



- **Make sure DS-400 attached to test gas and power**
- **Make sure the instrument is located in fresh air, turn on, and allow to warm up**
- **Note instrument readings, and perform fresh air zero if necessary**
- **Place instrument in DS-400**
- **Docking station controlled by instrument's control buttons:**
 - **Push "Test" for Bump Test**
 - **Push "Cal" for Auto Cal**
 - **Push "Cancel" to charge only**

January 23, 2013

G450 / G460 full technician training v27

Slide 93



How to do bump test

- **Make sure instrument turned on**
 - **Best if instrument allowed to warm-up at least 5 minutes before bump test**
- **Make sure Docking Station plugged in and connected to gas**
 - **Higher inlet is for fresh air**
 - **Lower inlet is for span gas**
- **Place instrument in Docking Station**
- **Instrument display will indicate status and results of test**



January 23, 2013

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Slide 94



How to do bump test

- *After 10 second count-down; Docking Station automatically performs bump test*
- *Instrument screen shows a check mark besides each sensor as bump check completed*
- *If instrument is not removed from Docking Station; 5 minutes after test completed instrument automatically turns off and goes into charging mode*



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DS400 Docking Station

- **Bump-Test includes:**
 - Visual alarm function
 - Audible alarm function
 - Time for activation to alarm 1
 - Time for activation to alarm 2
 - Time to t50
- **Calibration Test Includes:**
 - Fresh air zero adjustment
 - Span calibration adjustment
- **All test results:**
 - Stored to instrument memory
 - Stored to flash memory card in Docking Station



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What to do if instrument fails bump test

- **Red color warning screen and message indicates bump test failed**
- **This means instrument needs to be "Autocal" adjusted before further use**
- **Remove instrument from Dock, and press "Reset" (center) control button to clear alarm message**
- **Place instrument back in Dock**
- **Before end of count down press Autocal button**

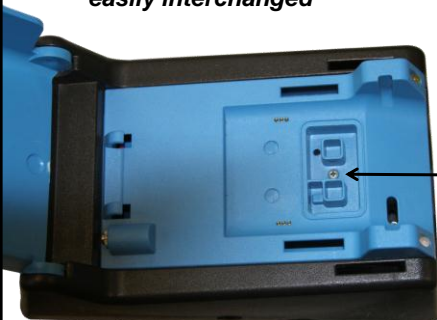
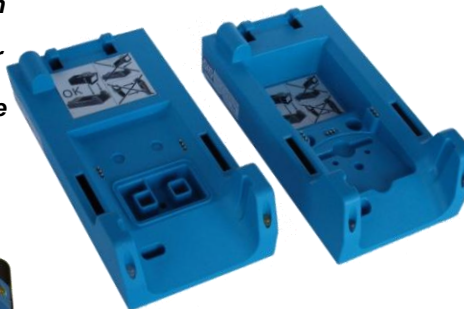


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DS-400 charging tray options

- **DS-400 Docking Stations can be equipped with a "single" or "double" charging tray for recharging the instrument and pump battery pack at the same time**
- **The trays are designed to be easily interchanged**



The charging tray is secured in the Docking Station housing by a single Phillips screw

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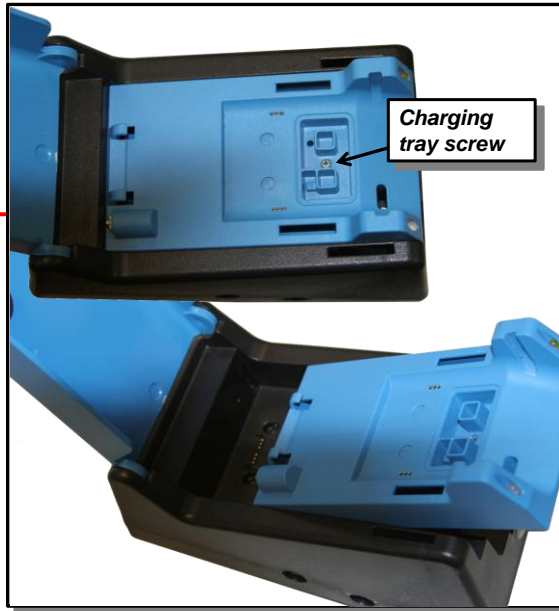
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Slide 98



**Removing or changing
the DS-400 charging tray**

- **Remove the charging tray screw;**
- **Lift the tray from the front and pull up and forward**



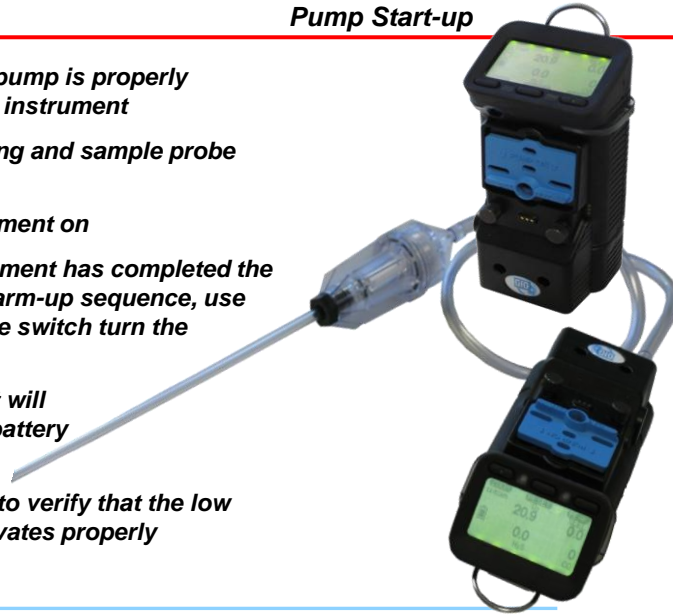
DS400 Docking Station options

- **"USB anywhere" external hub allows customer to transmit test results via Ethernet connection to internal or external network**



Pump Start-up

- **Make sure the pump is properly attached to the instrument**
- **Attach the tubing and sample probe assembly**
- **Turn the instrument on**
- **After the instrument has completed the self test and warm-up sequence, use the on / off slide switch turn the pump on**
- **The instrument will display pump battery status**
- **Block the inlet to verify that the low flow alarm activates properly**



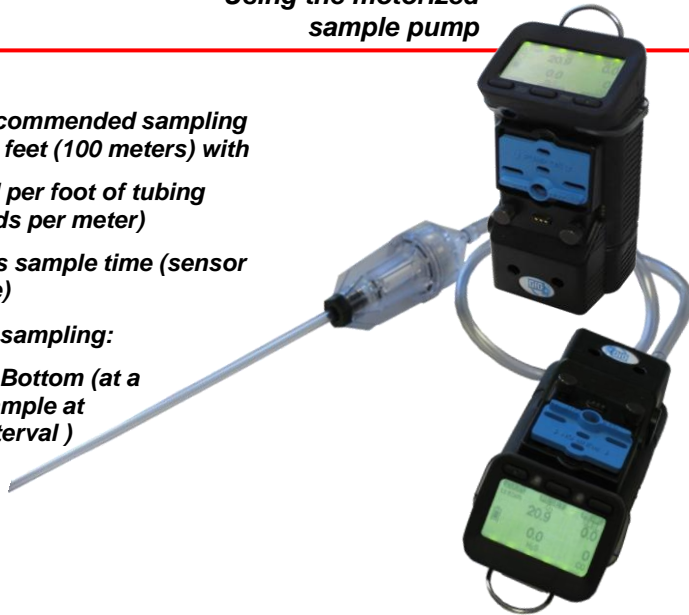
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Slide 101

Using the motorized sample pump

- **Sampling Rules**
 - **Maximum recommended sampling distance 300 feet (100 meters) with**
 - **1 second per foot of tubing (3 seconds per meter)**
 - **2 minutes sample time (sensor response)**
- **Confined Space sampling:**
 - **Top, Middle, Bottom (at a minimum, sample at every 4 ft. interval)**



