

Model 106-L Ozone Monitor™

Federal Equivalent Method (FEM)

Recommended for Both Ambient and Industrial Ozone Applications



Standard Enclosure



Industrial Enclosure



OEM Version

The Model 106 series of ozone monitors was designed specifically for the industrial ozone industry to cover four different ozone concentration ranges by varying the optical path length. The ranges are: -L (low, 0-20 ppm); -M (medium, 0-1,000 ppm); -MH (medium high, 0-10,000 ppm, 0-1 vol%) and -H (0-20 wt%, 0-14 vol%). The Model 106 series is designed as an "ozone monitor on a board" in which nearly all of the components are mounted directly to the printed circuit board with very few wire connections, making these instruments highly robust and very easy to service. As seen in the images above, all models are available in a standard enclosure, weather-resistant Industrial enclosure, or with no enclosure for OEM applications for those who want to mount the instrument in their own enclosure or use it as a component of a larger system. For more details on OEM applications see: [Model OEM-106](#). Multi-channel sampling configurations are available for the Model 106-L, -M, and -MH (3-channel and 6-channel configurations).

The Model 106-L Ozone Monitor is designed for measurements of ambient ozone concentrations down to very low ppb levels. However, because of the large dynamic range of our ozone monitors, the Model 106-L also can be used for accurate measurements of ozone at concentrations up to 20 ppm (20,000 ppb). The accuracy and precision of this instrument is comparable to our original Model 202 Ozone Monitor widely used for field measurements by atmospheric researchers. Like the Model 202, it has been designated by the EPA as a Federal Equivalent Method (FEM) for monitoring for compliance with the US Clean Air Act: [EQOA-0914-218](#). The Model 106-L Ozone Monitor is recommended for workplace health and safety monitoring where ozone is being produced and used in a wide range of industrial applications like water treatment, food processing, aquaculture, fruit and vegetable warehouses, etc. For a pocket-sized personal monitor to measure individual exposures see: [Personal Ozone Monitor](#).

Specifications

Measurement Principle	UV absorption at 254 nm, single beam
Certifications	Federal Equivalent Method EQOA-0914-218 CE
Measurement Interval	2 s
Linear Dynamic Range	0-20,000 ppb (0-20 ppm)
Resolution	0.1 ppb
Precision (1 σ for 10-s average; aka rms noise)	Greater of 1.5 ppb or 2% of reading
Limit of Detection (10-s average, 2 σ)	3.0 ppb
Accuracy	Greater of 1.5 ppb or 2% of reading
Baseline Drift	< 3 ppb/day, < 6 ppb/year
Sensitivity Drift	< 1%/day, < 3%/year
Calibration	NIST Traceable; annual calibration recommended
Measurement Time and Frequency	2 s, 0.5 Hz
Data Averaging Options	10 s, 1 min, 5 min, 1 hr
Response Time, 100% of Step Change	For 2 s output: 4 s, 2 data points For 10 s output: 20 s, 2 data points
Adaptive Filter	Available; user-defined parameters
Data Logger Capacity	32,736 lines (10 s avg. = 3.8 days; 5 min avg = 113 days)
Data Transfer Baud Rates	2400, 4800, 19200
Ozone Units	ppb, pphm, ppm, $\mu\text{g m}^{-3}$, mg m^{-3}
Temperature Units	$^{\circ}\text{C}$, K
Pressure Units	mbar, torr
T and P Corrected	Yes
DewLine™ for Humidity Control	Yes
Operating Temperature Range	0 to 50 $^{\circ}\text{C}$
Operating Altitude Range	0-13.5 km
Flow Rate	Minimum Required: 0.6 L/min; Nominal: 1 L/min; Maximum: 1.5 L/min

Digital Data Outputs	USB, RS232, LCD display
Analog Data Outputs	0-2.5 V analog, 4-20 mA, user-scalable in menu
Power Requirements	100-240 VAC, 50/60 Hz 11-28 V DC, nominally 500 mA at 12 V DC, 6 watt
Relays with 2 Setpoints	Two available: Relay 1 responds based on user's ozone set points. Relay 2 responds based on user's ozone set points OR responds based on diagnostics (T, P, flow, lamp voltage) Four relays provided in Industrial models and in the 3-channel and 6-channel optional configurations
Flow-Through Option Available	Yes
Multi-Channel Options Available	Yes, 3-channel and 6-channel configurations
Size	Standard: 3.6 × 7.9 × 9.4 inches (9 × 20 × 24 cm) OEM: 2.5 × 7 × 9 in (6.4 × 17.8 × 22.9 cm) Industrial: 16 × 14 × 9.3 in (40.7 × 35.7 × 23.6 cm)
Weight	Standard: 4.2 lb (1.9 kg) OEM: 2.8 lb (1.3 kg) Industrial: ~14 lb (6.4 kg)
Options	Particle Filter, Exhaust Port, Flow-Through Configuration, Multi-Channel Configurations

