



Model 7401 Alpha Spectrometer

Features

- Stainless steel vacuum chamber
- Accommodates samples up to 50 mm (2 in.) diameter
- Supports the use of alpha detectors up to 1200 mm²
- Optional reverse sample bias (standard with 7401VR)
- Built-in counter/timer
- Integral vacuum gauge with vacuum/bias interlock
- Bias supply variable to 198 V dc, positive or negative
- Digital display of:
 - Counter/Timer, Chamber Pressure, Detector Bias, Leakage Current, Pulser Energy, Discriminator Energy

Description

The CANBERRA Model 7401VR Alpha Spectrometer is a comprehensive alpha spectrometer that can accommodate samples up to two inches in diameter in a double-width NIM package. The versatile sample chamber and instrument electronics support CANBERRA's own PIPS® Detectors, which combine high resolution and low backgrounds in a rugged alpha detector with active areas up to 1200 mm². In addition, the alternative use of most charged particle detectors is also supported. The Model 7401 fully integrates into one package a stainless steel vacuum chamber for low backgrounds and ease of cleaning, a vacuum gauge, detector bias supply, preamp/amplifier, pulser, discriminator, counter, and digital display. A stainless steel shelf and sample holder are included with each spectrometer, for reproducible detector/sample spacing, which is user selectable from 1 to 49 mm, in 4 mm increments.

The full functionality of the Model 7401 is enhanced by a microprocessor-managed user interface.

Front panel controls allow the user to quickly set and easily display the bias voltage on the detector, the energy value of the calibrated internal pulser, the energy value of the discriminator and the preset time for the built-in counter. Additionally, the front panel display also monitors chamber pressure, detector leakage current, accumulated counts and elapsed time. To facilitate routine work and quick setup, the detector bias voltage, discriminator energy and pulser settings are retained in memory when the device is switched off. For gross alpha counting, the counter can be started, stopped and reset using the simple front panel switches. For added convenience, the time display can be internally configured for either seconds or hours.

To support a variety of alpha detectors, the built-in detector bias supply is adjustable from 2 to 198 V dc, positive or negative. Premature and possibly damaging application of bias to the detector is avoided by a user-configured interlock. The interlock safely inhibits the bias supply until proper vacuum is attained, then the bias voltage is gradually ramped to the predetermined setting, over approximately one minute.



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The precision preamp and amplifier provide the optimal pulse shaping and signal conditioning required for detectors used in alpha spectrometry. Gain and offset of the amplifier can be adjusted by means of front panel access to multi-turn controls. For reference, the internal test pulser can be set to mark energies from 0.1 to 10 MeV and can be used to calibrate the spectrometry system without the use of alpha emitting sources. The counter discriminator also is calibrated in energy units and is fully variable between 0.1 and 10 MeV. The discriminator output, indicating activity above the selected setting, is available at the rear panel counts output. The rear panel also has a connector for signal input from an optional external test pulser. When combined with appropriate CANBERRA Mixer/Routers, Multiplexers and software products, a single multichannel analyzer (MCA) can easily support multiple 7401 Alpha Spectrometers in a complete data acquisition and analysis system.

Three versions of the Model 7401 are available:

- Model 7401 – Standard model.
- Model 7401-RSB – With Reverse Sample Bias option.
- Model 7401VR – Higher chamber pressure range (0-20 mm Hg) and Reverse Sample Bias option.

The Model 7401 Alpha Spectrometer has a pressure gauge with an operating range of 0-1000 $\mu\text{m Hg}$ (0-133 Pa). For those who need to operate at higher chamber pressures, the Model 7401VR Alpha Spectrometer has a pressure gauge range of 0-20 mm Hg (0-2.67 kPa). Chamber pressure is manually controlled by a three-position mechanical valve. To provide reliable performance with little maintenance, the stainless steel door of the chamber is equipped with hinges which automatically adjust to and compensates for proper gasket compression. For added confidence, the vacuum chamber is helium leak tested to 10^{-10} cc/s during manufacture.

Reverse sample bias is available as an option in the Model 7401VR and Model 7401-RSB. In applications requiring this option, reverse bias is provided by four 3-volt batteries.

Specifications

INPUT

- TEST INPUT – Accepts signal from external square wave or tail pulser; $Z_{in} = 93 \Omega$; gain nominally $\times 10$; rear panel BNC.