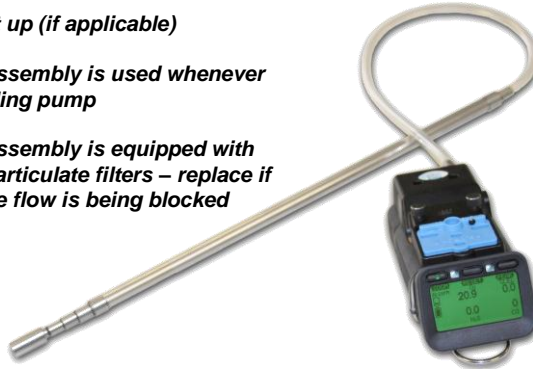
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Slide 102

Performing a gas test

- Perform proper instrument start up
- Make sure instrument has been properly bump-tested before use
- Perform proper pump start up (if applicable)
- Make sure sample probe assembly is used whenever using the motorized sampling pump
- Make sure sample probe assembly is equipped with hydrophobic barrier and particulate filters – replace if discolored or dirty, or if the flow is being blocked
- Test all areas as required
- Fill in Gas Test Sheet



January 23, 2013

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Slide 103

Time required for proper testing

- Wait until the sensor readings have completely stabilized!
- Remember that you may need up to 2-minutes – or even longer – for the sensors to finish stabilizing
- If tubing or a wand is used as well you have to add an additional 1-sec per foot of tubing for the gas to reach the sensors
 - So, if you were testing a vessel that was 10 feet deep and using 10 feet of tubing, how long would it take to sample and test the atmosphere in the bottom of the vessel?
 - 2 minutes + (1 sec. x 10 feet) = 2.17 minutes

The time it takes for the sensors to finish stabilizing after the gas begins to reach the sensors

The time it takes for the pump to pull the sample through a 3.5 meter length of tubing

Time required for each test



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Slide 104

G450 / G460 Advanced Operation

WARNING: Advanced user options and setup choices should only be accessed or changed by authorized personnel



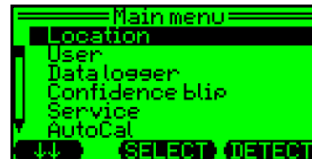
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Slide 105

Advanced user options: Service Mode

- From “Main menu” screen choose “Service”
- The LCD will ask you for a security code
- Enter “0 0 1 1”
- The “Service menu” screen should appear with the following choices: “System” and “Sensors”



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Slide 106

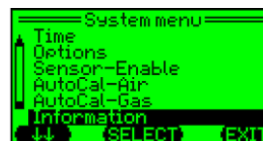
Making a change and leaving "Service Mode"

- Use arrow keys to select (highlight) option or setting you intend to change
- Press "Edit", then use arrow keys to change setting
- Press "Exit" to return to normal operation (you may need to press "Exit" several times)
- You **MUST** press "Yes" to save the changes



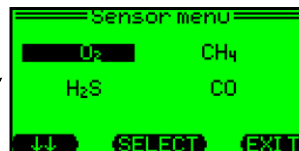
Advanced user options: Service Mode "System" menu

- Use "System" choice to:
 - Set "Bump test" due date
 - Set "Calibration" due date
 - Set interval for "Inspection" due date
 - Set "Time"
 - Set system "Options" (language, vibrating alarm, alarm latch, SD card check, display zoom, auto-save setup changes)
 - "Sensor-Enable" to turn sensors off or on
 - "AutoCal - Air" specify which sensors adjusted during the "AutoCal - Air" procedure
 - "Autocal - Gas" specify which sensors adjusted during the "AutoCal - Gas" procedure
 - "Information" verify firmware version currently installed



Advanced user options: Service Mode "Sensor" menu

- Use the "Sensors" choice to change settings for individual sensors
- Each sensor has unique list of options and setting choices



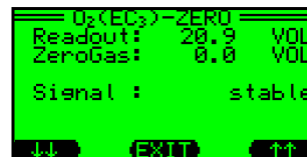
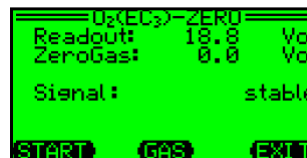
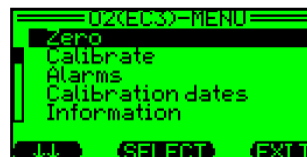
↓↑	- Move to next sensor
SELECT	- Select sensor
EXIT	- Return to service Menu



Advanced user options: Oxygen "Sensor" menu

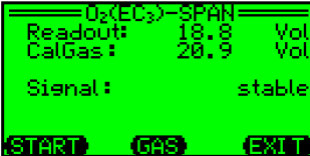
- "Adjust Zero Point"

WARNING: In the "Adjust Zero Point" procedure readings of the O₂ sensor are adjusted while the sensor is exposed to pure nitrogen (0.0% oxygen). Never attempt to "Adjust Zero Point" while the sensor is located in fresh air



**Advanced user options:
Oxygen "Sensor" menu**

- **"Calibration"**
 - *In this step oxygen sensor readings are span adjusted to match the concentration of oxygen in fresh air (20.9%)*
 - *This is the same procedure as the "AutoCal - air" adjustment normally used to adjust sensor readings to match the expected concentrations in fresh air*



**Advanced user options:
Oxygen "Sensor" menu**

- **Oxygen sensors have three user adjustable alarm settings**
 - *Alarms 1 and 2 are normally "descending" alarms that are activated by the concentration falling below the alarm value*
 - *Alarm 3 is an "ascending" alarm that is activated by the concentration rising above the alarm value*
 - *Highlight the desired alarm, then press "Edit" to change the value*
 - *Press "Exit" to accept the new value and return to the O2 sensor menu*

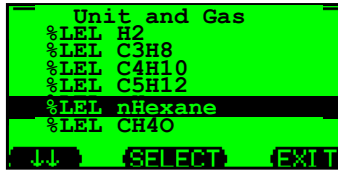
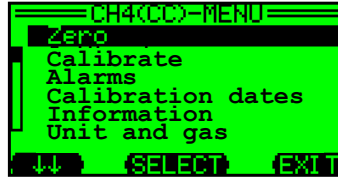
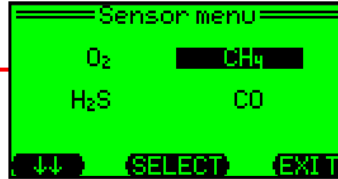


WARNING: Setting an alarm value to (--) turns the alarm off. When the alarm is turned off the user will not be notified in the event of an alarm. This could result in injury or death.



