TRACE GC

Gas Chromatograph

Getting Started

Thermo Finnigan

TRACE™ GC Getting Started
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- installation
- re-calibration
- changes and repairs

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- the instrument is used according to the instructions provided, and if its operation is only entrusted to qualified, trained personnel

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About This Manual

Overview

The TRACE GC *Getting Started* manual offers step-by-step instructions for making your first analysis with the TRACE GC a success. If you follow the procedures provided, by the end of the guide you will have:

- checked the TRACE GC's software configuration to make sure it matches the hardware configuration and your purchase order
- installed the detectors, if necessary
- analyzed a standard test mixture
- gained an understanding of the possibilities for automating analyses

This guide is written for users with some experience in gas chromatography. Less experienced users are encouraged to explore additional sources of information. If you would like more instruction, ask your customer service representative about ThermoFinnigan training courses in basic gas chromatography.

WARNING! Before using this guide, you must have already prepared your workspace and installed the TRACE GC in accordance with the TRACE GC *Site Preparation and Installation Manual.*

This manual is organized as follows:

Chapter 1, *Configuring the TRACE GC*, explains how to check and modify the TRACE GC's configuration by examining and editing the software menus.

Chapter 2, *Working with Detectors*, explains how to install a detector on the TRACE GC. It also contains detector parameters and operating tips.

Chapter 3, *Operating the TRACE GC*, contains instructions to run an analysis.

Chapter 4, *Automating Your Analyses*, discusses the basics of automation in analytical methods and autosampler sequences.

Appendix A, *Customer Communication*, contains contact information for ThermoFinnigan offices worldwide. Use the *Reader Survey* in this section to give us feedback on this manual and help us improve the quality of our documents.

The *Glossary* contains definitions of terms used in this guide and the help diskette. This also includes abbreviations, acronyms, metric prefixes, and symbols.

The *Index* contains an alphabetical list of key terms and topics in this guide, including cross-references and the corresponding page numbers.

Conventions Used in This Manual

The following symbols and typographical conventions are used throughout this manual.

Bold	Bold text indicates names of windows, menus, dialog boxes, buttons, and fields.
Italic	Italic indicates cross references, first references to important terms defined in the glossary, and special emphasis.
`Monospace`	Monospace, or Courier, indicates filenames and filepaths, or text the user should enter with the keyboard.
`Monospace Bold`	Monospace Bold indicates messages or prompts displayed on the computer screen or on a digital display.
»	This symbol illustrates menu paths to select, such as **File»Open…**.
KEY NAME	Bold, uppercase sans serif font indicates the name of a key on a keyboard or keypad, such as <Enter>.
CAUTION	This symbol alerts you to an action or procedure that, if performed improperly, could damage the instrument.
NOTE	This symbol alerts you to important information related to the text in the previous paragraph.

WARNING! This symbol alerts you to an action or procedure that, if performed improperly, could result in damage to the instrument or possible physical harm to the user. This symbol may be followed by icons indicating special precautions that should be taken to avoid injury.

This symbol indicates electric shock hazard.

This symbol indicates danger from hazardous chemicals.

This symbol indicates danger from high temperature surfaces or substances.

This symbol indicates a fire hazard.

This symbol indicates an explosion hazard.

This symbol indicates a toxic hazard.

This symbol indicates the presence of flammable materials.

This symbol indicates the presence of radioactive material.

This symbol indicates an operation or procedure that must NOT be performed by the user. A ThermoFinnigan authorized Customer Support Engineer must perform this procedure.

This symbol indicates all metal objects, such as watches and jewelry, must be taken off.

This symbol indicates an eye hazard. Eye protection must be worn.

This symbol indicates the user must wear a protective screen when performing the procedure.

This symbol indicates the user must wear protective shoes when performing the procedure.

This symbol indicates the user must wear protective clothing when performing the procedure.

This symbol indicates the user must wear gloves when performing the procedure.

Instrument Markings and Symbols

The following table explains the symbols used on ThermoFinnigan instruments. Only a few of them are used on the TRACE GC gas chromatograph.

Symbol	Description
	Direct Current
	Alternating Current
	Both direct and alternating current
3	Three-phase alternating current
	Earth (ground) terminal
	Protective conductor terminal
	Frame or chassis terminal
	Equipotentiality
	On (Supply)
	Off (Supply)

Symbol	Description
	Equipment protected throughout by DOUBLE INSULATION or REINFORCED INSULATION (Equivalent to Class II of IEC 536)
	Instruction manual symbol affixed to product. Indicates that the user must refer to the manual for specific Warning or Caution information to avoid personal injury or damage to the product.
	Caution, risk of electric shock
	Caution, hot surface
	Caution (refer to accompanying documents)
	In-position of a bistable push control
	Out-position of a bistable push control

Using the TRACE GC Document Set

The TRACE GC Document Set (CD-Rom PN 317 095 00) includes all manuals in electronic format, and serves as your library for information about the TRACE hardware and software.
The TRACE GC Document Set (PN 317 093 00) as paper copy is also available. Furthermore,ThermoFinnigan part numbers (PN) for the paper copy manuals are provided for each book title.

