Petrochemical

Transformer Oil Gas Analysis - TOGA

Instruments, Inc.

www.dps-instruments.com

The DPS TOGA GC Systems are designed to analyze oil from electrical insulation materials that may have decomposed under thermal, or electrical stresses. The gaseous decomposition products indicate the type of fault inside the transformer. The DPS TOGA GC Systems separate all 11 components in one injection; Hydrogen, Oxygen, Nitrogen, Methane, Carbon Monoxide, Ethane, Carbon Dioxide, Ethylene, Propane, Acetylene, and Propylene. All compounds are detected with the sensitive and universal Helium Ionization Detector (HID). A Flame Ionization Detector (FID) and Methanizer can be added for even lower detection limits of the hydrocarbons, CO & CO2. Our innovative 2 column and valve configuration simplifies this analysis and follows ASTM 3612C for gas analysis using headspace injection. The headspace sample can be injected using a multi-vial autosampler, or a single sample headspace accessory can be built into our Series 600 Lab GC, or the Portable Companion 2 for analyses in the field. The fast heating and rapid cooling column oven in every DPS GC assures rapid sample turnaround. The fully integrated TOGA GC Analyzer Systems are small and lightweight and all DPS systems are modular for expandability, upgrades, and easy service.

Available Configurations Include:

600-C-078 - Series 600 TOGA GC Analyzer (HID, Headspace Concentrator, 2 Columns)
600-C-082 - Series 600 TOGA GC Analyzer (HID, FID/Methanizer, Headspace Concentrator, etc.)

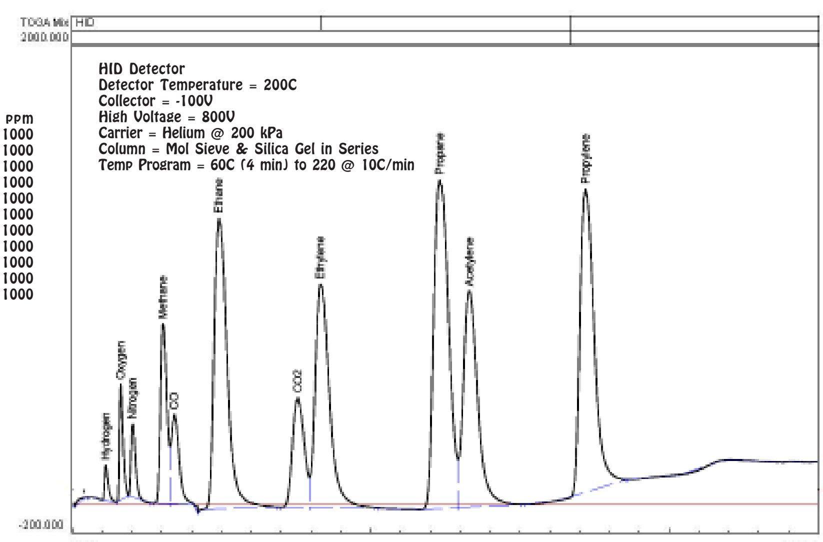
500-C2-078 - Companion 2 Portable TOGA GC Analyzer (HID, Headspace Concentrator, 2 Columns)
500-C2-082 - Companion 2 Portable TOGA GC Analyzer (HID, FID/Methanizer, Headspace Concentrator, etc.)