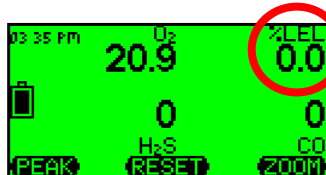
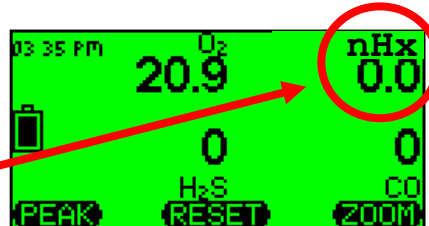
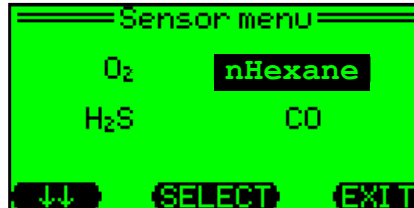
**Advanced user options:
LEL "Sensor" menu**

- **LEL sensor menu choices:**
 - **Zero:** Perform fresh air zero adjustment
 - **Calibrate:** Perform span calibration adjustment
 - **Alarms:** Change current alarm settings for LEL sensor
 - **Calibration dates:** Most recent three dates
 - **Information:** Display sensor ID information
 - **Gas and unit:** Choose correction factor for new gas from library



**Selecting a new gas from the
"Gas and Unit" library**

- **LEL readings are displayed in measurement units for gas selected**
- **Name of gas selected will appear in the sensor menu LEL position**
- **In normal operation screen will show name of new gas selected in place of "% LEL"**



CC LEL sensor "Gas and Unit" library choices

- The following CC LEL sensor "gas and unit" choices are available as setup choices in the on-board library:

CC LEL Gas List	Common Name
CH4	Methane
H2	Hydrogen
CH4O	Methanol
C3H8	Propane
C2H6O	Dimethylether
Acetone	Acetone
C3H8O	Isopropyl Alcohol
C3H6O2	Methyl Acetate
C4H10	Butane
EtActat	Ethyl Acetate
n-Butanol	n-Butyl alcohol
C5H12	Pentane
MEK	Methyl Ethyl Ketone
MIBK	Methyl Isobutyl Ketone
n-Hexane	n-Hexane



January 23, 2013

G450 / G460 full technician training v27

Slide 115

Additional catalytic LEL sensor response factors

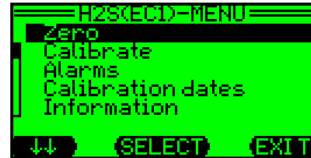
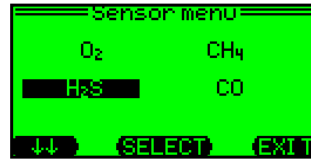
- Listed responses are for guidance only
- Relative response ratios may differ from sensor to sensor, and may shift over the life of the sensor
- Cumulative exposure to sensor poisons and / or inhibitors may also affect the relative response ratios
- The relative response values have been rounded to the nearest 5%

Gas	Relative response (compared to CH4)	Correction factor
Acetone	0.70	1.43
Acetylene	0.900	1.11
Ammonia	1.40	0.71
1, 3-Butadiene	0.60	1.67
n-Butane	0.65	1.54
Carbon monoxide	1.20	0.83
Cyclohexane	0.50	2.00
Ethyl acetate	0.55	1.82
Ethyl alcohol	0.85	1.18
Ethylene	0.90	1.11
Gasoline (unleaded)	0.60	1.67
Gasoline (leaded)	0.60	1.67
n-Heptane	0.45	2.22
n-Hexane	0.55	1.82
Hydrogen	1.10	0.91
Isobutylene	0.80	1.25
Isopropyl alcohol	0.65	1.54
Methane	1.00	1.00
Methyl alcohol	0.85	1.18
Methylethylketone	0.55	1.82
n-Octane	0.35	2.86
n-Pentane	0.55	1.82
Propane	0.65	1.54
Propylene	0.87	1.15
Toluene	0.40	2.50

January 23, 2013

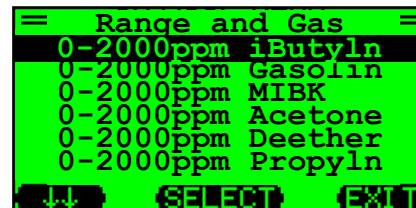
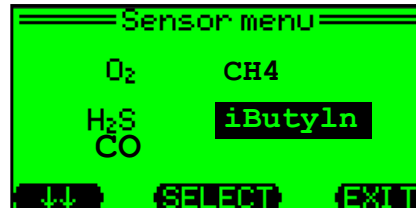
**Advanced user options:
Toxic "Sensor" menus**

- **Toxic sensor menu choices include:**
 - **Zero:** Perform fresh air zero adjustment
 - **Calibrate:** Perform span calibration adjustment
 - **Alarms:** Change current alarm settings for LEL sensor
 - **Calibration dates:** Most recent three dates
 - **Information:** Display sensor ID information



PID sensor menu

- **PID sensor choices include "Range and Gas"**
- **Use to choose correction factor for new gas from PID library**
- **PID readings displayed in measurement units of gas selected**
- **Name of gas selected will appear in the sensor menu PID position**
- **In normal operation screen will show name of new gas**

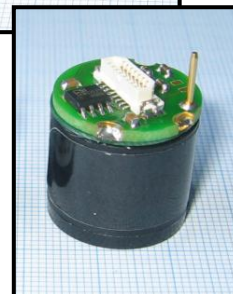
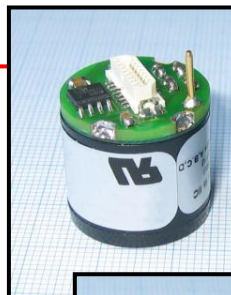


PID sensor “Gas and Unit” library choices

PID Gas List Abbreviations	Common Name	Range with 0 – 2000 ppm full range PID (ISO)	Range with 0 – 500 ppm full range PID (ISO)
iButyln	Isobutylene	0 – 2000	0 – 500
VOC	Generic VOC with user assigned CF	0 – 2000	0 – 500
Gasolin	Gasoline	0 – 2000	0 – 500
MIBK	Methyl-iso-butyl-ketone	0 – 2000	0 – 500
Acetone	Acetone	0 – 2000	0 – 500
Deether	Diethylether	0 – 2000	0 – 500
Propyln	Propylene	0 – 2000	0 – 500
MEK	Methyl-ethyl-ketone	0 – 1500	0 – 375
Diesel	Diesel	0 – 1500	0 – 375
TrClEyn	Trichloroethylene	0 – 1000	0 – 250
Benzene	Benzene	0 – 1000	0 – 250
Toluene	Toluene	0 – 1000	0 – 250
Xylene	Xylene	0 – 1000	0 – 250
Styrene	Styrene	0 – 800	0 – 200
Jetfuel	Jet fuel (JP-8)	0 – 800	0 – 200
nButnol	n-Butyl-alcohol	0 – 6000	0 – 1500
EtActat	Ethyl acetate	0 – 6000	0 – 1500
nHexane	n-Hexane	0 – 6000	0 – 1500
NH3	Ammonia	0 – 6000	0 – 1500
cHexane	Cyclo hexane	0 – 3000	0 – 750
VyChlrd	Vinyl chloride (VCM)	0 – 3000	0 – 750
MeBromd	Methyl bromide	0 – 3000	0 – 750
nNonane	n-Nonane	0 – 3000	0 – 750
Octane	Octane	0 – 3000	0 – 750
Heptane	Heptane	0 – 3000	0 – 750

PID range and resolution

- Two versions of the PID sensor available for G460:
 - “Standard” PID provides 0.5 ppm resolution over 0 – 2000 ppm (isobutylene scale)
 - “High Resolution” PID provides 0.1 ppm resolution over 0 – 500 ppm (isobutylene scale)
- “VOC” choice allows the user to specify custom correction factor for a gas not included in the standard on-board library
- The full range for the gas selected depends on the relative response of the sensor to the target gas compared to isobutylene
 - For instance, when “NH3” (ammonia) is selected, because of the lower relative response to ammonia compared to isobutylene, the full range is expanded from 0 – 2000 (iso scale) to 0 – 6000 ppm (NH3 scale)



**Advanced user options:
Viewing or changing span gas values**

- G450 / G460 instruments automatically adjust sensor readings during the AutoCal® process
 - Fresh "Air" AutoCal® adjusts sensor readings to match those expected in uncontaminated air that contains 20.9% O₂
 - "Gas" AutoCal® adjusts sensor readings to match the concentrations in the calibration gas used for this procedure
 - The factory default "span" gas values used by the instrument to adjust sensor readings are:
 - LEL Sensor: 50% LEL
 - CO Sensor: 200 ppm
 - H₂S Sensor: 20 ppm