Acceptance Package (PN 317 092 20)
This folder contains required shipping documents and quality report forms.

Site Preparation and Installation Manual (PN 317 091 90)
This manual and diskette describes how to set up a workspace for the TRACE GC and how to connect the instrument to the gas supplies and peripheral devices. It also contains a list of spare parts.

Getting Started (PN 317 092 30)
This guide contains procedures for checking configuration, installing detectors, and making a first analysis with the TRACE GC.

Operating Manual (PN 317 091 70)
This manual provides descriptions of the TRACE GC hardware and software and instructions for their use. It also contains the instrument warranty.

Quick Reference Card (PN 317 092 40)
This reference card contains guidelines for carrier gas use and injection procedures.

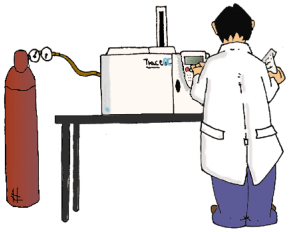
K-Factor Quick Reference (P/N 317 092 41)
This reference card contains information to interpretate results from a Column Evaluation.

Preventive Maintenance Schedule (PN 317 092 80)
This document provides a recommended maintenance schedule and a year-long log book to record maintenance, observations, supply lists, and service records.

Maintenance and Troubleshooting Guide (PN 317 091 80)
This manual contains instructions for diagnosing and resolving operational problems.

Standard Operating Procedures (PN 317 092 00)
This manual contains a series of instructions, operations and test criteria for final testing of the TRACE GC.

Spare Parts Catalog (P/N 317 092 10)
This manual contains the spare parts catalog of the TRACE GC System.



1

Configuring the TRACE GC

This chapter explains how to check and modify the TRACE GC's configuration by examining and editing the software menus. To configure an instrument, you match the software specifications with the hardware. If a ThermoFinnigan customer service engineer has already performed this task, you do not need to repeat it unless you wish to change the configuration. For instance, if you want to exchange detectors, you will need to edit the **`RIGHT`** or **`LEFT DETECTOR`** menus and possibly others.

The TRACE GC has been configured to your specifications at the factory. Now you will check your purchase order against the instrument settings.

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Getting Ready

If a ThermoQuest customer service engineer installed your instrument, your detectors probably have been installed. If not, you will check the configuration and install the detectors accordingly. For instance, if the **`LEFT DETECTOR`** menu specifies an FID (flame ionization detector), you will install an FID at the left detector position.

CAUTION **Before turning on the TRACE GC, check to see which detectors were ordered with your instrument. If an ECD (electron capture detector) will be used, do not turn on the power until it has been installed. If these detectors are configured but not installed, the TRACE GC could shut down. For installation instructions, see *Working with Detectors* on page 21.**

After the ECD detectors are installed, turn on the power switch.

Figure 1-1 below shows the TRACE keypad. To check the configuration, you will use the keypad to call up the appropriate menus.