Series 600 GC

Companion 2 Portable GC
(with Headspace Concentrator)

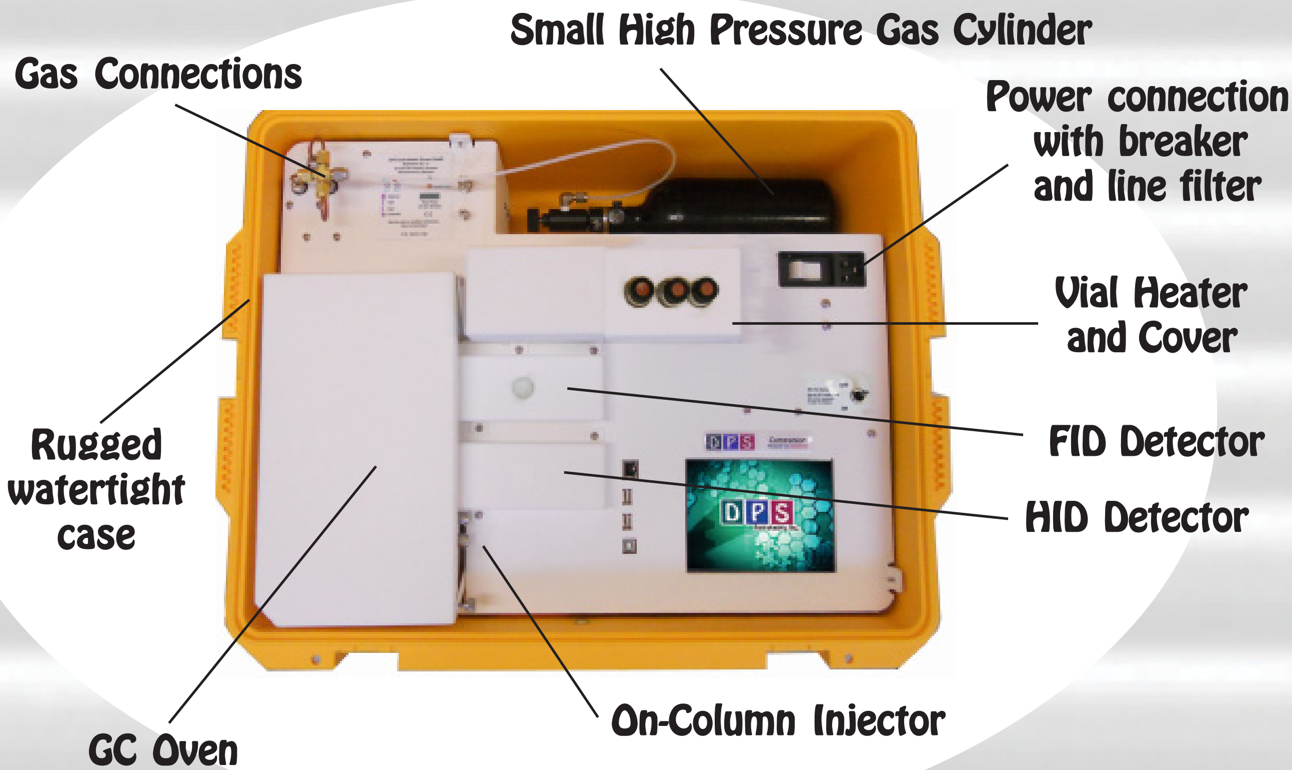
TOGA - Gas Analysis

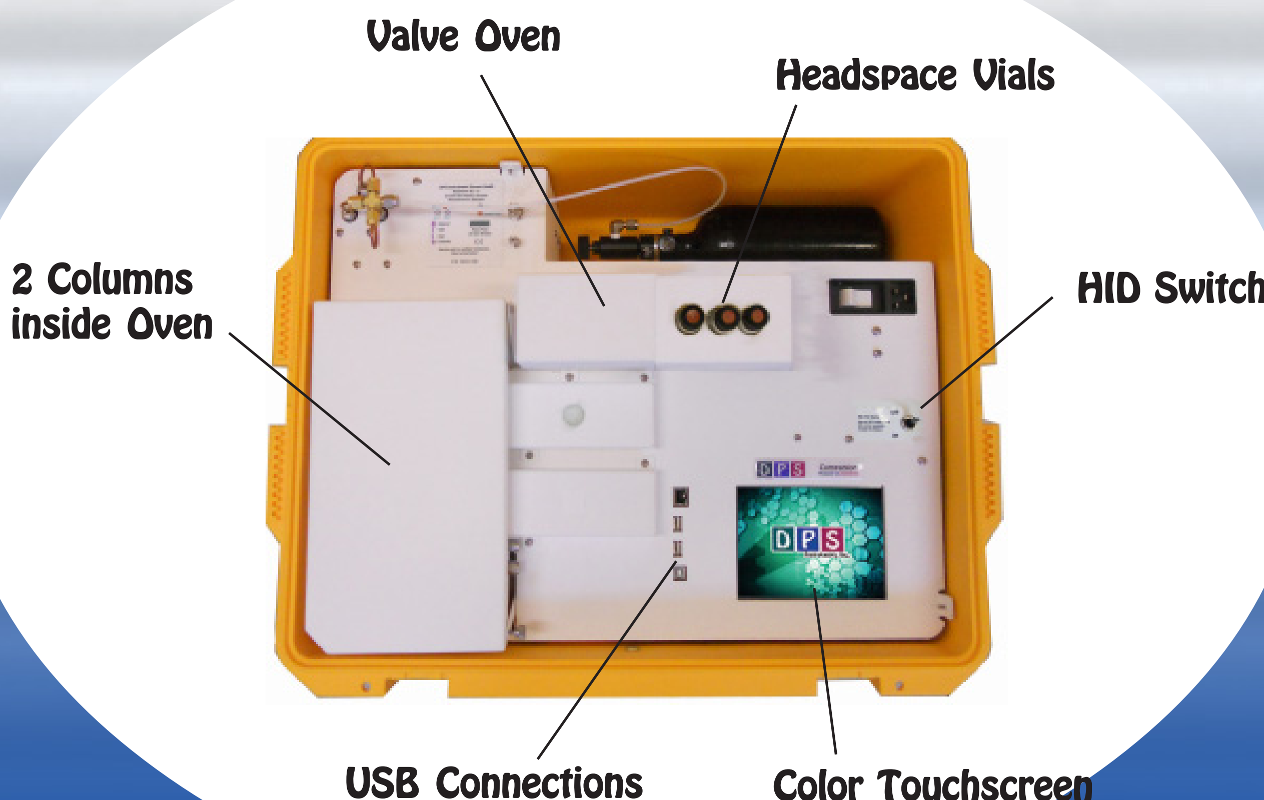
Component	Area	ppm
Hydrogen	831.2	1000
Oxygen	2722.6	1000
Nitrogen	2147.6	1000
Methane	7037.0	1000
CO	3685.2	1000
Ethane	24484.2	1000
CO2	7996.0	1000
Ethylene	19515.4	1000
Propane	30906.7	1000
Acetylene	18363.6	1000
Propylene	27521.3	1000



3/2022
Specifications may change without notice.