January 23, 2013

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Slide 121

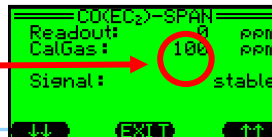
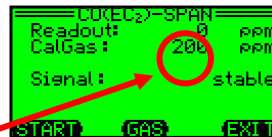
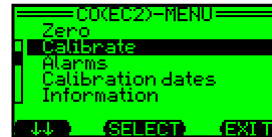
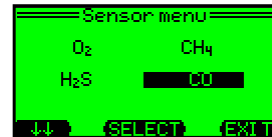
**Advanced user options:
Viewing or changing span gas values**

- In order to use gas with a different concentration to calibrate the instrument, you will need to change the span "Gas" value for that sensor
- From the "Sensor Menu" choose the sensor with the span gas values you want to view or change, then choose "Calibrate", then "Gas"
- Use the arrow keys to adjust the gas value, then "Exit"



Old value

New value



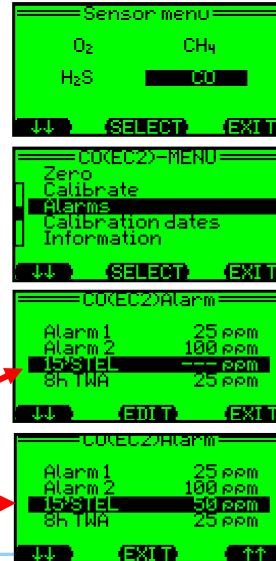
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Advanced user options: Viewing or changing alarms

- From the "Sensor Menu" choose the sensor with the alarm values you want to view or change, then choose "Alarms",
- Use the arrow keys to select the alarm to adjust, then "Edit"
- Use the arrow keys to adjust the alarm, the "Exit" when finished

NOTE: Setting the value to zero turns the alarm off. The display will show a dashed line.



STEL
alarm off

STEL
alarm on

January 23, 2013

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G450 / G460 Advanced Service Procedures

WARNING:
Advanced service
procedures should
only be undertaken
by authorized
personnel



January 23, 2013

G450 / G460 full technician training v27

Slide 124



Date Code Method of Calibration

WARNING: Date code method of calibration should **ONLY** be used when other methods fail to permit proper adjustment of sensors

- To avoid accidentally using the wrong calibration gas, or zeroing the instrument in the presence of contaminants, the G450 and G460 include a maximum permitted adjustment between one fresh air zero, or one span calibration and the next
- If the change between the zero or span setting exceeds this maximum, the instrument will not properly adjust
- Entering the service menu via the "Date Code" method turns the protective window off, permitting the affected sensor(s) to be properly adjusted



Date Code Method of Calibration

WARNING: Once you have entered the Service Menu via the Date Code Method you **MUST** zero and span calibrate **ALL** sensors before further use

- Select the Service Menu in the normal way
- When prompted, use the date of the day and the month as the Password
 - For instance, if the current date is January 24, 2011 the four digit Date Code Password would be: 2401
- If the affected sensor is still incapable of proper zero or span adjustment when properly exposed to gas, it will probably need to be replaced
- Do not make any unnecessary changes to the instrument's programming while in this restricted Factory Service Mode!
- All installed sensors **MUST** be zero and span calibrated before further use



Updating G450 / G460 Firmware

- **You will need:**
 - **Latest firmware version to be installed**
 - **Latest version can be downloaded from www.goodforgas.com**
 - **Charger cradle and data download interface cable**
 - **Make sure the GfG drivers for the interface cable have been installed on your computer**



January 23, 2013

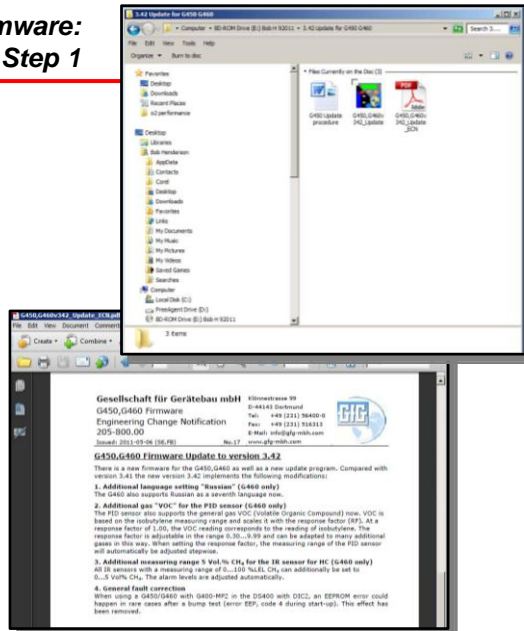
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Slide 127



Update firmware: Step 1

- **Load the new “Update firmware” application onto your computer**
 - **The latest version can be downloaded at www.goodforgas.com**
- **Read the description of changes from the previous version**
- **Decide whether to proceed with update**



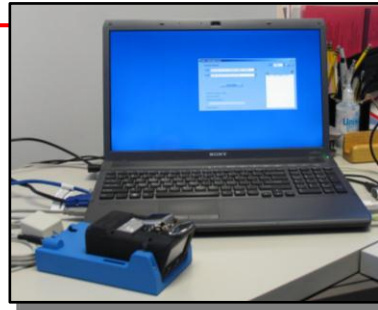
January 23, 2013

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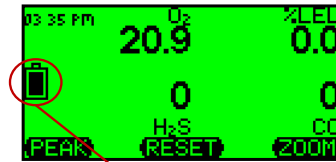
Slide 128

Update firmware: Step 2

- **Connect download interface cable to cradle and connect cable to USB port in computer**
- **Turn instrument on then place in cradle**



- **Make sure neither the instrument or computer run out of power during update procedure**
- **Make sure battery gauge in LCD shows at least two segments**
- **Do not disconnect or disturb interface cable and instrument during update process**

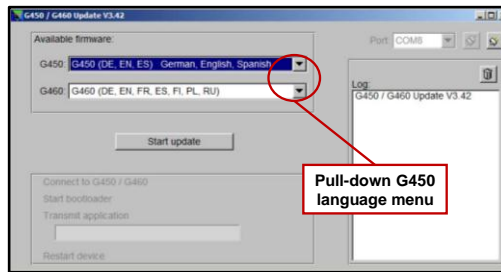
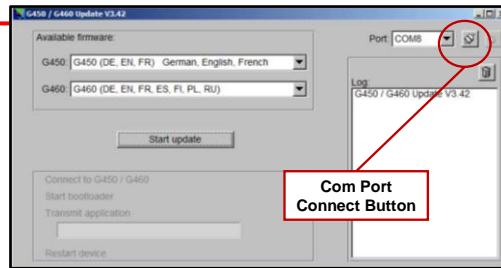


Battery power gauge



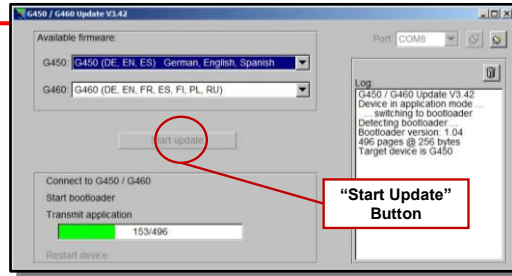
Update firmware: Step 3

- **Open G450 / G460 Update program**
- **Select com port from pull down menu then click on "connect" button**
 - **Note: Correct com port is usually the one with the highest number**
- **Choose desired set of languages from pull-down menu**
 - **G450 supports sets of three languages at a time as choices in on-board memory**
 - **G460 supports all available languages at same time in on-board memory**

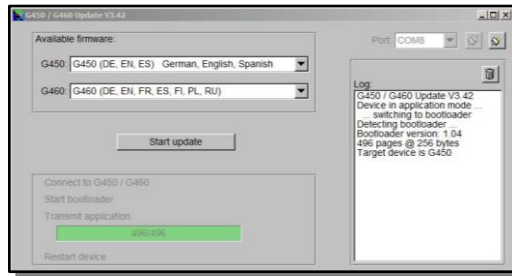


Update firmware: Step 4

- Click on “Start Update” button
 - A green status bar will indicate progress
- The instrument will turn itself back on in normal operation when the update is complete



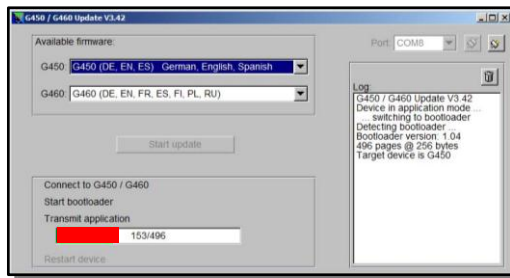
• The instrument must be calibrated before it is put back into service!