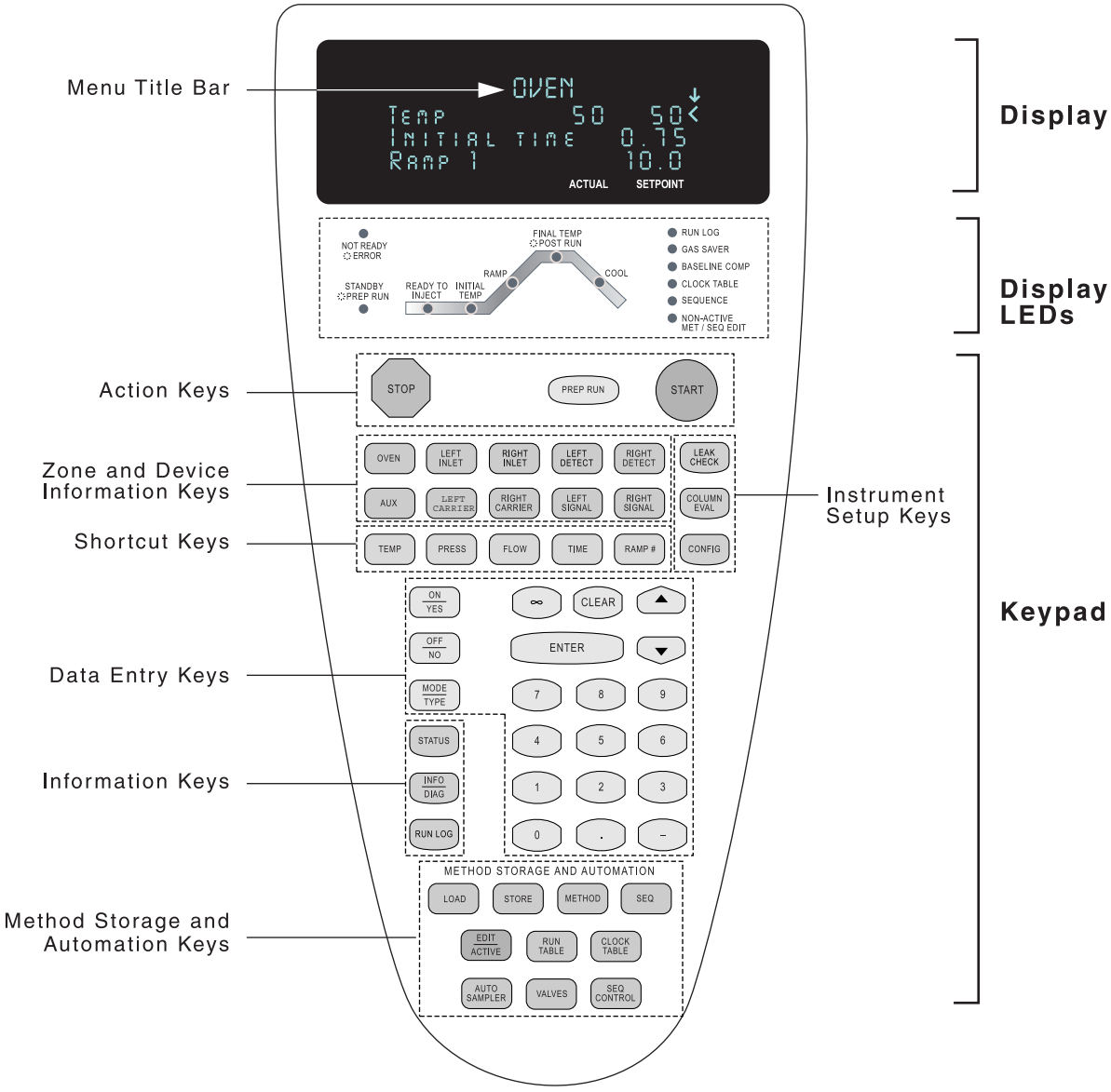


Figure 1-1. TRACE GC Keypad

To see the configuration settings for your instrument, press **CONFIG**. The **CONFIGURATION** main menu appears. Each item in the **CONFIGURATION** main menu leads to a submenu.

Navigating TRACE GC Menus

The display screen on the keypad shows the TRACE GC menus, and can show up to three lines at a time. If the menu has more than three lines, a scroll indicator (↓, ↑, or ↕) in the upper right corner of the display indicates which direction you can scroll to see additional lines. A title bar in capital letters always appears on the top line to let you know which menu you are viewing.

Viewing a Submenu

When you press **CONFIG**, the **CONFIGURATION** main menu appears. Use the following procedure to examine the configuration submenus.

1. Press ▼ to move through the menu. The cursor (<) moves as you scroll.
2. To see a submenu, press **ENTER** or **MODE/TYPE**. If the configured options are incorrect, use the procedure in *Editing a Menu Item* on page 20 to correct them.
3. To return to the main menu or the next higher level menu, press **CLEAR**.

Figure 1-2 below shows how the **OVEN** submenu display might look.

```
          OVEN          ↓
Temp            40  40  <
Initial time      0.00
Ramp 1             Off
```

Figure 1-2. Oven Menu Display

Table 1-1 shows the **CONFIGURATION** main menu and explains what to check for.

Table 1-1. Main Configuration Menu

Menu	Comments and Checkpoints
`CONFIG↓`	The scroll indicator (↓) denotes that the menu contains more items than what is currently shown on the display.
`Oven<`	❑ If you ordered **oven cryogenic options**, they should appear in this menu.
`Active inlet`	❑ This menu item should appear if you ordered a **column select valve**.
`Left inlet`	Controls mode for left on-column. No options appear if you are using a split/splitless or packed column inlet. ❑ Check to see that the **inlet** and **mode** you specified is configured.
`Left carrier`	❑ Check that the correct carrier gas for the left inlet has been chosen. ❑ If you ordered a **hydrogen sensor**, `H2` should appear on this menu.
`Right inlet`	Controls mode for the right on-column. No options will appear if you are using a split/splitless or packed column inlet. ❑ Check to see that the **inlet** and **mode** you specified is configured.
`Right carrier`	❑ Check that the correct carrier gas for the right inlet has been chosen. ❑ If you ordered a **hydrogen sensor**, `H2` should appear on this menu.
`Left detector`	❑ Check that the **detector type** matches your order.
`Right detector`	❑ Check that the **detector type** matches your order.
`Aux detector`	❑ If you ordered an **auxiliary detector**, this item should appear.
`Aux Zones`	❑ If you ordered **auxiliary devices** such as a jet separator, they should appear in this menu.
`Time`	Sets time and date.
`Valves`	❑ If you ordered any extra **valves**, they should appear on this menu. (A valve oven's three valves would be listed here.)
`Autosampler`	❑ If an **autosampler** is not connected, the submenu will not appear when you select it.
`Handshaking`	Configures signal polarity to and from external devices.
`Keyboard & display`	Controls keyboard and display preferences.

