

## Gas Chromatography

# Clarus 690 Gas Chromatograph



The PerkinElmer Clarus® 690 Gas Chromatograph (GC) is a fully automated gas chromatograph with programmable pneumatic control (PPC).

## OVEN

The Clarus 690 GC provides the fastest heat-up and cool-down oven available in a conventional GC. The oven gives excellent temperature control and fast cool-down times for maximum productivity. All temperature and time functions are microprocessor-controlled and are shown on the touch-screen display.

### Oven heat-up

The oven provides heat-up rates in defined temperature ranges to a maximum of 140 °C/min. The heat-up rates are determined by ballistic heating of the oven, after the oven has been at 50 °C for an hour, with a single injector and a single detector heated to 250 °C. The oven heat-up rate is met over the temperature range indicated below when the instrument's nominal AC line voltage (220 VAC, 230 VAC or 240 VAC for fast heating; 120 VAC or 230 VAC for standard heating) is applied to the instrument.

#### Typical Clarus 690 GC Dual-Channel Ramp Rates\*

Temperature Range (°C)	Standard Oven Heating (°C/min)	Fast Oven <sup>†</sup> Heating (°C/min)
50-70	80	140
70-115	60	105
115-175	45	85
175-300	30	55
300-450	20	35

\* Heat-up rates determined by ballistic heating of the oven with a single injector and a single detector heated to 250 °C.

† Fast oven heating requires 220 to 240 volts.

### Ballistic oven cool-down

The ballistic cool-down time for the oven from 450 °C to 50 °C is less than 2.0 minutes under the following conditions:

- 1 injector and 1 detector at 250 °C
- Lab conditions at 22 °C
- Ballistic cool-down starts immediately after heat-up

## Oven and column characteristics

<b>Volume (HxWxD)</b>	9 in. (229 mm) x 9 in. (229 mm) x 9.8 in. (249 mm) = 794 cubic in. Maximum usable depth = 6.3 in.
<b>Columns</b>	Accepts 1/8-in. o.d. stainless steel, 6 mm o.d. glass and all fused silica, packed or capillary columns 6.5-in. diameter coil. An interface adapter will be required for packed columns.
<b>Maximum packed column length</b>	Two 12 ft x 1/8-in. o.d. stainless steel or two 3 m x 6 mm o.d. glass nominal 6.5-in. diameter coil with uniform shape and contact between successive turns and co-overlapping turns.

## Oven temperature

<b>Range</b>	-99 °C (with subambient accessory) to 450 °C
<b>Settings</b>	Temperature is directly selectable in 1 °C steps throughout the temperature range
<b>Average ambient sensitivity</b>	Not more than 0.05 °C change over a 5 °C change in ambient temperature, within the 10 to 35 °C allowable ranges
<b>High-temp protection</b>	Firmware protection same as Clarus 590 GC firmware (prevents safety hazard)

## Oven temperature programming

<b>Temperature settings</b>	Initial, final temperature, selectable within 1 °C increments
<b>Time settings</b>	1 min increments for values 0 to 998 mins 0.1 min increments for values 0 to 99.8 mins 0.01 min increments for value 0 to 9.99 mins and infinite time (999 mins)
<b>Programming rate</b>	Settable from 0.0 °C/min to 160.0 °C/min in 0.1 °C increments
<b>Program steps</b>	10 program steps and 9 program ramps

## PNEUMATICS

PPC provides optimum performance with all types of columns and detectors. Each injector or detector option is ordered with PPC pneumatics. There are up to twelve PPC zones configured as two carrier (two zones each), two detector (two zones each) and four auxiliary channels.