Update firmware: If a problem is encountered

- A red status bar indicates a problem has been encountered
- Remove the instrument from the cradle, then replace in cradle and click on the start button to repeat the update process

• If the update application fails to restart the procedure, try momentarily disconnecting the interface cable from the computer, and / or closing and restarting the update application



Configuration Update Software

- **Warning:**
 - GfG “Config update” software is primarily designed for use during factory production procedures
 - Use of GfG “Config update” software is restricted to factory trained and authorized service technicians
 - Use **ONLY** those “Config update” choices which are absolutely necessary to complete the required service procedure



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Slide 133

Using Configuration Update Software

- **You will need:**
 - **Charger cradle and data download interface cable**
 - Make sure the GfG drivers for the interface cable have been installed on your computer
 - **GfG “Config update” software**
 - Latest version can only be obtained from GfG factory headquarters in Ann Arbor, Michigan
 - Contact factory to obtain latest version



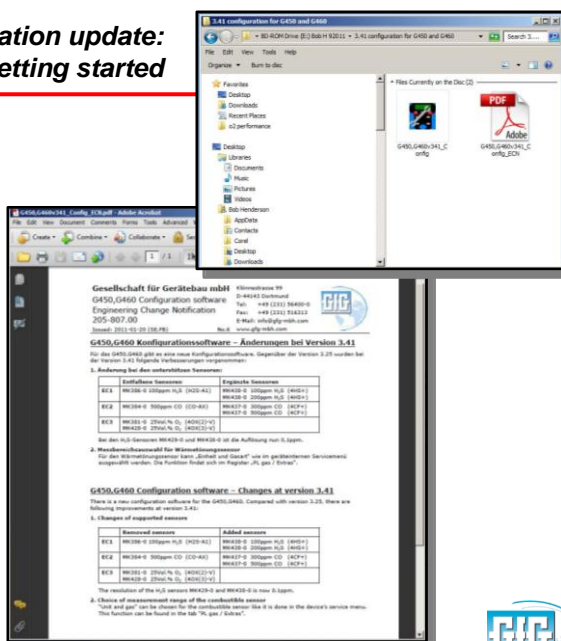
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Slide 134

Configuration update: Getting started

- Load the “Config update” software onto your computer
- Read the ECN (“Engineering Change Notice”) that explains the changes from the previous version
- Decide whether to proceed with update



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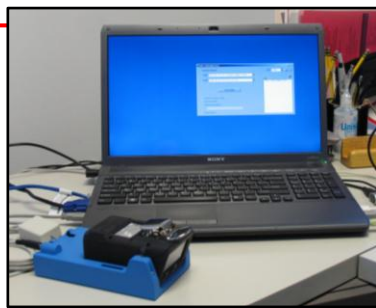
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Slide 135



Configuration update: Connecting with computer

- Connect download interface cable to cradle and connect cable to USB port in computer
- Turn instrument on then place in cradle



- Make sure neither the instrument or computer run out of power during update procedure
- Make sure battery gauge in LCD shows at least two segments
- Do not disconnect or disturb interface cable and instrument during update process



Battery power gauge

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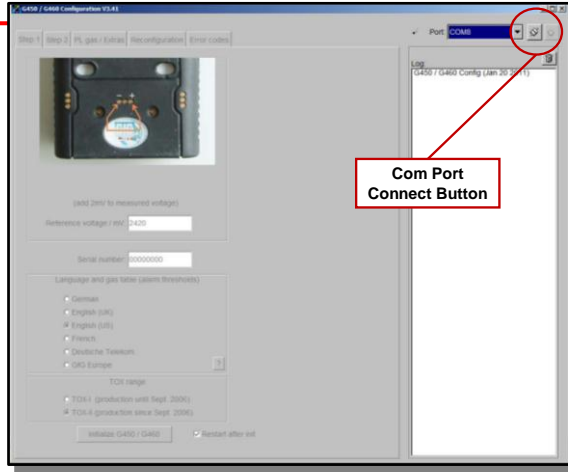
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Slide 136



Configuration update: Open Com Port

- **Open G450 / G460 “Config update” program**
- **Select com port from pull down menu then click on “connect” button**
- **Correct com port is usually the one with the highest number**



Configuration update: “Step 1” screen

- **After successfully opening com port “Config update” software opens on the “Step 1” screen**

• **The choices in the “Step 1” screen are only used during in-factory production procedures**

• **Do not make any changes in the “Step 1” screen**

• **DO NOT INITIALIZE THE INSTRUMENT!**

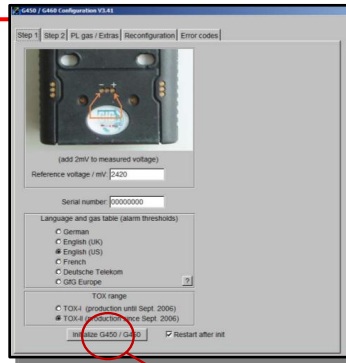


DO NOT INITIALIZE INSTRUMENT!



Configuration update: What if you accidentally click the "Initialize" button in the "Step 1" screen?

- Clicking "Initialize" resets the instrument to the original defaults for a brand new board.
- You **MUST** verify that all settings (including alarms, language, datalogger, vibrator and serial number) are correct **BEFORE** the instrument is returned to service.
- The "Reconfiguration" tab is used to assign a new serial number, and to activate the datalogger and vibrator alarm.
- **MAKE CERTAIN** the "Datalogger" and "Vibrator" boxes are checked (selected) in the "Reconfiguration" screen before the instrument is returned to service.
- Verify that the bump test, calibration, inspection and sensor alarms are all properly set before the instrument is returned to service. You can verify these settings either by turning the instrument on in normal operation, and watching the sequence of screens during the self-test and warm-up sequence; or you can use the "0011" passcode to enter the "Service" menu in the normal way to verify settings and make changes.



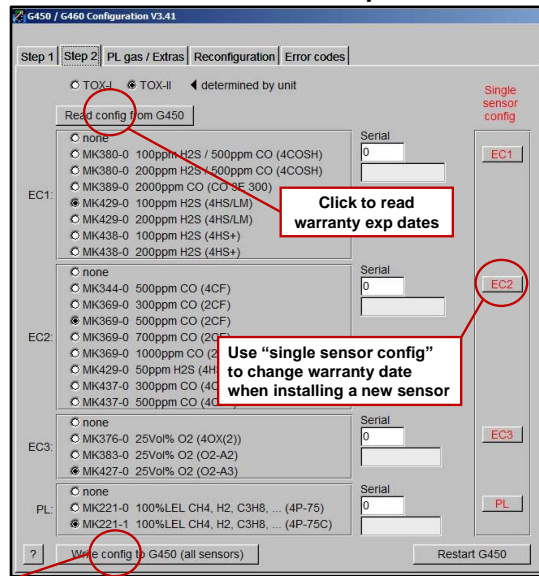
DO NOT INITIALIZE INSTRUMENT!

- "Step 2" screen used to reset sensor warranty expiration dates or pick different type of sensor for installation in the identified sensor location
- Click "Read config from G450" to verify the current sensor settings and warranty expiration dates
- Click "single sensor config" to reset the warranty clock with today's date (the new warranty exp date will be three years from today)

Do not "write config to all sensors" unless you have replaced all of the sensors with brand new sensors!