Editing a Menu Item

If you need to make changes to a submenu, use the following procedure.

1. To select a menu item, use the ▼ key to scroll through the menu until the cursor (<) points to the item you want to edit.

2. To display the selected field's range and options, press the **INFO/DIAG** key once. If the field cannot be edited, no information will appear. Press **CLEAR** to return to the menu.

3. You can change the field's content in several ways:

   - To choose on/off or yes/no, use the **ON/YES** and **OFF/NO** keys.

   - To enter a number, use the numeric keypad.

   - If the field cannot be filled with on/off, yes/no, or a number, press **ENTER** or **MODE/TYPE** to display a submenu of choices. In the submenu, you might use the keypad, or you might select an item by scrolling with the arrow keys. While you are editing a numeric field, a blinking asterisk (*) appears to the right of the menu item.

NOTE You cannot edit items in parentheses.

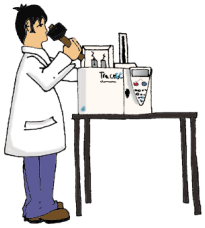
4. When you have entered the proper information in the field, press **ENTER** to load the new setpoint. The blinking asterisk disappears and the cursor advances to the next menu item.

   To erase an entry before choosing it, press **CLEAR**.

5. Use the ▼ key to scroll to the next item you want to edit.

Do you want to know more?

For more information on configuring the TRACE GC, see Chapter 3, *Configuration*, in the TRACE GC *Operating Manual.*



2

Working with Detectors

This chapter explains how to install a detector on the TRACE GC. It also contains detector parameters and operating tips.

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The FID (Flame Ionization Detector), NPD (Nitrogen Phosphorus Detector), FPD (Flame Photometric Detector), PID (Photoionization Detector), TCD (Thermal Conductivity Detector) and PDD (Pulsed Discharge Detector) are already installed on the TRACE GC according to your requirements. Due to Local Regulations of radioactive materials, the ECD (Electron Capture Detector) is sent separately from the GC unit.
If you need to install other detectors, do so in accordance with the configuration settings. For example, if the left detector is specified as an ECD, install the ECD on the left side.

Installing Detectors

The detector base body allows you to easily install or exchange detectors. Use the following procedure to install a detector.

1. Remove the TRACE GC cover plate from the top of the instrument.
2. Install the appropriate detector.
3. Tighten the detector nut.
4. Attach the appropriately labeled cables to the detector body.

Figure 2-1 shows how an ECD would fit into the detector base body.

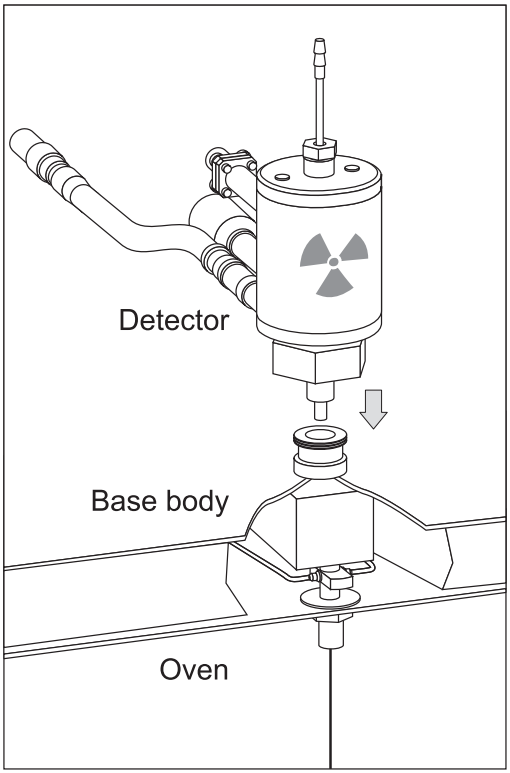


Figure 2-1. Detector Installation Diagram

Do you want to know more?

For more information on installing and maintaining detectors, see the TRACE GC *Maintenance and Troubleshooting Manual.*

Getting the Most from the Detector

Table 2-1 describes the TRACE GC detector options, parameters, possible applications, and operating suggestions.

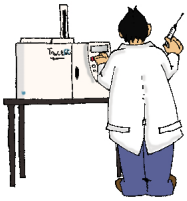
Table 2-1. Detector Options, Sensitivities, and Tips

Detector	Minimum Detectable Amount	Linear Range	Typical Applications	Operating Tips
FID	3 pg C/s	10^6	• hydrocarbons • almost all organic compounds, such as alcohols, essential oils, and fatty acids	Make sure the flame is adjusted correctly. For maximum sensitivity with capillary columns, use makeup gas (nitrogen).
NPD	N 0.05 pg/s P 0.02 pg/s	10^4	• triazine herbicides • organophosphorus pesticides (EPA 507) • nicotine, caffeine nitrosamines (EPA 607)	Both sensitivity and specificity are affected by the amount of hydrogen flow and the amount of heat supplied to the thermionic source. Avoid column liquid phases with N or P, halogenated solvents, and silylation reagents.
ECD	0.01pg/s (lindane)	10^4	• organochlorinated pesticides • halogenated contaminants in water and soil • PCBs in oil	Use a filter to trap oxygen and water.
FPD	P = 0.1 pgP/s S = 5 pgS/s	10^4(P)	• organophosphorus pesticide • phosphine • sulphur gases	The detector is equipped with sulphur interference (394 nm). Use 526 nm interference filter for phosphorus determinations.

