

Thermo Scientific Prima BT Bench top Mass Spectrometer

Highly precise, multiport magnetic sector mass spectrometer

The Thermo Scientific™ Prima™ BT Bench top Mass Spectrometer is a highly reliable, precise, and flexible gas analyzer specifically designed for process development laboratories.

- Scanning Magnetic-sector technology
- 16-port Rapid Multistream Sampler (RMS)
- 6-port Automatic calibration manifold
- High analytical precision, accuracy, and stability



The Thermo Scientific Prima BT Bench top Mass Spectrometer is an industrial laboratory gas analyzer based on scanning magnetic-sector mass spectrometry. Designed for continuous operation in a process environment, the Prima BT mass spectrometer is simple to operate and easy to maintain.

Operating Principles

The sample gas is introduced via a stream selector and a pressure reduction system, comprised of a capillary and molecular leak that transmits a small proportion of the gas into the ion source which operates under high vacuum. Using an electron emitting filament, the ionization chamber converts the sample molecules into ions which are positively charged molecules or parts of molecules. These ions are then separated according to their mass by a variable magnetic field. The different mass ions are then quantified by the detector in accordance with the abundance of the signals at these masses.

Analytical Platform

The primary feature of the Prima BT mass spectrometer is the magnetic sector analyzer. This field-proven technology has demonstrated the strongest performance for industrial on-line gas analysis. Magnetic sector technology offers precision, accuracy, long intervals between calibrations, and resistance to contamination. The flat-topped peak profile ensures that the gas composition measurements are highly reproducible and the laminated magnet enables high scanning speeds.

The Prima BT mass spectrometer offers robust performance in the presence of gases and vapors that have the potential to contaminate internal vacuum components. As the ions are extracted from the ion source at high energy, excellent stability is achieved for low molecular weight compounds such as hydrogen and helium.



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Inlet System Options

Available options include stepper motor controlled Rapid Multi-stream Sampling (RMS), single point solenoid inlet, and single point continuous inlet.

The unique RMS inlet system allows for the selection of 1 to 16 streams and sets new standards for speed and reliability of multi-stream sampling and maintenance intervals. Stream settling times are application dependent and user configurable. The RMS includes digital sample flow recording for every selected stream. This can be used to trigger an alarm in case of fall off in sample flow, for example due to a blocked filter in the sample conditioning system.

This unit includes inlet electronics for control of the stepper motor, calibration panel and RMS temperature (up to 80°C). The position of the stream selector is optically encoded for reliable, computer controlled stream selection. The temperature and position control signals are communicated to the software system via the internal industrial network.

Calibration Panel Option

An optional panel assembly is available when the RMS or single point solenoid configuration is selected. The panel contains six solenoid valves for automatic selection of calibration gases.

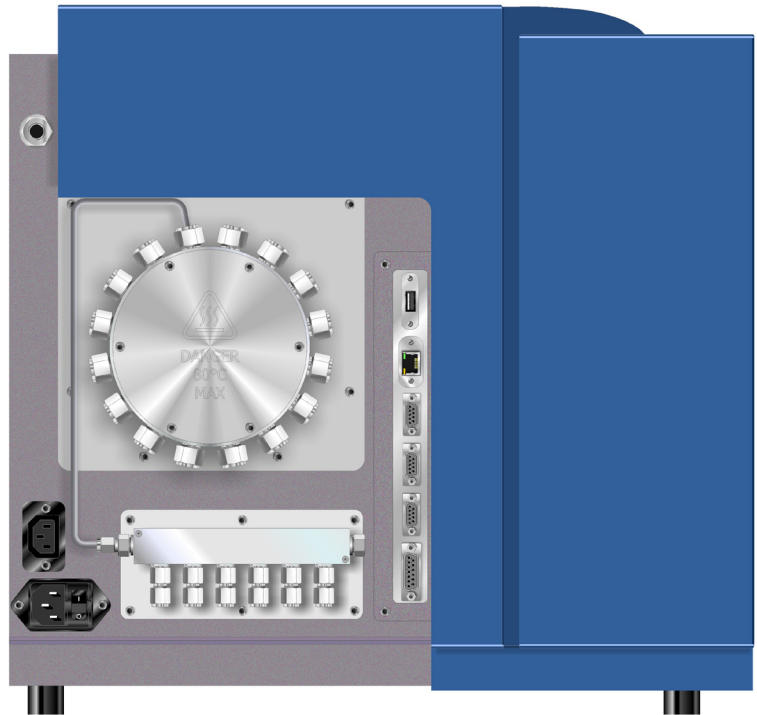
Electronics

Power supply and distribution has been engineered to ensure minimum power consumption and maximum reliability with extensive system monitoring at all points around the network.

The local processor provides embedded processing power for true, stand-alone control of all mass spectrometer functions while the local network provides control of all ancillary equipment. A serial port is provided for connection to a PC and an additional two configurable serial ports allow for remote communication. OLE for process control (OPC) and Modbus protocol communications are provided as standard.

