TORONTECH

TVAC THERMAL VACUUM TEST CHAMBER

TVAC Thermal Vacuum Test Chamber - ToronTVAC™ Series

ToronTVAC™ Series is a cold plate thermal vacuum chamber line for aerospace, defense, and electronics teams that need unit-level TVAC testing in their own lab. Three standard models offer cubic working volumes measuring 250, 400, and 800 mm per side. Each system pairs a 304 stainless steel chamber with turbomolecular pumping and a temperature-controlled cold plate. Together they create a repeatable vacuum and thermal environment for components, modules, and small subassemblies. Engineers use it to find temperature-driven faults before hardware ships or flies.

Every model reaches an ultimate vacuum below 1.0×10^{-4} Pa and operates across -70°C to +120°C. Temperature ramps run at 2°C/min, and wider temperature ranges are available on request. Four large test flanges accept vacuum-tight electrical feedthroughs, so power, signal, and sensor lines reach the test article while the chamber stays sealed. The ToronTVAC™ 400F and C1000 also accept an optional five-sided thermal shroud. All pumps, controls, and utilities sit in an integrated equipment cabinet.

A PLC with a PC-based control terminal runs test profiles, monitors chamber pressure, and records temperature data for each run. Torontech includes installation, commissioning, and operator training, and every system carries a two-year warranty. Buyers select the chamber size that fits their largest fixture and cable routing plan. Feedthroughs are then configured to match the program's instrumentation. This gives small satellite, avionics, and sensor programs a practical route to in-house thermal vacuum capability.

APPLICATIONS

TVAC Thermal Vacuum Test Chamber - ToronTVAC™ Series Applications

The ToronTVAC™ Series supports thermal vacuum work wherever hardware must perform reliably in vacuum and at temperature extremes. Typical users include spacecraft suppliers, defense electronics manufacturers, and university

research groups.

- Small Satellite and CubeSat Units: functional checks of avionics boxes, power distribution units, and payload electronics under vacuum before system-level integration
- Electronics Thermal Cycling: repeated hot and cold dwells on circuit card assemblies, control modules, and power converters to expose solder joint fatigue and intermittent connections
- Thermal Balance and Model Correlation: steady-state temperature holds that compare measured values with thermal model predictions and confirm interface conductance assumptions
- Optical and Sensor Payloads: screening of detectors, camera modules, and star tracker subassemblies for focus shift, signal drift, or calibration change at temperature
- Defense Avionics and RF Hardware: vacuum-temperature stress screening of guidance electronics, RF modules, and communication units to reveal latent workmanship defects
- Vacuum Bakeout of Flight Parts: elevated-temperature holds up to +120°C that drive moisture and volatile residues out of harnesses, adhesives, and assemblies before integration
- Root Cause Investigation: recreating anomalies seen during system tests under controlled pressure and temperature profiles to confirm a failure mechanism or verify a design fix
- University and Research Laboratories: in-house TVAC capability for student satellite teams and thermal research groups that would otherwise book time at outside test facilities

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FEATURES

TVAC Thermal Vacuum Test Chamber - ToronTVAC™ Series Key Features

The ToronTVAC™ Series combines high vacuum, conductive temperature control, and flexible instrumentation access in three chamber sizes. Each feature addresses a practical need in unit-level thermal vacuum testing.

- Three Standard Chamber Sizes: working volumes of 250, 400, and 800 mm per side let buyers match the chamber to the largest test article and fixture instead of paying for unused volume
- Ultimate Vacuum Below 1.0×10^{-4} Pa: pressure capability well below the convection-free threshold leaves margin for outgassing loads during long thermal runs
- Dry Backing Pump: a turbomolecular pump backed by a multistage Roots dry pump avoids oil backstreaming and keeps contamination-sensitive hardware clean
- -70°C to +120°C Operating Range: covers typical cold and hot plateaus for unit-level cycling, with wider ranges available on request
- 2°C/min Ramp Rate: consistent temperature transitions shorten cycle time and keep test profiles repeatable run after run
- Temperature-Controlled Cold Plate: a heat transfer oil loop conditions the plate for direct conductive coupling to the test article, with plate size scaled to each model
- Optional Five-Sided Thermal Shroud: available on the ToronTVAC™ 400F and C1000 to add a controlled radiative boundary around the test article
- Four Large Test Flanges: ISO 160 or ISO 200 ports accept custom vacuum-tight electrical feedthroughs for power, signal, and data lines
- Dedicated Temperature Measurement Feedthrough: a 55-pin measurement flange and 12 temperature sensors support detailed temperature mapping across the test article
- DN160 Viewing Window with 24 V Interior Lighting: operators can check the test setup visually without venting the chamber