DPS Companion 2 TOGA Layout





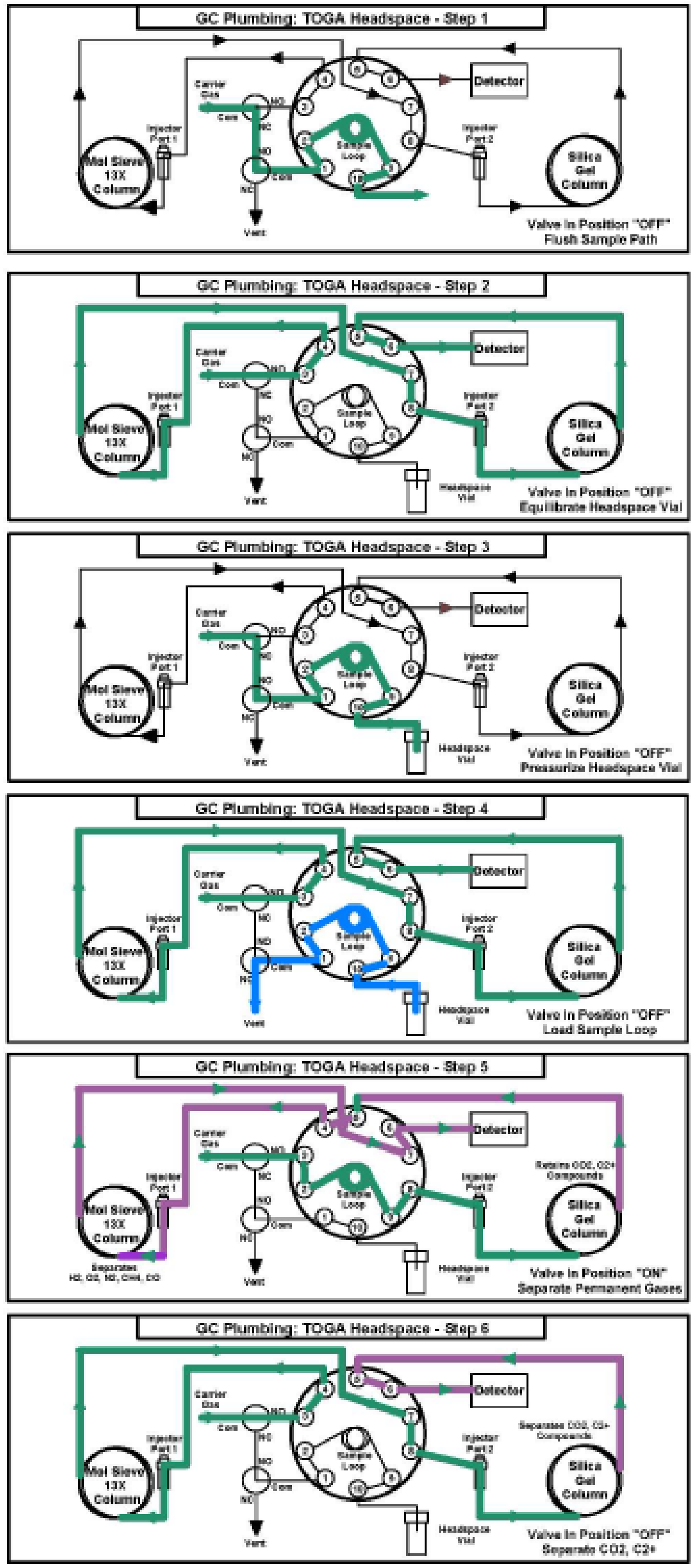
Plumbing Diagram

TOGA Headspace Concentrator - The Headspace Concentrator for Companion GC's are built right in to provide the shortest possible sample path. The Sample Vial is heated and then consistently Pressurized before loading the Sample Loop. A fixed Sample Loop ensures reproducible sampling and the sample lines are Flushed between analyses to limit any cross over contamination. The entire sequence of the Headspace Concentrator is automated through the Timeline sequence of the DPS GC Control Software for the analysis of one sample at a time, while two other samples are heated to equilibrate.

TOGA Plumbing Diagram - In the 1st Step the carrier gas is diverted to Flush out the Sample Lines between runs. During the 2nd Step the carrier gas flows to the analytical column and the Headspace Vial is heated with the Vial Heater and allowed to equilibrate. The Sample Probe is then inserted into the Headspace Vial. During the 3rd Step the Headspace Vial is pressurized for a few seconds. In the 4th Step the sample is loaded onto the Sample Loop by releasing the pressure in the headspace vial. In the 5th Step the Sample Valve is rotated to the ON position and the carrier gas sweeps the components from the Sample Loop onto the analytical columns.

TOGA Column Configuration - The unique 2 column configuration simplifies the compound separation and analysis of the TOGA Headspace sample. The columns are plumbed in series through the same Sample Valve as the Headspace Concentrator.