The Vacuum System

The Prima BT mass spectrometer vacuum system includes an external floor mounting rotary pump that provides backing vacuum for evacuating the analyzer. It also provides pumping for the inlet bypass capillary, a pump controller to control the operation of the high-performance turbo-molecular pump, and an active cold-cathode vacuum gauge for interlock protection of the ion source filaments. As an option the external



Prima BT Mass Spectrometer configured for 15 Sample Streams and 6 Calibration Streams

floor mounting rotary pump can be replaced by an internal diaphragm pump to fit within the instrument enclosure.

Thermo Scientific™ GasWorks Software

The GasWorks software is designed for easy configuration and simple operation and maintenance of Thermo Scientific Process Mass Spectrometers without specialist knowledge of mass spectrometry. Included in the system are industry standard communication protocols, multi-level security, event logging, automatic calibration and tuning, diagnostics, and Wizard PRO help functions. Additionally, the suite features an extensive array of data presentation forms that can be configured to meet the needs of a variety of control-room or laboratory situations.

System Architecture

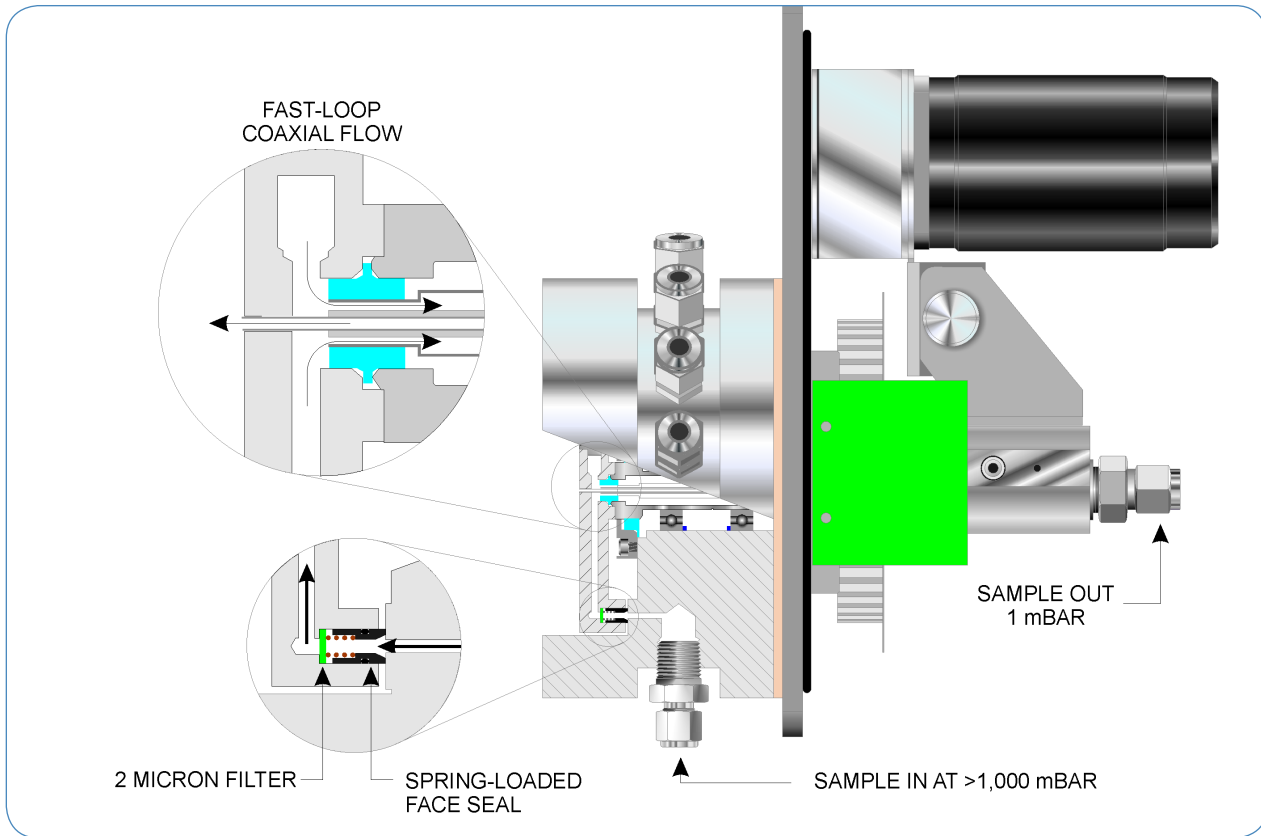
GasWorks Software is a two-processor system. The primary machine is the control engine built into the instrument and provides a fully multi-tasking 32-bit real time industrial control system to manage all aspects of instrument control. It contains a database of all instrument configurations and operational details, and retains this through power fail thus allowing restart without user intervention. This database contains all data needed for instrument operation allowing the configured analyzer to be self-automated, programmed to automatically send results to the DCS or LIMS, and to additionally perform

self-calibration when necessary.