### Carrier-gas pneumatics

- Carrier-gas pneumatics are included with the Clarus 690 injector
- Carrier PPC zones compensate for variations in ambient temperature and pressure for maximum stability
- Split-vent pneumatics are included with the Clarus 690 split/splitless and PSS (programmable split/splitless) injectors
- PPC provides direct setting of split-flow rates and ratios
- Split-vent PPC zones compensate for variations in ambient temperature for maximum stability
- PPC provides direct setting in mL/min, psig or kPa or cm/sec
- Automatic leak testing with PPC
- Three-ramps pressure program
- Pneumatic program rates: 0-100.0 psi/min, 0-100.0 mL/min, 0-200.0 cm/sec or ballistic

### Detector pneumatics

- PPC is available for all detectors
- PPC provides direct setting in mL/min
- Detector PPC zones compensate for variations in ambient temperature for maximum stability

## Auxiliary pneumatics

- Four auxiliary zones
- PPC provides direct setting in mL/min, psig or kPa
- Auxiliary PPC zones compensate for variations in ambient temperature for maximum stability

## AUTOSAMPLER

The Clarus 690 GC offers an optional, built-in syringe autosampler for maximum sampling capabilities. All control is accomplished through the keyboard or by a data system such as TotalChrom® chromatography data systems.

<b>Injection speed</b>	Normal, fast, slow
<b>Program modes</b>	Two methods may be programmed
<b>Sample positions</b>	108, plus one priority
<b>Vial size</b>	2-mL (0.25 mL with insert) crimp-top caps 2-mL screw-top caps
<b>Waste and wash vials</b>	4 waste and 4 wash
<b>Waste and wash vial size</b>	4 mL
<b>Syringe size</b>	0.5 µL, 5.0 µL or 50.0 µL
<b>Sampling volume</b>	0.1 µL to 0.5 µL from the 0.5-µL syringe in 0.1-µL increments or 0.5 µL to 5.0 µL from the 5.0-µL syringe in 0.5-µL increments or 5.0 µL to 50.0 µL from the 50.0-µL syringe in 5.0-µL increments
<b>Viscosity settings</b>	0-15
<b>Maximum injections per vial</b>	15
<b>Maximum solvent postwashes</b>	15
<b>Maximum sample pumps</b>	15
<b>Maximum sample prewashes</b>	15
<b>Minimum sample</b>	5 µL when used with the 0.25-mL vial insert; 350 µL when used with the 2-mL vial
<b>Reproducibility</b>	< 0.5% RSD for packed columns 1% C <sub>9</sub> in C <sub>7</sub> , 1 µL injected
<b>Sample pre-rinse</b>	Prepares the autosampler syringe in advance of the GC becoming ready

## INJECTORS

The Clarus 690 GC supports a comprehensive array of injectors that provides accuracy and precision to all of your sampling applications. Up to two injectors may be installed and operated with independent temperature control. Every injector is available with PPC.

### Packed-column injector

- Removable glass liner for trapping nonvolatile residues
- Adapter for on-column injection to wide-bore capillary columns
- 50 °C to 450 °C in 1 °C increments
- 1/8-in. fitting
- 1/4-in. column adapter available
- PPC pneumatics – programmed flow or pressure includes readout which displays pressure or column flow

### Split/splitless capillary injector

- Split ratio easily adjustable for a wide range of analytical conditions
- Charcoal trap in split vent prevents contamination of split valve and lab air
- Two choices of liner: 2-mm and 4-mm internal diameter
- 50 °C to 450 °C in 1 °C increments
- PPC pneumatics – four software configurable modes: programmed flow, programmed pressure, programmed velocity or constant flow. Vacuum compensation software selectable.
- PPC pneumatics include automatic control of split vent by split flow or split ratio

### Programmable on-column capillary injector

- Temperature-programmable inlet
- Two-ramps temperature program
- Oven-tracking mode for simple operation
- 50 °C to 500 °C in 1 °C increments
- Heat-up rate of 1 °C/min to 200 °C/min or ballistic
- Cools down from 380 °C to 50 °C in less than 5 minutes, while the oven is cooling in the same temperature range and with an FID at 380 °C
- 1/16-in. fitting
- PPC pneumatics include readout which displays pressure and column flow