DO NOT CLICK "WRITE CONFIG TO ALL SENSORS"

Configuration update: "Step 2" screen



Click to read warranty exp dates

Use "single sensor config" to change warranty date when installing a new sensor

Resetting the warranty expiration date for a new G450 sensor

- In the G450 replacing an old sensor with a new one does not automatically update the warranty exp date
- When a sensor is replaced with a newly purchased sensor the warranty exp date should be updated
- “Config update” software is used to update the warranty expiration to 3-years from today’s date
- Use the “Step 2” screen and “single sensor config” choice to update ONLY the warranty expiration dates of the newly installed sensor(s)

• Normally, when a sensor is replaced under warranty the original warranty date should NOT be updated

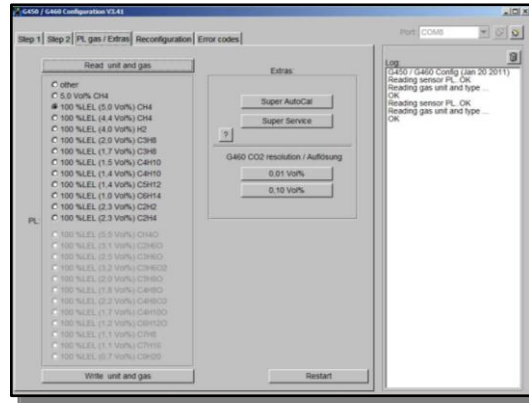
Configuration update: “Step 2” screen

- “Step 2”
 - Click “Restart” to update the instrument and return to normal operation



Configuration update: PL gas / extras screen

- The choices in the “PL gas / extras” screen are exclusively used during in-factory production procedures
- Do not make any changes in the “PL gas / extras” screen



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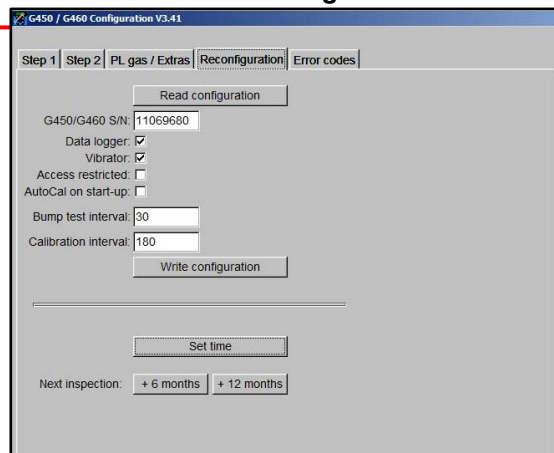
Slide 143



Configuration update: Reconfiguration screen

- The “Reconfiguration” screen is used to assign a new serial number to the instrument

- Make sure the assigned serial number matches the serial number on the external label
- NEVER turn-off (deselect) “Data logger”
- NEVER turn-off (deselect) “Vibrator”



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Slide 144



Sensor replacement

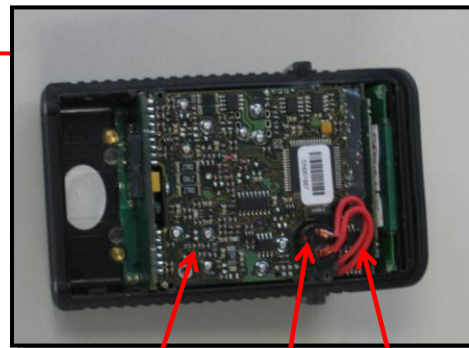
- **Make sure instrument is turned off**
- **Remove battery pack**
- **Using the star-hex tool, loosen the four screws holding the front and back of the instrument housing together**
- **GENTLY remove the back cover**
- **DO NOT USE SCREWDRIVERS OR OTHER HARD TOOLS TO PRY APART THE CASE SECTIONS!**

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Sensor replacement

- **GENTLY straighten yoke wires connecting the sounder with the main PCB (wires extend through circular hole in board to sounder)**
- **BE VERY GENTLE! If you pull too hard you can separate the wires from the board or sounder**



Main PCB

Yoke wires

Sounder

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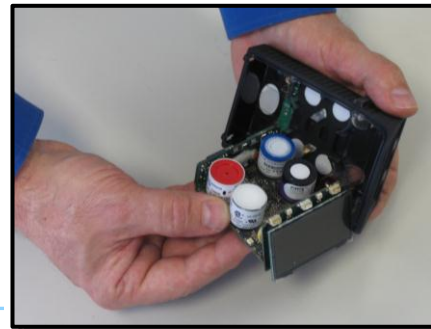
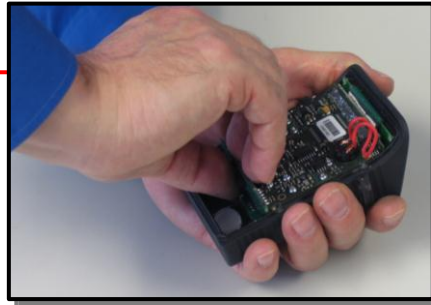
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Slide 146



Sensor replacement

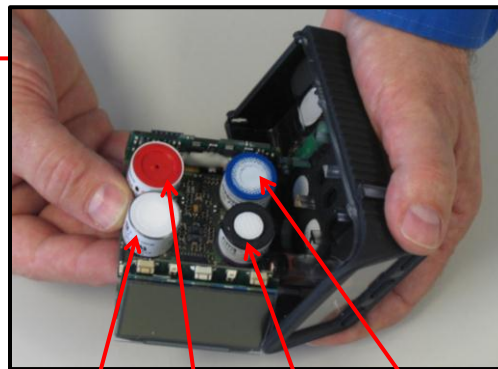
- **Once the yoke wires have been positioned vertically to board,**
- **GENTLY** loosen the main board and display assembly, then
- **Lift the main board and display assembly upwards from the housing and turn it so the sensors are exposed**
- **BE CAREFUL NOT PULL THE YOKE WIRES HARD ENOUGH TO CAUSE DAMAGE**



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G450 Sensor replacement

- **In the G450 the sensor positions are defined**
- **Identify the sensor you intend to replace**
- **Remove and replace the required sensors**
- **IN THE G450 THE SENSOR YOU REMOVE MUST BE REPLACED WITH THE EXACT SAME TYPE OF SENSOR IN THE EXACT SAME POSITION,**
- **SWITCHING SENSOR POSITIONS WILL RESULT IN CALIBRATION OR SENSOR TEST FAILURE WHEN THE INSTRUMENT IS RESTARTED**



LEL (stainless steel housing)

CO (solid red or red ring top)

H2S (blue ring top)

Oxygen (purple housing)

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Slide 148



G460 sensor replacement

- G460 sensors are equipped with “smart” PCBs that identify the type of sensor and other settings to the instrument
- As long as the type of sensor is supported when installed in a particular position on the PCB, the instrument will automatically update the sensor configuration when it is restarted



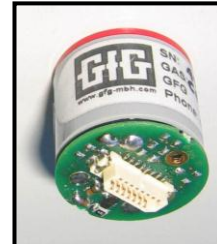
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Slide 149

G460 Interchangeable Smart Sensors

- Five Smart Sensor positions on PCB:
- All you need to do is plug the sensor into a position designed for that type of sensor
 - **EC 1:** COSH
 - **EC 1, 2, 3:** CO, H2S, O2, NH3, SO2, H2, PH3, HCN
 - **EC 2, 3:** NO, NO2, CL2, HCL, ETO, O3, CIO2, HF
 - **EC 2:** PID
 - **PL:** 1 – 100% LEL “pellistor” sensor
 - **IR:** 0.1 - 5.0 Vol % CO2; 0 – 100% LEL combustible; 0 – 100% vol combustible