OUTPUTS

- ENERGY OUTPUT – Provides positive, linear near-Gaussian shaped unipolar pulses proportional to energy, linear to + 10 V; max output 12 V; dc restored; $Z_{out} = 10 \Omega$; short circuit protected; rear panel BNC.

- TP (Test Point) – Replica of the energy output signal; isolated by 1 k Ω resistance; front panel mounted pin jack.
- COUNTS OUTPUT – NIM-standard positive logic pulse available on rear panel BNC connector for driving external counter; pulse width nominally 3.5 μs for any event above discriminator setting; $Z_{out} \approx 50 \Omega$, dc coupled.

DISPLAY

- Multi-purpose 5-digit LED display shows chamber pressure in $\mu\text{m Hg}$ (mm Hg on the 7401VR), detector leakage current (μA), gross counts, elapsed time, preset time, detector bias, discriminator level (MeV), and calibration pulser level (MeV); time readout in seconds or hours.

FRONT PANEL CONTROLS AND INDICATORS

- BIAS ON/OFF – Toggle switch controls high voltage supply.
- BIAS LED Indicator – Blinks when bias voltage is inhibited and while supply is increasing to preset value; steadily illuminated when supply approaches final value.
- FUNCTION LED Indicators – One of eight LEDs is illuminated when corresponding function is selected for display; COUNTS LED blinks when counter is active; CAL LED blinks when calibration pulser is active.
- INCREMENT/DECREMENT – Dual purpose momentary toggle switch selects display function and sets preset time, detector bias, calibration pulser level or discriminator level.
- DIGIT SELECT – Pushbutton switch chooses display digit to be incremented or decremented; operable when setting preset time, HV bias, calibration pulser, or discriminator level.
- START/STOP – Dual purpose momentary toggle switch starts or stops counter when counter functions are selected or starts/stops pulser when calibration pulser is selected.
- RESET – Pushbutton resets counter and timer.
- GAIN – Screwdriver adjustable multi-turn potentiometer adjusts amplifier gain.
- OFFSET – Screwdriver adjustable multi-turn potentiometer adjusts amplifier offset.
- PUMP/OFF/VENT – 3-position valve control; PUMP connects vacuum pump to chamber; OFF isolates pump from chamber and chamber from atmosphere; VENT vents chamber to atmosphere and isolates pump. Locks in pump position by turning handle one quarter turn counterclockwise.

REAR PANEL CONTROL

- VACUUM/BIAS INTERLOCK – Locking toggle switch enables or disables bias inhibit; inhibit is triggered when chamber pressure exceeds threshold.

INTERNAL CONTROLS (Circuit board mounted)

- VACUUM/BIAS INTERLOCK SET POINT – Dual position jumper chooses vacuum level at which bias is enabled. 7401 nominal trip level is 100 or 500 $\mu\text{m Hg}$ (13 or 67 Pa); factory set to 500 $\mu\text{m Hg}$ (67 Pa). 7401VR nominal trip level is 0.3 mm Hg (0.04 kPa) or 10 mm Hg (1.33 kPa); factory set to 10 mm Hg (1.33 kPa).
- BIAS POLARITY – Toggle switch sets polarity of detector bias supply and internal pulser. Factory set for positive bias.

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- **AMPLIFIER POLARITY** – Jumper allows amplifier to accept positive or negative detector pulses. Factory set to process negative pulses.
- **TIME FORMAT** – Jumper sets seconds or hours time display. Factory set for seconds display.

SYSTEM PERFORMANCE

(Based on use of a 450-20 AM PIPS detector with a good quality ^{241}Am point source.)

- **ENERGY RESOLUTION** – ≤ 20 keV (FWHM) with a detector-source spacing equal to the detector diameter.
- **DETECTOR EFFICIENCY** – $\geq 25\%$ for detector-source spacing of less than 10 mm.
- **BACKGROUND** – ≤ 1 count/hr above 3 MeV.