### PSS – programmable split/splitless capillary injector

- Temperature-programmable inlet
- Two-ramps temperature program
- Oven-tracking mode for simple operation
- 50 °C to 500 °C in 1 °C increments
- Heat-up rate of 1 °C/min to 200 °C/min or ballistic
- Cools down from 380 °C to 50 °C in less than 3.5 minutes, while the oven is cooling in the same temperature range and with an FID at 380 °C
- 1/16-in. fitting
- Large-volume injection of up to 50 µL with autosampler, 150 µL manually
- Split ratio easily adjustable for a wide range of analysis conditions
- Three choices of liner available: 1-mm and 2-mm i.d. and on-column
- Charcoal trap in split vent prevents contamination of split valve and lab air
- PPC pneumatics – four software configurable modes: programmed flow, programmed pressure, programmed velocity or constant flow. Vacuum compensation software selectable.
- PPC pneumatics include automatic control of split vent by split flow or split ratio

### Swafer

Swafer™ micro-channel flow technology is an innovative and user-friendly approach to automate flow-switching applications. From simple techniques like switching between liquid and headspace injections or connecting two detectors to a single column, to sophisticated multidimensional separations on complex samples, the Swafer technology can enhance productivity in most analytical labs.

- Complete independence of the column from injectors or detectors
- Can assist users in removing unwanted sample residue from columns after analysis or switching between injectors and detectors for analytical flexibility
- Manages difficult separations, delivering richer information
- Swafer Utility Software (SUS) designed to assist users in setting up and characterizing the performance of their PerkinElmer Swafer systems
- Easy setup configuration change, without requiring service information

## PREVENT

- Unique PerkinElmer sample-management system
- Available only with PSS injector
- Includes injector and detector restrictors
- PreVent™ time-saver mode prevents higher boiling components or residues from going through the column and the detector.
- PreVent enhanced large-volume injection (ELVI) mode isolates the column and detector from the effects of high levels of solvent. Eliminates solvent flooding of the column or allows the use of solvents such as methylene chloride with an ECD.
- PreVent isolation mode allows a septum change without interrupting carrier flow. Allows maintenance on the inlet WHILE chromatography is taking place.
- ProTect™ mode eliminates contamination by preventing heavy components in the sample from reaching the expensive and retentive chromatographic column. Allows back flushing during chromatographic run.
- MSVent™ mode allows changing of columns without cooling and venting the Clarus 600 MS, reducing instrument down-time, offering a significant time savings. In addition, MSVent facilitates connection of the vent to a second detector for dual-signal capability, providing greater flexibility and enhancing productivity.

## GAS-SAMPLING VALVES

- Wide offering of 4-, 6-, 8- and 10-port valves
- Large range of valved systems and standard analyzers available
- Keyboard-controlled
- 1/16- or 1/8-in. fittings

## DETECTORS

A wide choice of detectors, optimized for sensitivity and selectivity, is available for use with the Clarus 690 GC. Whether you choose the flame ionization detector (FID), the thermal conductivity detector (TCD), the electron capture detector (ECD) and/or environmental-specific detectors, all conform to the highest industry standards for reliability and performance. Every detector is available with PPC. Up to two detector modules may be installed and operated simultaneously with independent temperature and pneumatic control.

### Flame ionization detector (FID)

- Wide linear dynamic range
- No makeup gas required due to efficient sweeping of column effluent by hydrogen combustion gas
- Air flow designed to minimize contamination and residue buildup
- 1/8-in. fittings; also includes 1/16-inch capillary adaptor
- PPC pneumatics – software flow control of hydrogen and air
- Flame out warning and ready interlock
- Auto ignite if flame out detected

<b>Operating temperature</b>	100 °C to 450 °C in 1 °C increments
<b>Minimum detectable quantity</b>	$< 3 \cdot 10^{-12}$ g C/sec octane at a S/N = 2 to 1
<b>Linearity</b>	$> 10^7$
<b>Signal filtration</b>	50, 200, 800 msec
<b>Makeup gas</b>	Not required