Table 2-1. Detector Options, Sensitivities, and Tips (Continued)

Detector	Minimum Detectable Amount	Linear Range	Typical Applications	Operating Tips
PID	Benzene 1 pg/s (using 10.6 eV UV lamp)	10^5	• low boiling aromatics (BTEX) • policyclic aromatic hydrocarbons • amines	Select proper UV lamp according to the application.
TCD	600 pg ethane/ml He carrier	10^6	• permanents gases • organic and inorganic compounds not detectable by FID such as carbon disulphide, ammonia, water	Select Constant Voltage operation mode for maximum linearity.
PDD	0.2 pg/s methane	10^5	• permanents gases • light hydrocarbons • organic and inorganic compounds not detectable by FID such as carbon disulphide, ammonia, water	Use only Helium of high purity (99.999%) along with an helium purifier on both the carrier and discharge gas lines.

WARNING! Because of its radioactive source, an ECD has special handling and reporting requirements.



3

Operating the TRACE GC

This chapter contains instructions to run an analysis. With all components installed and configured, you are ready to make the first run, probably a simple manual injection of a test mixture. You will need to have your data system or integrator connected and turned on to see the chromatogram. Save the first chromatogram to compare future performance and to help resolve service issues.

Chapter at a Glance...

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Setting Up an Analysis

1. Choose the text mixture or standard you will inject. Your choice will depend on your intended applications and standard laboratory practice.

2. A default analytical method has been installed in the TRACE GC. To see its parameters, press each of the keys shown in Figure 3-1 and examine the settings for each menu item.

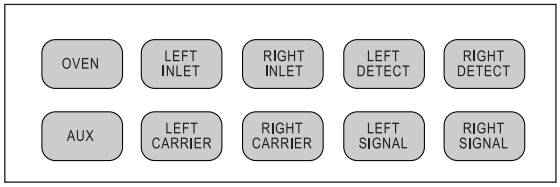


Figure 3-1. Zone and Device Keys to Set Run Parameters

3. If you want to make changes to any menu, follow the procedures outlined in *Editing a Menu Item* on page 20.

Example

Menu settings to run the ThermoFinnigan Calibration Mixture for an FID (PN 338 190 20) with a splitless injection might look like those in the following figure:

OVEN		
Temp	50	50
Initial time		1.00
Ramp 1		20.0
Final temp 1		200
Final time 1		1.0
Ramp 2		Off
Postrun temp		Off

LEFT INLET[1]		
Temp	230	230
Pressure	30	30
Mode	splitless	
Total flow	(60.0)	
Split flow	57	57
Splitless time	0.8	
Const sept purge?	Y	

LEFT DETECTOR[1]		
Flame		On
Base temp	250	250
Signal pA	(3.1)	
Ignition thresh	2.0	
Flameout retry	Off	
H2	35	35
Air	350	350
Mkup (N_2)	30	30

LEFT CARRIER[1]		
Col. flow	3.0	
Pressure	30	30
Flow mode	con pres	
Gas saver flow	Off	
Vacuum comp	Off	

LEFT SIGNAL (FID)[1]		
Output	(1000)	
Offset	Off	
Auto zero?	N	
Range=10^(0.3)	0	
Analog filter	Off	
Baseline comp	Off	

1. These settings could also be for a right inlet/detector/carrier/signal.

Figure 3-2. Menu Settings for ThermoFinnigan Calibration Mixture for an FID

Injecting a Test Mixture

Although in the future you will probably automate most analyses, you should do the first run with a manual syringe injection.

To analyze the Calibration Mixture for an FID, you will need a 10-µL syringe with a 51 mm needle. The column and liner shipped with your TRACE GC are appropriate for this analysis.

Do you want to know more?

For more information on performing injections, see Section III, *Injectors*, in the TRACE GC *Operating Manual*.

Table 3-1 lists three columns: TRACE GC Status, Manual Control, and Automated Control. The first column describes how the TRACE GC Status LEDs look during each stage in a run. The second column, Manual Control, describes the steps and decisions you would face in manually operating the TRACE GC. The third column describes automated control options you might consider.

Once you have prepared a syringe for injection, follow the instructions listed under Manual Control in Table 3-1. In the case of the calibration mixture for an FID, you would draw a 1-µL sample and inject this amount, including the mixture remaining in the needle.