In Step 5 the Sample Valve is rotated to Inject the sample onto the analytical columns. The Silica Gel column retains CO2 & the C2+ hydrocarbons, while the lighter compounds (H2, O2, N2, CH4, & CO) pass through and are further separated on the Molecular Sieve column. Once the lighter compounds have been separated the valve is rotated back in Step 6 and the heavier compounds (CO2 & C2+ hydrocarbons) are separated on the Silica Gel column.



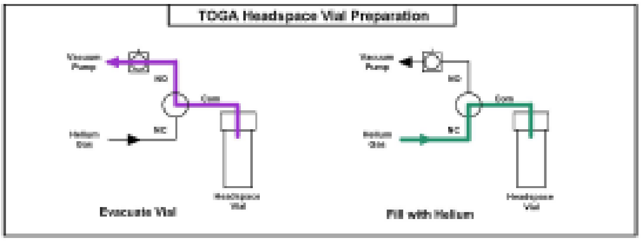
TOGA Headspace Plumbing Diagram

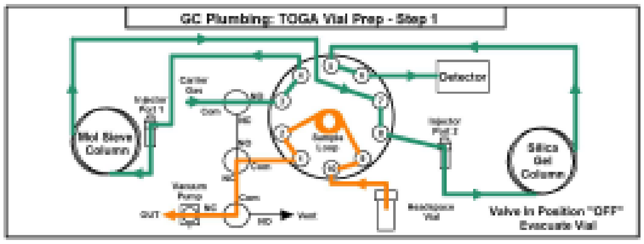
TOGA Vial Preparation Station

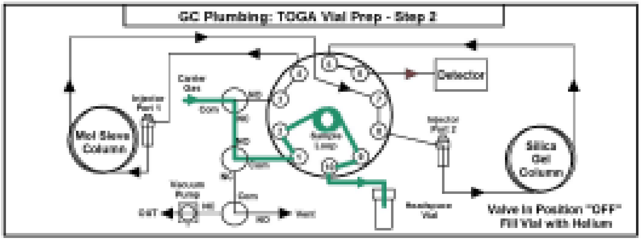
Clean Headspace Vials - One of the most difficult parts of the TOGA analyses is the sampling proceedure. The first step is taking a gas tight syringe and inserting the needle under the sureface of the oil to get a representative sample. The second step in injecting the oil into a clean vial. If either step is not sucessful, then you will see Oxygen and Nitrogen contamination from the air.

To insure that the sample vial is clean we have built in a Vial Preparation Station. Using the same technique that cylinder manufacturers employ to clean gas cylinders between uses; we evacuate, then re-fill the vial with helium several times to reduce Oxygen and Nitrogen to low ppm levels. The helium comes from the same supply as the carrier gas. A 2nd Method is loaded in the DPS Software to automatically clean the vials. The sample probe is inserted through the septum and the START button is pressed. The vials are prepared one at a time, but several can be prepared at once to be used throughout the day.

Plumbing Diagram - The first diagram is simplified to show that we evacuate and re-fill the vial using carrier gas. The 2nd diagram is the atual plumbing configuration when the Vial Preparation Station is connected to the rest of the TOGA plumbing.







TOGA Vial Preparation Diagrams

TOGA Gas Chromatograph Features

System Configuration - A Simple and efficient configuration using two packed columns, one valve, and a single HID Detector, or the HID in series with a FID/Methanizer The Silica Gel column separates all of the compounds except it has trouble with the permanent gases. To solve this problem, we have added a Molecular Sieve column in series with the Silica Gel column to separate the permanent gases. Once they are separated we switch the valve back to take the Molecular Sieve column out of the sample path and let the remaining compounds travel through the Silica Gel column to the HID detector.

Sample Information - The eleven most common compounds are included in this analysis scheme which meets ASTM-D3612C methodology. The compounds included in this method are H2, O2, N2, CH4, CO, C2H6, CO2, C2H4, C2H2, C3H6, and C3H4. The results from the analysis of these compounds helps target the underlying fault condition of the transformer. The action levels indicate the concentration levels where the falut is severe and action should be taken to mitigate any possible dangerous situation.