### Electron capture detector (ECD)

- High sensitivity and excellent selectivity
- High operating temperature for maximum stability
- 1/8-in. fittings
- PPC pneumatics – software flow control of makeup gas

<b>Source</b>	15 mCi <sup>63</sup> Ni
<b>Temperature protect</b>	470 °C by software
<b>Makeup gas</b>	Either Ar/CH <sub>4</sub> or N <sub>2</sub>
<b>Operating temperature</b>	100 °C to 450 °C in 1 °C increments
<b>Minimum detectable quantity</b>	< 0.05 pg perchloroethylene with argon/methane or nitrogen
<b>Linearity</b>	> 10 <sup>4</sup>
<b>Signal filtration</b>	200, 800 msec

### Thermal conductivity detector (TCD)

- Capillary-column compatible
- Proven constant current design
- Software protection to prevent filament burnout
- Ideal for series operation
- 1/8-in. fittings
- PPC pneumatics – software flow control of reference gas

<b>Operating temperature</b>	100 °C to 350 °C in 1 °C increments
<b>Sensitivity</b>	9 µV/ppm nonane at 160 mA at the bridge with a detector temperature of 100 °C
<b>Minimum detectable quantity</b>	Typically < 1 ppm nonane
<b>Linearity</b>	> 10 <sup>5</sup>
<b>Power supply</b>	Constant current with four selectable settings: 1: ±40 mA, 2: ±80 mA, 3: ±120 mA, 4: ±160 mA
<b>Signal filtration</b>	50, 200, 800 msec
<b>Filament protection</b>	Self-limiting and resetting after transient overloads in either channel
<b>Makeup gas</b>	Not required for 0.32- to 0.53-mm i.d. columns with flows ≥ 5 mL/min Required for 0.25-mm or smaller i.d. columns

### Photoionization detector (PID)

- Internal power supply and lamp control
- Series operation kit available
- 1/8-in. fittings
- PPC pneumatics – software flow control of makeup gas

<b>Operating temperature</b>	100 °C to 250 °C in 1 °C increments (can be set to 350 °C for cleaning)
<b>Minimum detectable quantity</b>	< 10 pg benzene
<b>Linearity</b>	> 10 <sup>7</sup>
<b>Signal filtration</b>	50, 200, 800 msec
<b>UV source lamp</b>	10.2 eV
<b>Input range</b>	1, 20
<b>Makeup gas</b>	Standard

### Nitrogen phosphorus detector (NPD)

- Modular design
- Ability to change prealigned bead in less than one minute
- Rapid conditioning, up and running in less than two hours
- 1/8-in. fittings
- PPC pneumatics – software flow control of hydrogen and air

<b>Operating temperature</b>	100 °C to 450 °C in 1 °C increments
<b>Minimum detectable quantity</b>	5 • 10 <sup>-13</sup> g N/sec 2,4-dimethylaniline, 5 • 10 <sup>-14</sup> g P/sec tributylphosphate
<b>Linearity</b>	> 10 <sup>4</sup>
<b>Signal filtration</b>	50, 200, 800 msec
<b>Selectivity</b>	50,000:1 (N/C), 10:1 (P/N)
<b>Input range</b>	1, 20
<b>Makeup gas</b>	Not required

### Flame photometric detector (FPD)

- GC software controls photo-multiplier tube voltage
- GC software linearizer for sulfur mode
- 1/8-in. fittings
- PPC pneumatics – software flow control of hydrogen and air

<b>Operating temperature</b>	250 °C to 450 °C in 1 °C increments
<b>Minimum detectable quantity</b>	1 • 10 <sup>-11</sup> g S/sec thiophene, 1 • 10 <sup>-12</sup> g P/sec tributylphosphate
<b>Linearity</b>	Sulfur 10 <sup>2</sup> (log-log), Phosphorus 10 <sup>3</sup>
<b>Signal filtration</b>	50, 200, 800 msec
<b>Selectivity</b>	10,000:1 (S/C), 100,000:1 (P/C)
<b>Makeup gas</b>	Not required