Table 3-1. Steps in a TRACE GC Run

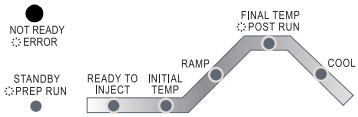
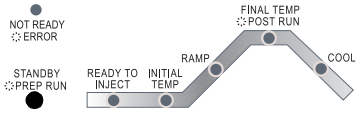
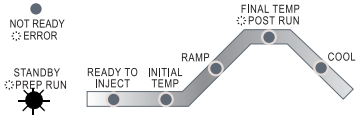
TRACE GC Status	Manual Control	Automated Control
NOT READY  At this point the TRACE GC is heating the oven to the temperature specified in the `OVEN` menu.	No action is necessary. However, you could set parameters for the run, if you haven't done so already. More information is available about the oven, inlets, carrier, and detectors in the TRACE GC *Operating Manual.*	No action is necessary. However, you could load a preprogrammed method and/or sequence. Press **LOAD** and make the appropriate menu selections. LOAD	
STANDBY  The oven has reached the initial temperature.	Press **PREP RUN**. PREP RUN	If you are using an autosampler, the autosampler sequence will automatically start the prep run before an injection. More information is available about the oven and equilibration times in the TRACE GC *Operating Manual.*
PREP RUN  The TRACE GC sets all conditions ready for a run. The Standby/Prep Run LED blinks during this phase.	No action is necessary during prep run.	No action is necessary during prep run. However, if you want the TRACE GC to wait additional time for an external device such as an MS, turn on the `Ready delay` feature in the **CONFIG»`OVEN`** menu. OVEN More information is available about Ready delay in *Configuration* in the TRACE GC *Operating Manual.*
NOTE	The **STATUS** key is useful during **NOT READY** to see a list of conditions which are preventing the instrument from going to **STANDBY**.	

Table 3-1. Steps in a TRACE GC Run (Continued)

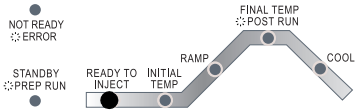
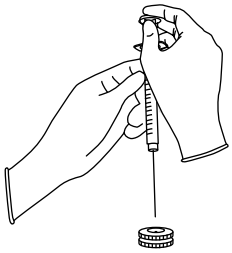
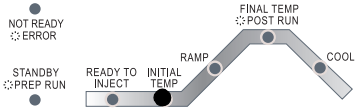
TRACE GC Status	Manual Control	Automated Control
READY TO INJECT  The Ready-to Inject LED lights when the prep run has finished.	Inject a sample. 	You can control all autosampler functions except alignment from the TRACE GC. Press **AUTOSAMPLER** to see the injection options. AUTO SAMPLER You can specify all features on this menu in an analytical method. You can set up an autosampler sequence to direct how a series of samples should be injected and run. More information is available in Sections VI and VIII in the TRACE GC *Operating Manual.*
	Press **START**. START	You can automatically start the TRACE GC by specifying an external device to start the TRACE GC. Ask your ThermoFinnigan field service representative to help you set up an External Event.
INITIAL TEMP  The Initial Temp LED lights after injection. It stays lit while the initial temperature remains constant.	Press **OVEN** and edit the `Initial Hold` menu item to change the hold time for the initial oven temperature. OVEN	You can include the initial holding time as part of the method. More information is available about initial conditions in Chapter 28, *Using Analytical Methods* in the TRACE GC *Operating Manual.*

Table 3-1. Steps in a TRACE GC Run (Continued)

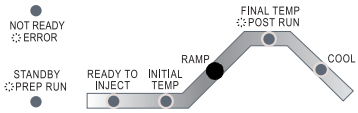
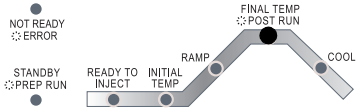
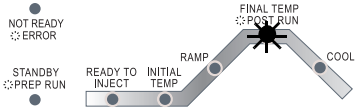
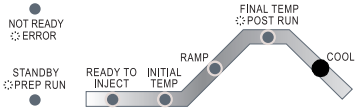
TRACE GC Status	Manual Control	Automated Control
RAMP  The Ramp LED lights when the temperature begins to rise in the first ramp. It stays on throughout the run's temperature variations.	You can specify up to seven temperature changes with holding times. Press **OVEN** to program ramps.  	You can program ramps into the method. More information is available about ramps in *Using Analytical Methods* in the TRACE GC *Operating Manual.*
	NOTE Depending on the installed inlet options, you may be able to program pressure ramps in addition to temperature ramps. More information is available about pressure ramps in the TRACE GC *Operating Manual.*	
	During a run, you can make changes in signal handling, open valves, and call up external events.	You can specify signal changes, valve actions, and external events as part of a method's run table. More information is available about the run table in the TRACE GC *Operating Manual.*
FINAL TEMP  The Final Temp LED lights when the last ramp's temperature is reached and stays on during the last ramp's holding time.	If you want to change the final holding time, press **OVEN** and edit the last ramp's `Final time`.  You can specify post run actions if you have not already done so.	You can program temperature rises and holding times into the method. More information is available about ramps in *Using Analytical Methods* in the TRACE GC *Operating Manual.*

Table 3-1. Steps in a TRACE GC Run (Continued)

TRACE GC Status	Manual Control	Automated Control
POST RUN  This LED blinks while the TRACE GC performs any post run activities specified in the **OVEN** menu, such as a column bakeout.	No action is necessary.	No action is necessary.
COOL  The TRACE GC returns to initial temperature and pressure conditions during this stage.	No action is necessary. However, you can set up conditions for a new run.	No action is necessary. However, you can load or program a new sequence. Your last sequence could have specified a new method to load.