Features

- Measurement based on UV absorption
- Low power consumption; can be operated with user-supplied battery
- Internal data logger with real-time clock
- 2-s measurement interval
- On-board microprocessor with interactive menus includes data averaging options of 10 s, 1 m, 5 m, 1 hr, and user-defined adaptive filter
- USB and RS-232 output of time/date, O₃ concentration, internal temperature and pressure
- Analog output (0-2.5 V and 4-20 mA) of ozone concentration in user-selected units and scaling factors
- Two 2-level relays for control purposes (e.g., control of ozone source; turn warning light on and off); four relays provided in Industrial model and in the 3-channel and 6-channel optional configurations
- Long-life pump (15,000 hr)
- Optional configurations for 3-channel or 6-channel air sampling

Model 202 Ozone Monitor™

EPA Federal Equivalent Method (FEM)



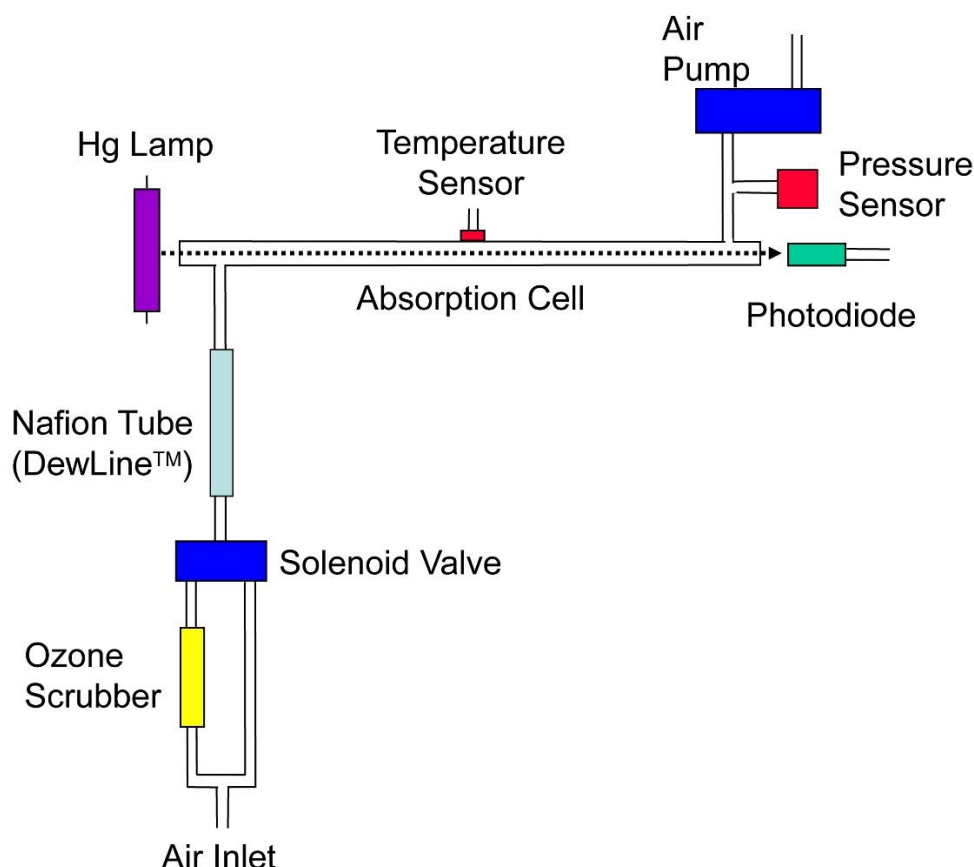
The 2B Technologies Model 202 Ozone Monitor™ is designed to enable accurate and precise measurements of ozone ranging from low ppb (precision of ~1.5 ppb) up to 20,000 ppb (20 ppm) based on the well-established technique of absorption of UV light at 254 nm. The Model 202 Ozone Monitor™ is lightweight (5.5 lb, 2.5 kg) and has a low power consumption (12V DC, 0.60 amp, ~7.2 watt) relative to conventional instruments and is therefore well suited for applications such as:

- Vertical profiling using balloons, kites, RPVs, and light aircraft where space and weight are highly limited
- Long-term monitoring at remote locations where power is highly limited
- Urban arrays of ground-based detectors
- Personal exposure monitoring for studies of health effects of air pollutants
- Environmental health and safety monitoring
- Laboratory studies of the effects of ozone exposure on materials and organisms

Flash memory (SD card) and a quiet long-life internal air pump are now provided as standard features on the Model 202.

