

Clarus 600 Gas Chromatograph

The PerkinElmer® Clarus® 600 Gas Chromatograph (GC) is a fully automated gas chromatograph with programmable pneumatic control (PPC).

OVEN

The Clarus 600 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 higher 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 600 GC Dual-Channel Ramp Rates

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

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

Volume (HxWxD)	9 in. (229 mm) x 9 in. (229 mm) x 9.8 in. (249 mm) = 794 cubic in. Maximum usable depth = 6.3 in.
Columns	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.
Maximum packed column length	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

Range	4 °C above ambient (with zones at 250 °C) to 450 °C
Settings	Temperature is directly selectable in 1 °C steps throughout the temperature range
Average ambient sensitivity	Not more than 0.05 °C change over a 5 °C change in ambient temperature, within the 10 to 35 °C allowable ranges
High-temp protection	Firmware protection same as Clarus 500 GC firmware (prevents safety hazard)

Oven temperature programming

Temperature settings	Initial, final temperature, selectable within 1 °C increments
Time settings	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)
Programming rate	Settable from 0.0 °C/min to 160.0 °C/min in 0.1 °C increments
Program steps	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 600 injector
- PPC is available for all injectors
- Two carrier zones
- Carrier PPC zones compensate for variations in ambient temperature and pressure for maximum stability
- Split-vent pneumatics are included with the Clarus 600 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
- Four detector pneumatic zones
- 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 600 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.

Injection speed	Normal, fast, slow
Program modes	Two methods may be programmed
Sample positions	82, plus one priority
Vial size	2-mL (0.25 mL with insert) crimp-top caps 2-mL screw-top caps
Waste and wash vials	4 waste and 4 wash
Waste and wash vial size	4 mL
Syringe size	0.5 µL, 5.0 µL or 50.0 µL
Sampling volume	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
Viscosity settings	0-15
Maximum injections per vial	15
Maximum solvent postwashes	15
Maximum sample pumps	15
Maximum sample prewashes	15
Minimum sample	5 µL when used with the 0.25-mL vial insert; 350 µL when used with the 2-mL vial
Reproducibility	< 0.5% RSD for packed columns 1% C ₉ in C ₇ , 1 µL injected
Sample pre-rinse	Prepares the autosampler syringe in advance of the GC becoming ready

INJECTORS

The Clarus 600 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 simultaneously 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
- 1/16-in. fitting
- 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
- 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
- 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

PREVENT

- Unique PerkinElmer sample-management system
- Available only with PSS or split/splitless capillary injector and PPC pneumatics
- 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 downtime, 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 600 GC. All built-in detectors include an automated background-compensation feature that corrects for column bleed. 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
- PPC pneumatics – software flow control of hydrogen and air
- “Flame out” warning and ready interlock

Operating temperature	100 °C to 450 °C in 1 °C increments
Sensitivity	> 0.015 coulombs/g C
Minimum detectable quantity	< 3 • 10 ⁻¹² g C/sec nonane at a S/N = 2 to 1
Linearity	> 10 ⁶
Signal filtration	50, 200, 800 msec
Input range	1, 20
Makeup gas	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

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

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

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

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

Nitrogen phosphorus detector (NPD) (continued)

Operating temperature	100 °C to 450 °C in 1 °C increments
Minimum detectable quantity	5 • 10 ⁻¹³ g N/sec 2,4-dimethylaniline, 5 • 10 ⁻¹⁴ g P/sec tributylphosphate
Linearity	> 10 ⁴
Signal filtration	50, 200, 800 msec
Selectivity	50,000:1 (N/C), 10:1 (P/N)
Input range	1, 20
Makeup gas	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

Operating temperature	250 °C to 450 °C in 1 °C increments
Minimum detectable quantity	1 • 10 ⁻¹¹ g S/sec thiophene, 1 • 10 ⁻¹² g P/sec tributylphosphate
Linearity	Sulfur 10 ² (log-log), Phosphorus 10 ³
Signal filtration	50, 200, 800 msec
Selectivity	10,000:1 (S/C), 100,000:1 (P/C)
Makeup gas	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 600 GC FEATURES

- Recorder attenuation range from 1 to 65,536 in binary steps
- 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
- Baseline compensation
- Auxiliary heated zone for accessory devices

PHYSICAL DETAILS

Electrical power requirements

Power consumption	Standard GC: 2400 VA (volt-amps) for the GC Standard GC with fast heating: 3120 VA (volt-amps) for the GC
Power specifications	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.).
Power outlets	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

Laboratory environment	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.
Storage	Ambient temperature: -20 °C to +60 °C (-4 °F to +140 °F) Relative humidity: 20% to 80%, without condensation
Altitude	Operating: 0-2000 m; Non-operating: 0-12,000 m (sea level to 39,370 feet).
Pollution degree	Will operate safely in environments that contain nonconductive foreign matter up to Pollution Degree 2 as defined in EN/IEC 61010-1.
European Union industrial environment	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 mains power network supplied from a high- or medium-voltage transformer dedicated to the supply of an installation feeding a manufacturing or similar plant.
Mean BTU output	3400
Dimensions (HxWxD)	Clarus 600 GC with Autosampler: 83 x 67 x 82 cm (33 x 26 x 32 in)
Weight	Clarus 600 GC with Autosampler: 69 kg (152 lb)

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