If you analyzed the calibration mixture for an FID, the resulting chromatogram should resemble the one shown in Figure 3-3 below.

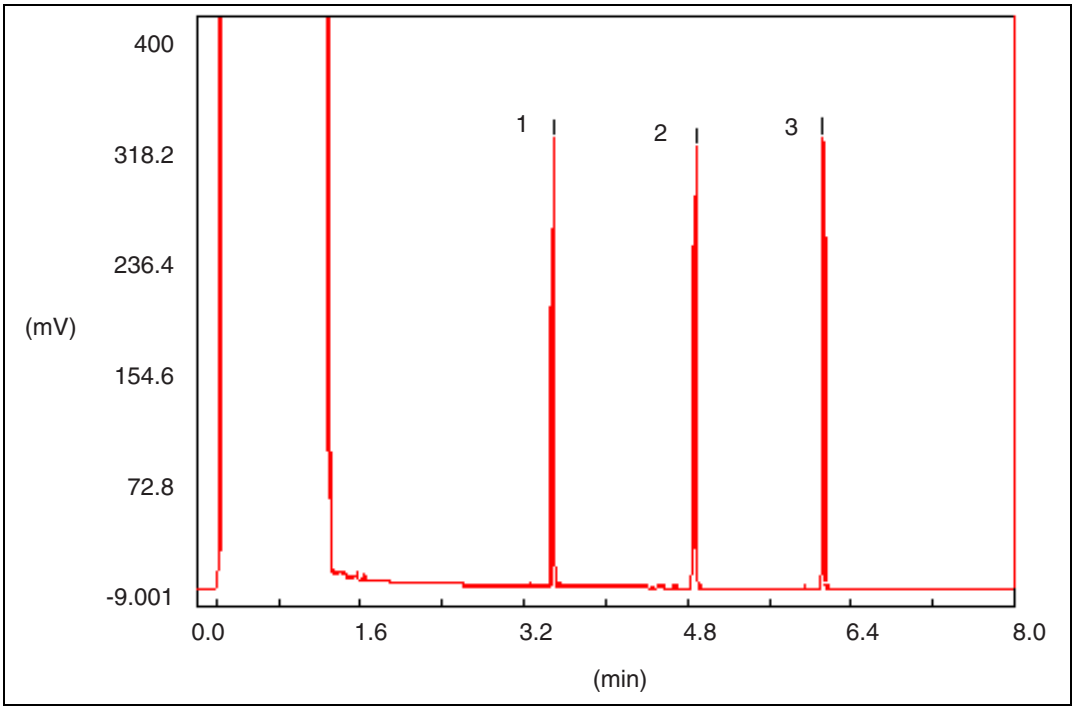


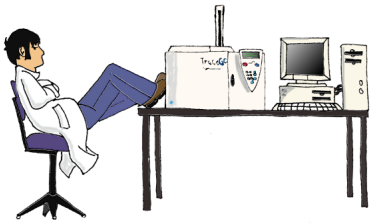
Figure 3-3. Chromatogram for ThermoFinnigan Calibration Mixture for an FID Detector

The three peaks correspond to those found in normal hexane:

1. dodecane
2. tetradecane
3. hexadecane

Do you want to know more?

For more information on the keys and LEDs, see Chapter 2, *The TRACE User Interface* in the TRACE GC *Operating Manual.*



4

Automating Your Analyses

This chapter discusses the basics of automation in analytical methods and autosampler sequences. After you have confirmed the TRACE GC's proper operation, you will probably want to automate many features.

Chapter at a Glance...

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Autosampler Sequence Basics 37

Developing an Analytical Method

An analytical method describes the treatment a sample receives during analysis. You can set parameters for:

- temperatures, including seven programmed changes (ramps)
- pressures
- flow rates
- inlet types
- detector types and parameters
- signal changes
- autosampler parameters
- timed events before, during, and after the run

You can store the methods you develop in the TRACE GC's memory or in the data system. The TRACE GC can hold up to 10 saved methods.

Figure 4-1 shows the keys you could use in developing a method. Pressing a key brings up a menu of choices related to the key name.

When you have set the parameters you want, store the method as follows:

1. Press **METHOD**.
2. Enter a number between 1 and 10 to denote the memory location where the method is to be saved.
3. Press **STORE**.

Later you will load the method by referring to its number.