### TOUCH-SCREEN GRAPHICAL USER INTERFACE

- Multi-language support (English, French, Italian, German, Spanish, Japanese, Chinese and Russian)
- Real-time graphical display of chromatogram and graphical display of temperature and pneumatic programs
- Injection countdown for manual injections
- Column pressure/flow/velocity calculator
- Meaningful error/alarm messages
- Log file
- Upgradable firmware
- Preventative-maintenance counter
- Password protection
- Status-summary screen
- 256-color display; Resolution: 240 x 320

### OTHER CLARUS 690 GC FEATURES

- Complete instrument control available under TotalChrom®, TurboMass™ and Waters® Empower® 3 Software
- Recorder attenuation range from 1 to 65,536 in binary steps for TCD, ECD, PID, FPD and NPD
- Long-term battery backup of GC methods, autosampler programs, flow and temperature-calibration data
- Software calibration of oven temperature and carrier gas flow with PPC
- Full instrument control via external computer
- Five stored methods
- Auxiliary heated zone for accessory devices

## PHYSICAL DETAILS

### Electrical power requirements

<b>Power consumption</b>	Standard GC: 2400 VA (volt-amps) for the GC Standard GC with fast heating: 3120 VA (volt-amps) for the GC
<b>Power specifications</b>	All electrical supplies must be smooth, clean and free of line transients greater than 40 V peak-to-peak and must meet and remain within the following tolerances:  For GC with standard (current) heating rate: 120 VAC $\pm 10\%$ @ 50/60 Hz $\pm 1\%$ @ 20 Amps 230 VAC $\pm 10\%$ @ 50/60 Hz $\pm 1\%$ @ 10 Amps  For GC with optional oven heater for fast heating rate: 220 VAC $\pm 5\%$ @ 50/60 Hz $\pm 1\%$ @ 15 Amps 230 VAC $\pm 5\%$ @ 50/60 Hz $\pm 1\%$ @ 16 Amps 240 VAC $\pm 5\%$ @ 50/60 Hz $\pm 1\%$ @ 13 or 16 Amps  Instruments and peripherals should not be connected to circuits with large inductive or large, frequent loads (i.e., large motors, discharge lamps, photocopy systems, radio transmitters, etc.).
<b>Power outlets</b>	A minimum of one dedicated 120 VAC outlet at 20 A or one 230 VAC outlet at 10 A (minimum) is required for the standard GC. When the optional oven heater is installed, the outlets will be as indicated above. Additional equipment, such as computers and printers, should be connected per their specifications.

### Environmental requirements

<b>Laboratory environment</b>	Install the GC in an indoor laboratory environment that is clean and free of drafts, direct sunlight and vibration. The laboratory should be free of flammable, explosive, toxic, caustic or corrosive vapors or gases and should be relatively free of dust. The ambient laboratory temperature should be 10-35 °C (50-95 °F) with a relative humidity of 20-80% with no condensation.
<b>Storage</b>	Ambient temperature: -20 °C to +60 °C (-4 °F to +140 °F) Relative humidity: 20% to 80%, without condensation
<b>Altitude</b>	Operating: 0-2000 m; Non-operating: 0-12,000 m (sea level to 39,370 feet).
<b>Pollution degree</b>	Will operate safely in environments that contain nonconductive foreign matter up to Pollution Degree 2 as defined in EN/IEC 61010-1.
<b>European Union industrial environment</b>	The 230 V/50 Hz Clarus GC has been manufactured for use in the European Union and is intended for the industrial environment. The instrument is to be connected to a main power network supplied from a high- or medium-voltage transformer dedicated to the supply of an installation feeding a manufacturing or similar plant.
<b>Mean BTU output</b>	3400
<b>Dimensions (HxWxD)</b>	Clarus 690 GC with Autosampler: 83 x 67 x 82 cm (33 x 26 x 32 in)
<b>Weight</b>	Clarus 690 GC with Autosampler: 69 kg (152 lb)