Parts per Million (ppm)

No.	Compound	HID Detection Limit	FID/Methanizer Detection Limit	Action Level
1	Hydrogen	50	NA	100-500
2	Oxygen	10	NA	NA
3	Nitrogen	10	NA	NA
4	Methane	10	1	100-400
5	Carbon Monoxide	10	1	100-1000
6	Ethane	10	1	100-400
7	Carbon Dioxide	10	1	150-3000
8	Ethylene	10	1	500-2000
9	Propane	10	1	100-500
10	Acetylene	10	1	100-400
11	Proplyene	10	1	100-500

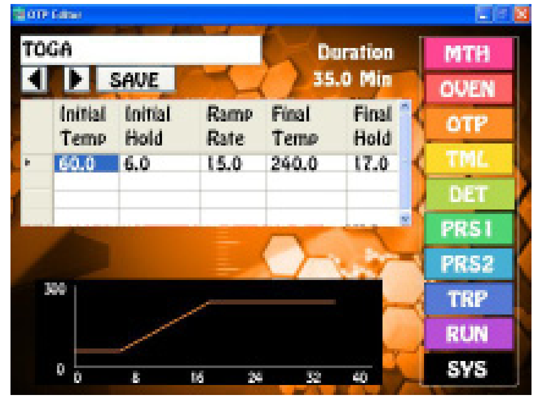
Headspace Accessory - The built-in headspace vial accessory, including vial heater, sample valve, pressure and vent solenoids, and sampling probe help automate the TOGA analysis in either the Companion or Series 600 GC TOGA Systems. The pre-purged vial containing the oil sample is heated and allowed to equilibrate in the vial heater prior to analysis. There are positions for 3 vials, so once the first has equilibrated, the analysis can proceed one sample after another. The analysis is only manual as far as the user needs to insert the sample probe into the headspace vial. The remainder of the analysis sequence is automated.

Headspace Autosampler - For a completely automated TOGA System the Series 600 GC can be equipped with a Headspace Autosampler with a 42 vial capacity. Once the vials are loaded the atosampler and Series 600 TOGA GC System work in unison to analyze and report the sequence of samples.

TOGA GC Control Software

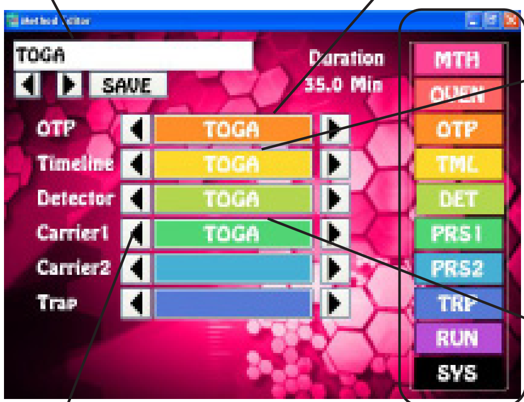
Easy to learn and master using a Graphical User Interface (GUI) and Color Touch Screen.

Editors let you customize the files associated with the GC Method.