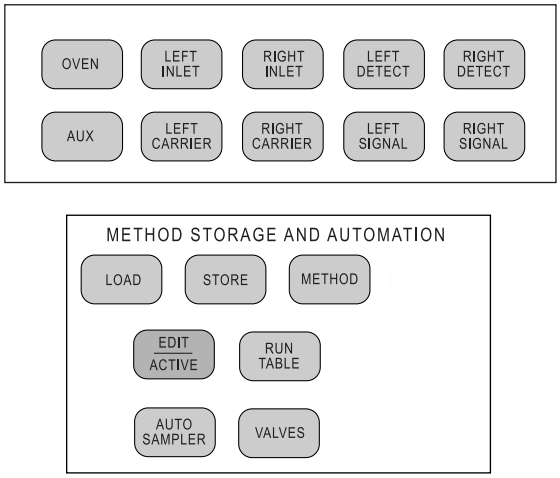

Figure 4-1. Keys Used in Developing an Analytical Method

Autosampler Sequence Basics

If you are using an autosampler, you can develop up to five sequences to describe how samples should be injected and what methods to use during analysis. You can store additional sequences in the data system.

Each sequence has the following areas of dialog:

- Subsequence, for using different methods for groups of samples in the tray
- Post sequence, for repeating the sequence and loading a new method
- Priority, only for AS 2000 autosampler, for interrupting a running sequence with a priority sample

Figure 4-2 shows the keys you would use to develop and run a sequence.

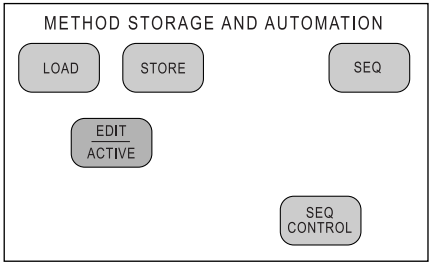

Figure 4-2. Keys Used in Developing an Autosampler Sequence

NOTE The **EDIT/ACTIVE** key allows you create and edit methods and sequences while a sequence is running. Your changes do not affect the current run.

When you have set the parameters you want, save the method as follows:

1. Press **SEQ**.
2. Enter a number between 1 and 5 to denote the memory location where the method is to be saved.
3. Press **STORE**.

Do you want to know more?

For more information on developing a method or a sequence, see Section VIII, *Methods and Sequences* in the TRACE GC *Operating Manual*.

A

Customer Communication

This appendix contains contact information for ThermoFinnigan offices worldwide. This appendix also contains aone-page *Reader Survey*. Use this survey to give us feedback on this manual and help us improve the quality of our documentation.

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Part No.: M31709230

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Glossary

This section contains an alphabetical list and descriptions of terms used in this guide and the help diskette. This also includes abbreviations, acronyms, metric prefixes, and symbols.

A

A	ampere
ac	alternating current
ADC	analog-to-digital converter

B

b	bit
B	byte (8 b)
baud rate	data transmission speed in events per second

C

ºC	Celsius
CIP	Carriage and Insurance Paid To
cm	centimeter
CPU	central processing unit (of a computer)
CSE	Customer Service Engineer

D

d	depth
DAC	digital-to-analog converter
dc	direct current
DS	data system

E

ECD	Electron Capture Detector
EMC	electromagnetic compatibility
ESD	electrostatic discharge

F

ºF	Fahrenheit
FID	Flame Ionization Detector
FOB	Free on Board
FPD	Flame Photometric Detector
ft	foot

G

g	gram
GC	gas chromatograph
GND	electrical ground

H

h	height
h	hour
harmonic distortion	A high-frequency disturbance that appears as distortion of the fundamental sine wave.
HV	high voltage
Hz	hertz (cycles per second)

I

IEC	International Electrotechnical Commission
impulse	See *transient*
in.	inch
I/O	input/output

K

k	kilo (10^3 or 1024)
K	Kelvin
kg	kilogram
kPa	kilopascal

L

l	length
l	liter
lb	pound
LED	light-emitting diode

M

m	meter (or milli [10^{-3}])
M	mega (10^6)
µ	micro (10^{-6})
min	minute
mL	milliliter
mm	millimeter
m/z	mass-to-charge ratio

N

n	nano (10^{-9})
NPD	Nitrogen Phosphorous Detector

O

Ω	ohm

P

p	pico (10^{-12})
Pa	pascal
PCB	printed circuit board
PDD	Pulsed Discharge Detector
PID	Photo Ionization Detector
psi	pounds per square inch

R

RAM	random access memory
RF	radio frequency
ROM	read-only memory
RS-232	industry standard for serial communications

S

s	second
sag	See *surge*
slow average	A gradual, long-term change in average RMS voltage level, with typical durations greater than 2 s.

surge	A sudden change in average RMS voltage level, with typical duration between 50 µs and 2 s.

T

TCD	Thermal Conductivity Detector
transient	A brief voltage surge of up to several thousand volts, with a duration of less than 50 µs.

V

V	volt
V ac	volts, alternating current
V dc	volts, direct current
VGA	Video Graphics Array

W

w	Width
W	Watt

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