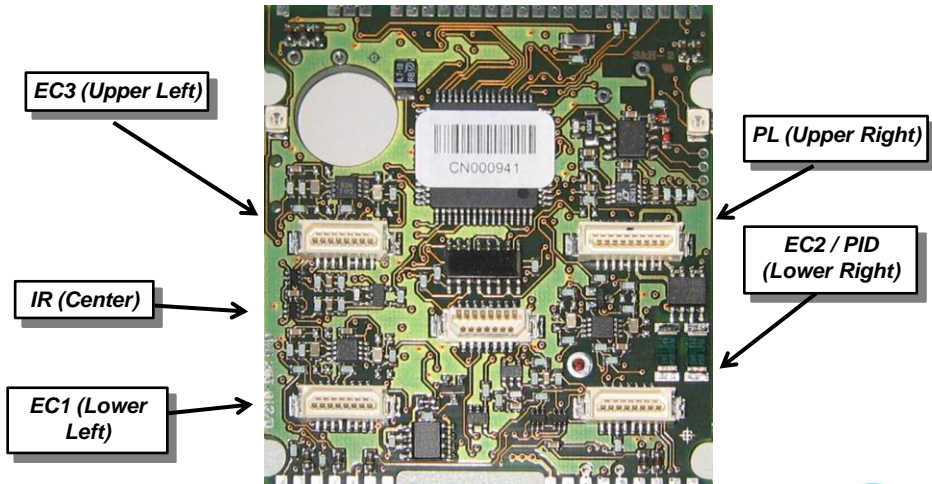


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Slide 150

**G460 Main PCB:
Five Smart Sensor Positions**



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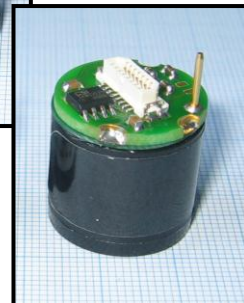
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Slide 151



G460 Smart Sensor PID

- **PID Smart-Sensor**
 - **Broad range VOC measurement**
 - **Extremely sensitive**
 - **Available in two ranges:**
 - **0.5 – 2,000 ppm (Standard PID sensor)**
 - **0.1 – 500 ppm (Optional high resolution PID sensor)**



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Slide 152



G460 PID maintenance

- **The G460 PID is protected by both external and internal filters**
 - **Because gas diffuses into and out of the sensor (rather than using a pump to pull the atmosphere across the lamp and electrodes) the system is less prone to particulate contamination**

Note: The PID lamp and electrodes should only be cleaned when needed!

- **The primary symptoms that indicate the need to clean the lamp are:**
 - 1. Unstable readings**
 - 2. Oversensitivity to humidity**
 - 3. Failure to calibrate**



G460 PID Maintenance

- **The following slides show the step-by-step procedure for cleaning the G460 PID**
- **The manufacturer of the PID lamp (Baseline-MOCON, Inc.) has also posted a training video at the following link:**

<http://vimeopro.com/gasanalysis/pid-tech-plus>

The password is: baseline11

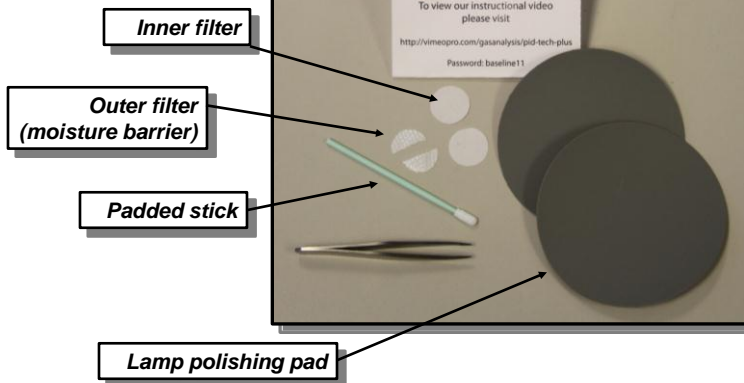
- **G460 PID cleaning kit (PN 7740-026): includes replacement filters, lamp polishing pads, tweezers and compressor stick**

Note: The appearance of the Baseline-MOCON "PID Plus" sensor in the video is slightly different from the GfG PID version. The procedure for disassembly and cleaning the lamp is exactly the same, however.



G460 PID Maintenance Kit

- **PID maintenance kit components**



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Slide 155



G460 PID Maintenance Cautions

- **Wear gloves when handling or disassembling PID**



Note: Direct contact between fingers and PID lamp, electrodes and other components can leave oils and contaminants behind that can degrade performance

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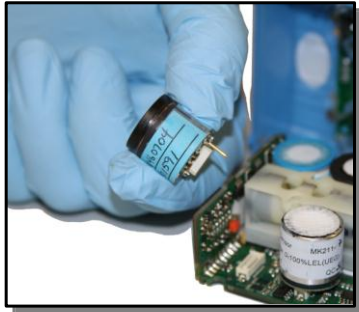
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Slide 156



G460 PID Maintenance

- **Make sure instrument is turned off!**
- **Remove battery, open housing, and CAREFULLY remove main board and display assembly exposing sensors**
- **Remove PID sensor**



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Slide 157



G460 PID Maintenance

- **Use tweezers to pry the top off of the sensor**
- **Position the tweezers next to the cap opening**
- **Remove the sensor cap**



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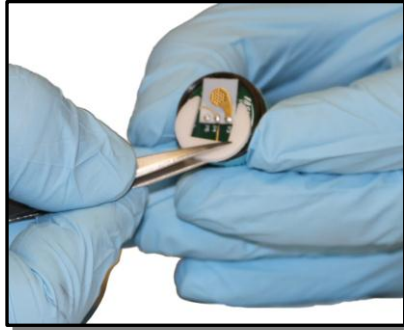
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Slide 158



G460 PID Maintenance

- *Remove filters (inner and outer)*
- *Remove spacer*



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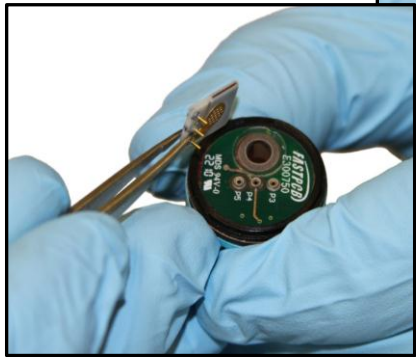
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Slide 159



G460 PID Maintenance

- *Gently remove sensor PCB*
- *Grip at back of board (near pins)*



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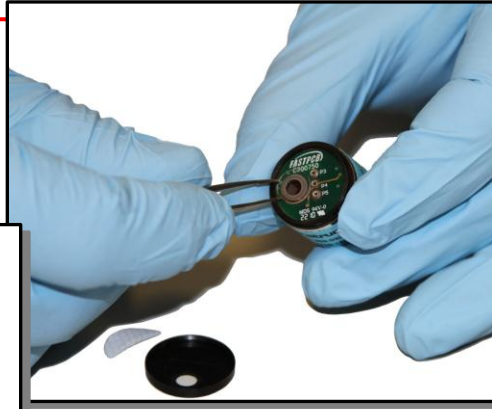
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Slide 160



G460 PID Maintenance

- *Use tweezers to GENTLY pry the lamp out of the sensor*
- *Do not touch window or body of lamp with naked fingers*