- PLC and PC-Based Control System: programmable profiles, remote distributed I/O, and a PC terminal simplify test setup, live monitoring, and temperature data recording
- Automated Valves and Vacuum Gauges: a pneumatic gate valve, full-range gauge, and Pirani transducer support controlled pump-down and venting sequences
- 304 Stainless Steel Chamber: corrosion-resistant construction stands up to repeated pump-down cycles and routine cleaning
- Utility Monitoring: flow and pressure switches on the cooling water and compressed air lines protect the system if site supplies drop out
- Installation, Commissioning, and Training Included: on-site startup support and a two-year warranty help teams begin productive testing quickly

THEORY & METHOD

Theory and Method

Thermal vacuum testing works because pressure controls how heat moves around a test article. Air at ambient pressure carries heat by convection and gas conduction, masking how a unit behaves in orbit. Once chamber pressure falls near 1×10^{-3} Pa, gas molecules rarely strike surfaces and convective transfer becomes negligible. Heat then flows only through conduction at mounting interfaces and through radiation, which scales with the fourth power of absolute temperature. Engineers can then study hot spots, interface resistance, and outgassing under realistic conditions.

The ToronTVAC™ Series reaches this regime with a two-stage pumping train. A multistage Roots dry pump evacuates the chamber through the viscous flow range using meshing lobed rotors that run without sealing oil. A turbomolecular pump then takes over, and its high-speed rotor blades strike gas molecules and drive them toward the exhaust. The dry backing stage prevents oil backstreaming, which protects contamination-sensitive surfaces. Full-range and Pirani gauges track pressure throughout, while a pneumatic gate valve isolates the chamber from the pumps.

A heat transfer oil loop circulates through the cold plate and sets its temperature. The circulation unit adds heat or removes it as the programmed profile demands, and the plate exchanges that heat with the test article by direct conduction. Surfaces facing the chamber interior exchange heat by radiation, and the optional thermal shroud adds a controlled radiative boundary. The PLC drives ramps, dwells, and repeated cycles for thermal cycling work. Long steady holds support thermal balance tests.

TECHNICAL SPECIFICATIONS

TVAC Thermal Vacuum Test Chamber - ToronTVAC™ Series Technical Specifications

Parameter	ToronTVAC™ 250F	ToronTVAC™ 400F	ToronTVAC™ 800F
Chamber Material	304 stainless steel	304 stainless steel	304 stainless steel
Chamber Dimensions (W × D × H)	300 × 300 × 300 mm	500 × 500 × 500 mm	1000 × 1000 × 1000 mm
Internal Working Dimensions (W × D × H)	250 × 250 × 250 mm	400 × 400 × 400 mm	800 × 800 × 800 mm
Ultimate Vacuum	$< 1.0 \times 10^{-4}$ Pa ($< 7.5 \times 10^{-7}$ Torr)	$< 1.0 \times 10^{-4}$ Pa ($< 7.5 \times 10^{-7}$ Torr)	$< 1.0 \times 10^{-4}$ Pa ($< 7.5 \times 10^{-7}$ Torr)
Operating Pressure	1.3×10^{-3} Pa (approx. 1×10^{-5} Torr)	1.3×10^{-3} Pa (approx. 1×10^{-5} Torr)	1.3×10^{-3} Pa (approx. 1×10^{-5} Torr)
Operating Temperature Range	-70°C to +120°C (-94°F to +248°F); wider ranges on request	-70°C to +120°C (-94°F to +248°F); wider ranges on request	-70°C to +120°C (-94°F to +248°F); wider ranges on request
Heating/Cooling Rate	2°C/min (3.6°F/min)	2°C/min (3.6°F/min)	2°C/min (3.6°F/min)
Cooling Capacity	2.3 kW at -40°C	2.3 kW at -40°C	2.3 kW at -40°C