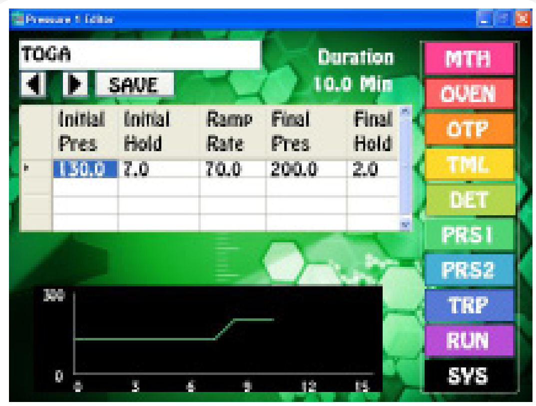
Oven Temp Program Editor

Method Name



Timeline Editor

File Selection Arrows



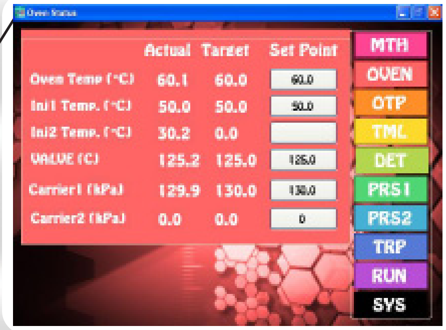
Carrier Pressure 1 Editor

Navigation Buttons to Quickly jump from one screen to another. Most pages are one button away!

Keyboard to Enter Filenames

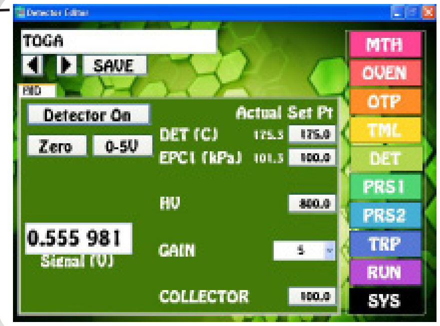
Number Pad for entering Values

GC Status pages display the parameters in the method, both graphically and as text and values.



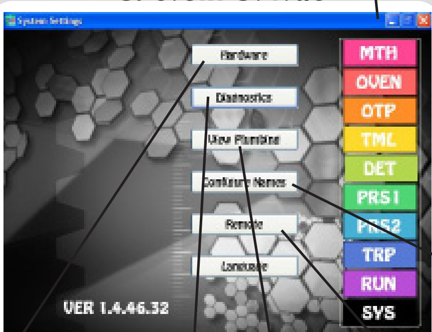
Oven Status

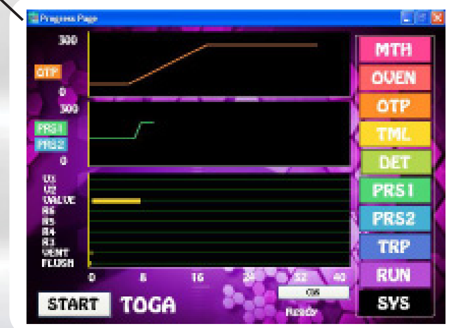
Method Editor



Detector Status

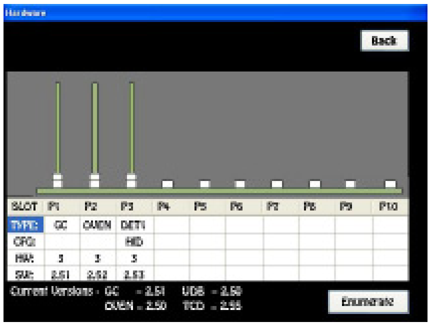
System Status



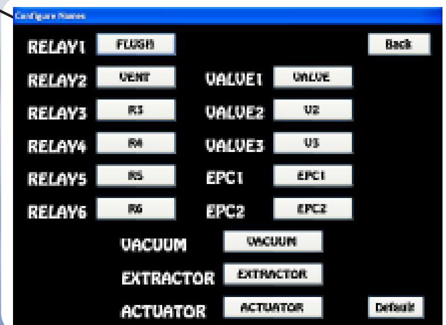


Run Status

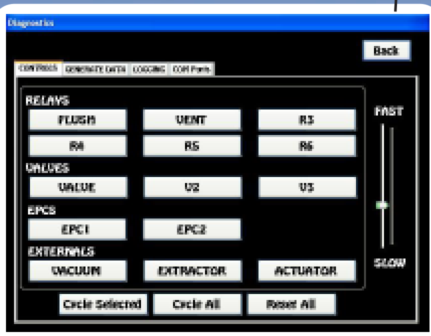
System status pages display the health and viability of the GC instrument.