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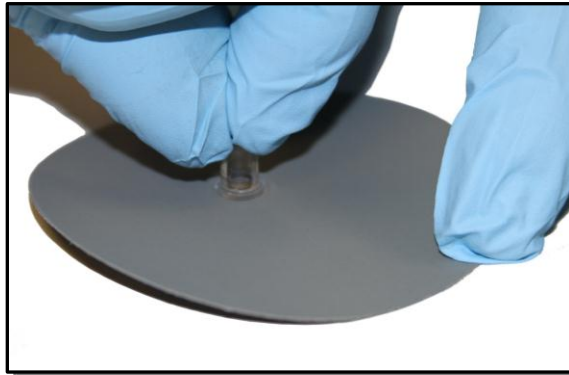
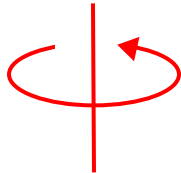
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Slide 161



G460 PID Maintenance

- *Use circular motion to polish face of lamp window with polishing pad*



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Slide 162



G460 PID Maintenance

- **Clean any lamp, pin, or electrode PCB surfaces that have come into contact with naked skin with alcohol before reassembling**
- **Make sure that all components are COMPLETELY air-dried before reassembly**
- **Do not use blowers or heated air sources to speed up drying!**



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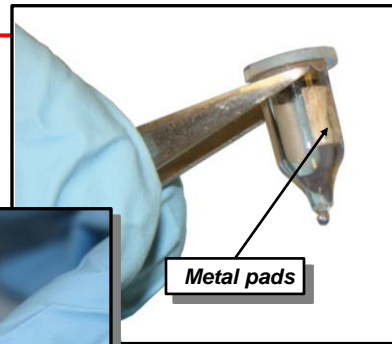
Slide 163



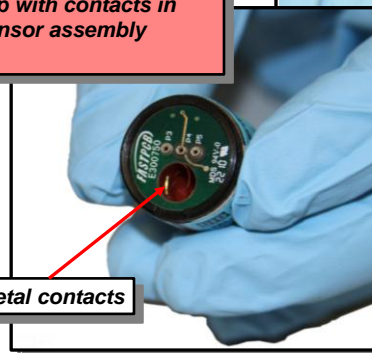
G460 PID Maintenance

- **Insert lamp back into PID sensor assembly**

NOTE: Metal pads in PID lamp MUST line up with contacts in socket of sensor assembly



Metal contacts



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Slide 164



G460 PID Maintenance

- Use padded stick to press lamp into place



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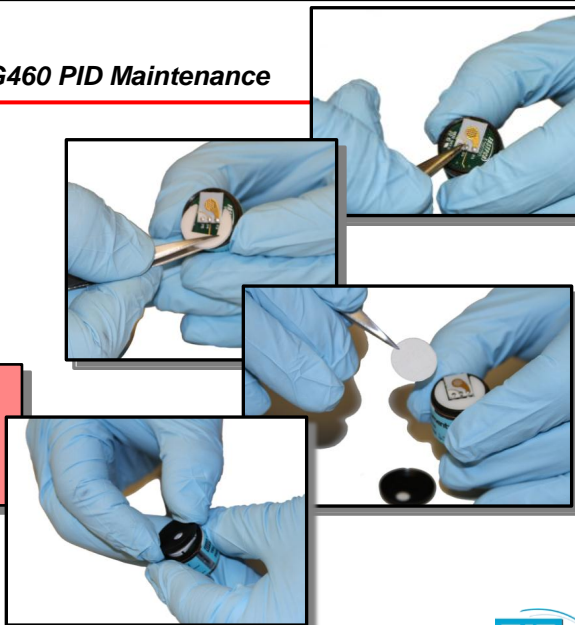
Slide 165



G460 PID Maintenance

- **Reassemble:**
 - Sensor PCB
 - Spacer
 - Filters (2)
 - Sensor cap
- Plug PID sensor back into instrument

Calibrate the PID sensor before returning the G460 to service!



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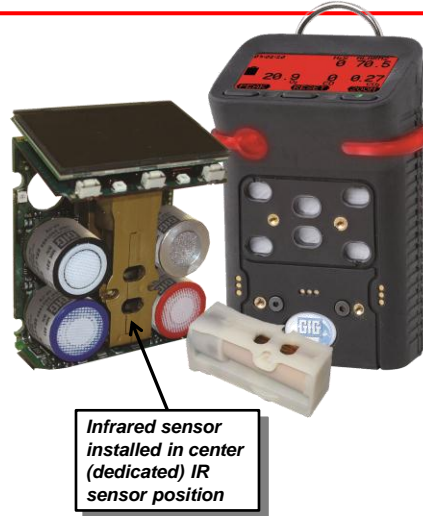
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Slide 166



Infrared CO₂ and combustible gas Smart Sensor

- **Proprietary GfG infrared sensor technology**
- **Three-wavelength smart-sensor design**
- **Expected operational life: 5+ Years!**
- **Available as a one channel or two channel detector for simultaneous measurement of CO₂ and combustible gas**
- **Full range:**
 - **0.1 – 5.0 % volume carbon dioxide (CO₂)**
 - **0 – 100% LEL combustible gas**
 - **0 – 100% volume combustible gas**



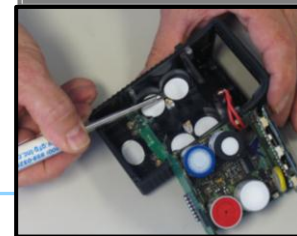
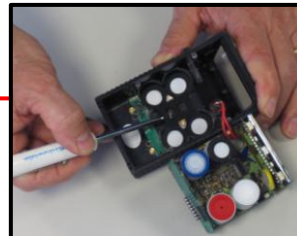
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Slide 167

Changing sensor gasket and filters

- **Gently remove the old gasket**
- **A new gasket should be installed anytime a sensor is replaced**
- **Filters that have become discolored or dirty should be replaced as needed**
- **Make sure the new filter is positioned properly**
- **IF THE NEW FILTER IS NOT INSTALLED PROPERLY THE INSTRUMENT HOUSING MAY LEAK WHEN EXPOSED TO RAIN OR MOISTURED**

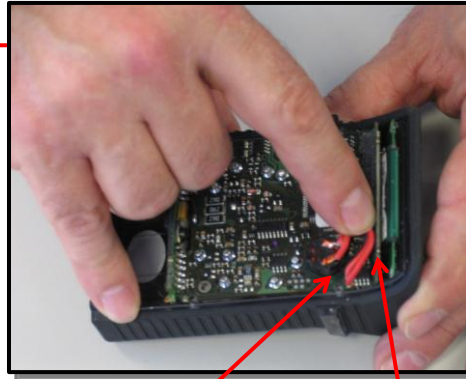


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Reassembling the instrument housing

- Reinstall the main PCB and display assembly
- Make sure the assembly is inserted properly within the grooves of the housing
- **DO NOT FORCE!**
- **BE CAREFUL NOT TO PINCH OR PULL UNNECESSARILY ON THE YOKE WIRES**
- Fold the yoke wires flush with the main PCB
- **MAKE SURE THE YOKE WIRES ARE POSITIONED BENEATH THE EDGE OF THE DISPLAY**



Make sure the yoke wires are bent flush with the main PCB and below the lip (edge) of the display

Edge of display



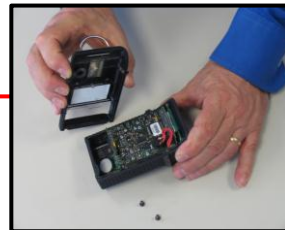
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Slide 169

Reassembling the instrument housing

- Reattach the back of the instrument housing
- **SQUEEZE THE CASE SECTIONS FIRMLY TOGETHER BEFORE TIGHTENING THE FOUR SCREWS**
- Tighten the 4 screws in diagonal sequence (just like tightening the lug nuts on a tire)
- **TIGHTEN THE FOUR SCREWS SECURELY BUT DO NOT OVERTIGHTEN!**



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Returning the instrument to service

- **Calibrate ALL sensors in the instrument (whether or not they have been changed) before returning the instrument to service**
- **It is best to let new sensors stabilize in the instrument for 30 minutes prior to calibration**



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Slide 171



Questions?



January 23, 2013

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Slide 172