ELECTRONICS PERFORMANCE

- **BIAS SUPPLY**
 - Range – Nominal 1 V to ± 198 V dc, adjustable in 2 V steps from 2 V to full voltage.
 - Stability – Better than 50 ppm/ $^{\circ}\text{C}$.
 - Noise – ≤ 5 mV peak-to-peak.
 - Display Resolution – 0.1 V.
- **CALIBRATION PULSER**
 - Range – 0.1 to 10 MeV, adjustable in 0.1 MeV steps.
 - Stability – Better than 50 ppm/ $^{\circ}\text{C}$.
 - Display Resolution – 10 keV.
- **DISCRIMINATOR**
 - Range – 0.1 to 10 MeV.
 - Display Resolution – 10 keV.
- **DETECTOR CURRENT MONITOR**
 - Range – 0 to 20.00 μA .
 - Display Resolution – 0.01 μA .
- **VACUUM GAUGE**
 - 7401 and 7401-RSB Range – 0 to 1000 $\mu\text{m Hg}$ (0 to 133 Pa).
 - 7401VR Range – 0 to 20 mm Hg (0 to 2.67 kPa).
- **COUNTER**
 - Count Range – 0 to 99 999 counts.
 - Time Range – 0 to 99 999 seconds or 0 to 999.99 hours.
 - Preset Time Range – Same as Time Range.
 - Time base – 50 Hz or 60 Hz power line frequency or internal crystal, automatically selected.
- **PREAMPLIFIER/AMPLIFIER**
 - Shaping – 0.5 μs unipolar, dc restored.
 - Integral Nonlinearity – $\leq 0.4\%$ of full scale.
 - Gain Range – 6 MeV to 13 MeV full scale (17 to 40 V/pC, 1 to 2.5 V/MeV).
 - Gain Drift – ≤ 200 ppm/ $^{\circ}\text{C}$.
 - DC Drift – $\leq \pm 100$ $\mu\text{V}/^{\circ}\text{C}$.
 - Noise – ≤ 0.12 fC RMS referred to input at 0 pF input capacitance.
 - Offset range – 0 to ± 200 mV.

CONNECTORS

- **TEST INPUT, ENERGY OUTPUT and COUNTS OUTPUT** – BNC type UG-1094/U.
- **VACUUM** – 9.5 mm (3/8 in.) O.D. aluminum fitting mounted through rear panel.
- **DETECTOR** – Axial microdot.

POWER REQUIREMENTS

- +24 V dc – 100 mA +12 V dc – 250 mA
- 24 V dc – 50 mA –12 V dc – 50 mA

PHYSICAL

- **SIZE** – Standard double-width NIM module 6.86 x 22.12 cm (2.70 x 8.71 in.) per DOE/ER – 0457 (1990).
- **NET WEIGHT** – 2.5 kg (5.5 lb).
- **SHIPPING WEIGHT** – 3.2 kg (7.0 lb).
- **VACUUM CHAMBER AND HARDWARE** – 8.16 x 6.03 x 6.25 cm (3.25 x 2.375 x 2.5 in.) (height, width, depth). Stainless steel chamber, door, shelf and sample holder.
- **SAMPLE SIZE** – Up to 51 mm (2 in.) diameter.
- **MAXIMUM DETECTOR SIZE** – 1200 mm².
- **SAMPLE-DETECTOR SPACING** – 1 to 49 mm in 4 mm steps.
- **SAMPLE HOLDER** – One Model 7401SH-M sample holder for 32 mm (1.25 in.), 25 mm (1 in.) or 19 mm (0.75 in.) samples is supplied. Other sample holder sizes are available as extra cost options.

ENVIRONMENTAL

- **OPERATING TEMPERATURE** – 0 to 50 $^{\circ}\text{C}$.
- **OPERATING HUMIDITY** – 0 to 80% relative, non-condensing. Meets the environmental conditions specified by EN 61010, Installation Category I, Pollution Degree 2.

OPTIONS

- **Model 7401-RSB Reverse Sample Bias Alpha Spectrometer** – Includes four 3 V batteries mounted on the sample shelf. The average battery life is 8 years.
- **Model 7401VR Alpha Spectrometer** – Same as 7401 except the pressure gauge has a range of 0 to 20 mm Hg (0 to 2.67 kPa); also includes Model 7401-RSB Reverse Sample Bias option.
- **Model 7401SH-3 sample holder for 19 mm (3/4 in.) samples.**
- **Model 7401SH-4 sample holder for 25 mm (1 in.) samples.**
- **Model 7401SH-8 sample holder for 51 mm (2 in.) samples.**



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