The Model 202 has been designated by the EPA as a Federal Equivalent Method (FEM): [EQOA-0410-190](https://www.epa.gov/eqoa/eqoa-0410-190). As a designated FEM, the Model 202 Ozone Monitor may be used by states and other monitoring agencies under 40 CFR Part 58, Ambient Air Quality Surveillance, for monitoring for compliance with the Clean Air Act.

Schematic Diagram



Features

- Quiet, long-life internal air sampling pump
- Low power consumption: ~7.2 watts
- Internal data logger (EEPROM), logs 16,383 lines of data
- Real-time clock
- Both serial and user-scalable analog voltage outputs
- Flash card memory (SD card) for virtually unlimited, portable data storage
- Three 0-2.5 VDC analog inputs for logging other measurements, such as external temperature, pressure, and humidity
- Convenient user interface to microprocessor, including calibration parameters (gain and zero)
- Selectable measurement time of 10 s or data averaging times of 1 min, 5 min and 1 hr (custom averaging times available)
- Selectable units for ozone, pressure, and temperature
- DewLine™ for elimination of any water vapor interference, a unique feature of 2B Tech instruments

Options

- External particle filter
- Serial-to-USB converter
- Cold-weather package (pump, lamp heater for use down to -20°C)
- High-altitude upgrade (pressure sensor for use up to 25 km altitude)
- Rack-mount case configuration

Specifications

Measurement Principle	UV Absorption at 254 nm
Certifications	Federal Equivalent Method (FEM), EQOA-0410-190 CE
Linear Dynamic Range	0 ppb to 20 ppm
Resolution	0.1 ppb
Precision (1 σ ; rms noise)	Greater of 1.5 ppb or 2% of reading (in 10-s measurement mode)
Limit of Detection (2 σ)	3.0 ppb (in 10-s measurement mode)
Accuracy	Greater of 1.5 ppb or 2% of reading
NIST-Traceable Calibration	Yes
Measurement Interval	10 s (Data averaging options: 1 min, 5 min, 1 hr)
Flow Rate (nominal)	~1 Liter/min
Flow Rate Requirement	>0.6 L/min
Baseline Drift	<2 ppb/day <5 ppb/year
Sensitivity Drift	<1%/day <3%/year
Measurement Time, Frequency	10 s, 0.1 Hz
Response Time, 100% of Step Change	20 s, 2 points
Averaging Times	1 min, 5 min, 1 hr
Ozone Units	ppb, pphm, ppm, $\mu\text{g m}^{-3}$, mg m^{-3}
Pressure Units	mbar, torr
Temperature Units	°C, K
T and P Corrected	Yes
Operating Temperature Range	0 to 50°C standard; optional -20 to 50°C with low temperature modifications (pump and lamp heater cold-weather package)
Operating Altitude Range	~0-13.5 km (150-1,013 mbar) standard; optional ~0-25 km (30-1,013 mbar) with upgraded pressure sensor

Power Requirement; Supplied by battery or 110/220 VAC Power Pack	11-14 V DC or 120/240 VAC, nominally 600 mA at 12 V, 7.2 watt (6.2 watt with cell heater unplugged)
Size	3.7 × 8.5 × 11.8 inches (9.5 × 21.5 × 30 cm)
Weight	5.5 lb (2.5 kg); 2.8 lb (1.3 kg) without instrument case
Internal Data Logger Capacity	16,383 lines (10-s measurement mode = 1.9 days; 1-min avg = 11 days; 5-min avg = 1.9 mo; 1-hr avg = 1.9 yr)
SD Card Logger Capacity	Minimum 2 GB (> 5-year capacity for 10-s measurement mode)
Analog Inputs for Internal Logging of Other Instruments	3 Analog Inputs, 0-2.5 V (for example could log external T, P, and RH)
Data Outputs	RS232, 0-2.5 V Analog, LCD Display
Data Transfer Baud Rates	2400, 4800, 19200
Output Ranges	User-Defined Scaling Factor in Menu
DewLine™	Yes
Quiet, Long-Life Internal Air Pump	Yes
Flow Meter	Yes
Options	External Particle Filter Serial-to-USB Converter Cold-Weather Package, -20 to 50°C (pump, lamp heater) High-Altitude Upgrade (~0 to 25 km) Rack-Mount Case Configuration