Parameter	ToronTVAC™ 250F	ToronTVAC™ 400F	ToronTVAC™ 800F
Heating Capacity	3 kW	3 kW	3 kW
Cold Plate Dimensions	250 × 250 mm	400 × 400 mm	800 × 800 mm
Thermal Shroud (5-Sided)	Not available	Optional, 400 × 400 mm	Optional, 800 × 800 mm
Vacuum System	Turbomolecular pump + multistage Roots dry pump	Turbomolecular pump + multistage Roots dry pump	Turbomolecular pump + multistage Roots dry pump
Flange Connections	4 × ISO 160 (custom vacuum-tight electrical feedthroughs on request)	4 × ISO 200 (custom vacuum-tight electrical feedthroughs on request)	4 × ISO 200 (custom vacuum-tight electrical feedthroughs on request)
Equipment Power	15 kW	20 kW	35 kW
Cooling Method	Water-cooled	Water-cooled	Water-cooled
Cooling Water Flow Rate	≥ 30 L/min (≥ 7.9 US gpm)	≥ 40 L/min (≥ 10.6 US gpm)	≥ 60 L/min (≥ 15.9 US gpm)
Cooling Water Connection	DN25	DN25	DN32
Compressed Air Pressure	0.5 to 0.7 MPa (73 to 102 psi)	0.5 to 0.7 MPa (73 to 102 psi)	0.5 to 0.7 MPa (73 to 102 psi)
Compressed Air Flow Rate	10 L/min (0.35 cfm)	10 L/min (0.35 cfm)	10 L/min (0.35 cfm)
Compressed Air Connection	Φ10 mm	Φ10 mm	Φ10 mm
Site Utilities	Cooling water and compressed air supplied by customer	Cooling water and compressed air supplied by customer	Cooling water and compressed air supplied by customer
Equipment Net Dimensions	2000 × 1000 × 1800 mm	2000 × 1000 × 1800 mm	2500 × 1200 × 1800 mm
Installation Footprint	3000 × 2000 × 2500 mm	3000 × 2000 × 2500 mm	3500 × 2200 × 2500 mm
Total Equipment Weight	1,500 kg (3,307 lb)	2,000 kg (4,409 lb)	3,000 kg (6,614 lb)
Warranty	2 years	2 years	2 years

Standard Configuration

Item	Quantity	Description
Vacuum Chamber	1 set	400 × 400 × 400 mm working volume
Test Flange	4 sets	Sized per Flange Connections above; connectors not included
Temperature Measurement and Lighting Flange	1 set	DN160 with 55-pin and 4-pin feedthroughs
Viewing Window	1 set	DN160
Radiation Shield	1 set	Installed inside the chamber
O-Rings and Accessories	1 set	Chamber sealing components
Cold Plate	1 set	Temperature-controlled mounting plate; size per Technical Specifications
Temperature Sensors	12 sets	Test article and cold plate temperature measurement
Turbomolecular Pump	1 set	High vacuum pumping stage
Dry Pump	1 set	Oil-free backing and roughing stage
Pneumatic Gate Valve	1 set	DN160, chamber isolation
Pneumatic Butterfly Valve	1 set	DN25
Manual Butterfly Valves	3 sets	DN25
Full-Range Vacuum Gauge	1 set	Chamber pressure measurement
Pirani Vacuum Transducer	1 set	Rough vacuum measurement
Vacuum Piping and Accessories	1 set	Pumping line hardware
Thermal Oil Circulation Unit	1 set	Cold plate heating and cooling
Heat Transfer Oil	1 set	Initial fill

Item	Quantity	Description
Valves, Instrumentation, and Sensors	1 set	Temperature control loop hardware
Piping and Insulation	1 set	Insulated thermal oil lines
Programmable Logic Controller (PLC)	1 set	Test sequence and interlock control
PC-Based Control Terminal	1 set	Operator interface and data recording
Remote Distributed I/O	1 set	Field signal handling
Communication Module	1 set	Controller network communication
Control Module	1 set	Process control
Temperature Module	1 set	Temperature signal acquisition
24 V DC Power Supply	1 set	Control circuit power
Control Cabinet	1 set	Houses control hardware
Electrical Components	1 set	Switchgear and wiring components
Cables and Auxiliary Materials	1 set	Interconnect cabling
Control Software	1 set	Custom-developed control application
Integrated Equipment Cabinet	1 unit	Houses pumps, thermal unit, and controls
Interior Lighting Unit	1 unit	24 V, inside chamber
Cooling Water Unit	1 unit	Flow switch and valve
Compressed Air Unit	1 unit	Pressure switch and inline filter
Installation, Commissioning, and Training	Included	On-site startup and operator training

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