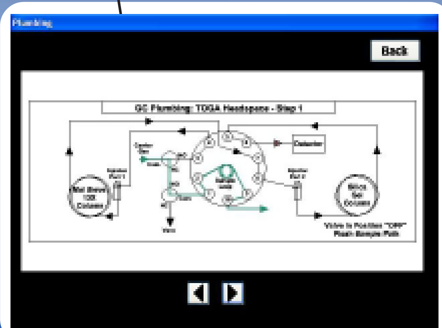
Hardware

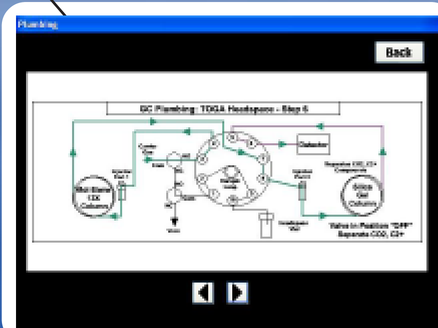


Configure Names



Diagnostics





Plumbing - Steps 1...6

TOGA GC Specifications:

Electronics Module:
- Enter and store GC Methods via Color Touch Screen
- Actual and set-point display of all GC parameters
- Safety Limits on all user entered parameters
- Oven Temperature Programs (OTP) with Multiple Ramps
- Pressure Programs for Carrier Gases with Multiple Ramps
- Timeline for sequencing Relays and Valve
- Detector Control of all Parameters on one page
- Electronic Pressure Controllers (EPC's):
  Atmospheric Pressure & Temperature Compensation
  EPC Pressure Control with 0.1 kPa set-point resolution
- Plug and Play GC Control, Oven, and Detector Board
- Microprocessor Controlled
- Proprietary Digital Signal Processing
- Digital Signal Outputs for each Detector
- Universal voltage input (85 – 240 Vac) with line
  filter and breaker.

Detector:
HID – Helium Ionization Detector (10 ppm detection limit)
FID – Flame Ionization Detector (1 ppm detection limit)

- 400 °C Temperature Limit with 0.1 °C set-point resolution
- 24-bit Digital Outputs for the detector via USB
- EPC Pressure Control with 0.1 kPa set-point resolution

Columns:
Molecular Sieve
Silica Gel

Results:
Automatically calibration corrected and reported in % or ppm

Lab Quality Analyses in the Field,
"It Goes with you Anywhere!"

Series 600 Oven Module:
- Ambient to 400°C Column Oven
- Up to 100 °C per/min Oven Ramp
- Fast Cooldown 300 °C to 50 °C in 3.5 min
- 1000 watt total Heater Elements
- Temperature Ramps with 0.1 °C set-point resolution
- 23 x 23 x 20 cm area for Glass, SS, or Capillary Columns

Companion 2 Oven Module:
- Ambient to 325 °C Column Oven
- Up to 80 °C per/min Oven Ramp
- Fast Cooldown 300 °C to 50 °C < 4 min
- 200 watt Heater Element
- Temperature Ramps with 0.1 °C set-point resolution
- 12.5 x 10.5 x 12.5 cm area for Packed, or Capillary Columns
- 7 amps at 48 Vdc total power consumption

Built-In Accessories:
- Sample Valve - Electronically Actuated
- Heated Valve Oven
- Headspace Concentrator
- Headspace Vial Prep Station
- Flow Control Solenoids

Injector:
- Heated On-column Injector
- Multiple Pressure Ramps with 0.1 kPa set-point resolution

Data Communications:
- Bi-directional communication with popular Data System

Network Connectivity:
- Enterprise Compatible Network GC running Windows XPe
- Ethernet Connection using Windows Network Protocol
- On Board ETX Computer for GC Control and
  Data Acquisition
- Remote Control of GC and Data Acquisition
  over LAN

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