The instrument controller does not require installation because the program is burned-in and the data loaded from the host GasWorks Software machine.

The remote GasWorks Software system operates on a personal computer (PC) running Windows® XP, Vista or 7, and provides a convenient graphical user interface for configuring analysis methods, derived value calculations, calibration routines, communication protocols, I/O, alarm levels, and more. The host GasWorks Software machine also provides real-time analysis numeric and trend displays, together with various mass spectral scan modes, data logging in csv spreadsheet format and dynamic data exchange (DDE) for presentation of the data over a network. Also provided are comprehensive data review programs for numeric and trend displays and statistical calculations of stored data.

The primary embedded computer system operates with a true industrial operating system in complete stand-alone mode. This ensures that measurement modes can be controlled without requiring access to the PC and the results can be communicated directly to the host, SCADA, or LIMS.



Accuracy Considerations

It is often the case, that the peaks being measured are 'overlapped' or composite with contributions from more than one component. A de-convoluting data reduction technique is involved in deducing the component contributions to the peaks.

With the Prima BT this is performed automatically by an embedded processor in the mass spectrometer. An important assumption is made (and is generally obeyed) that the overlapping peaks, when combined, obey the principle of linear peak superposition. The principle states that the composite peak height at a particular mass is simply equal to the sum of the peak heights which correspond linearly to the individual concentrations of the contributing components in the complex mixture.

The effect of overlapping peaks will necessarily influence the accuracy of measurement in the event that minor components in the sample gas are heavily overlapped by much larger concentrations.

The Applications Group at Thermo Fisher Scientific will provide a detailed performance guarantee (to be included in any quotation) on submission of a customer stream specification. The most appropriate analytical method and calibration scheme will also be defined for each of the sample streams to be measured.

Component	Concentration %mol	Standard deviation
Nitrogen	Balance	0.005%mol
Oxygen	15	0.005%mol
Argon	1	0.001%mol
Carbon dioxide	10	0.005%mol

Industry Laboratory Environment

The Thermo Scientific Prima BT mass spectrometer is intended for use in process development labs where gas component concentrations in the range 20ppm - 100% require precise measurement. Additional low parts per million (ppm) concentrations can be added to the analysis by use of the optional multiplier detector.

The Prima BT mass spectrometer is built on the technology of the Thermo Scientific Prima PRO process mass spectrometer and is designed for optimal performance levels when operated in a general-purpose, temperature-controlled environment.

World Class Service Support

The Prima BT mass spectrometer is supported by global service capabilities including a variety of unique service and support options designed to ensure instrument optimization and reduce potential downtime. Options include:

- Service Agreements
- Technical Support
- Spare Parts
- Field Installation and Service
- Product Training
- Comprehensive Service Kits

Thermo Scientific Prima BT Bench top Mass Spectrometer

Ion Source	Enclosed Electron Impact with Dual Filaments, temperature controlled (settable over range 120-200 degrees C, to ± 0.1 degrees C)
Analyzer Type	Scanning Laminated Electromagnet, 6 cm radius, 80 degrees deflection
Mass Range	Adjustable, default is 1-150 amu at 1000 eV ion acceleration voltage, (at 750 eV ion acceleration voltage, mass range is 1-200 amu)
Resolution	Switchable between two collector resolving slits, resolving powers of 60 (1mm) and 20 (4 mm) are standard. Optionally 140/85 (0.36 mm/0.69 mm) or 100/45 (0.56 mm/1.45 mm) or 140/45 (0.36 mm/1.45 mm) may be fitted
Mass Scale Stability	Measured at mass 28 < 0.013 amu over 24 hours
Peak Shape	At 60 resolution, the ratio of the width of the flat-top (99% height width) to the base peak width (5% height width) 0.5
Abundance Sensitivity	<250 ppm for 27/28 amu
Detector	Faraday and optional Faraday/SEM dual detector
Inlet	Temperature controlled micro-capillary with Molecular leak and bypass (standard configuration)
Vacuum System	Turbo-molecular Pump and external Rotary Pump Alternatively Turbo-molecular Pump and internal diaphragm pump
Sample Flow	Digitally measured and recorded for each stream for any instrument with RMS option
Precision	<0.1% relative (typical, application dependent) external rotary pump
Linearity	<1% relative over a decade change in concentration (typical, application dependent)
Dynamic Range	10 ppb – 100% (theoretical, application dependent) external rotary pump only
Stability	<1% relative over 1 week (typical, application dependent)
Power Requirements	115 Vac (± 5 Vac) or 230 Vac (± 10 Vac)
Physical Dimensions	52cm (20.5") H x 79cm (31.1") W x 47cm (18.5") D 100 kg (200lbs) configuration dependent

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