System Includes

- Model 202 Ozone Monitor with quiet, long-life internal air pump
- AC Power Adapter (100-240 VAC to 12 VDC) with Country-Specific Plug
- Zeroing Cartridge
- Flash Card Memory for virtually unlimited, portable data storage
- SD Card (minimum 2 GB) and SD Card Reader
- Operation Manual on USB Stick
- Calibration Data and NIST-Traceable Calibration Certificate
- Instrument Birth Certificate
- One-Year Warranty

Model 205 Dual Beam Ozone Monitor™

EPA Federal Equivalent Method (FEM)

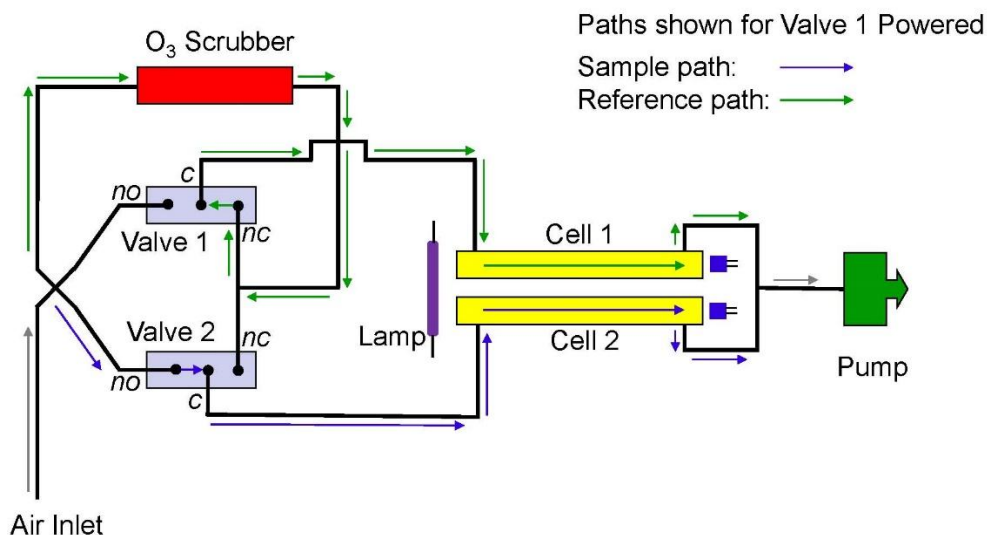


The 2B Technologies Model 205 Dual Beam Ozone Monitor™ is designed to enable accurate and precise measurements of ozone ranging from low ppb (precision of ~1 ppb) up to 20,000 ppb (20 ppm) based on the well-established technique of absorption of UV light at 254 nm. The Model 205 makes use of two detection cells to improve precision, baseline stability, and response time. In the Dual Beam instrument, UV light intensity measurements I_0 (ozone-scrubbed air) and I (unscrubbed air) are made simultaneously. Combined with other improvements, this made it possible to reduce the time between ozone measurements to 2 seconds, making our instrument the fastest UV-based ozone monitor on the market, while still retaining the small size, weight, and power requirements of our popular Model 202 Ozone Monitor. Fast measurements are especially desirable for aircraft and balloon measurements where high spatial resolution is desired. Alternatively, one can choose to average more points internally to obtain even better precision.

The Model 205 has all of the features of the Model 202, including choice of measurement or averaging time (2 s, 10 s, 1 min, 5 min, 1 hr), analog output (0-2.5 V), real time serial output, internal data logger with 3 analog inputs for simultaneous logging of other measurements (e.g., T, P, and RH), and real-time clock. Flash memory (SD card) and quiet long-life internal pump are now standard features.

The Model 205 Dual Beam Ozone Monitor is an Environmental Protection Agency (EPA) Federal Equivalent Method (FEM): [EQOA-0410-190](https://www.epa.gov/equivalent-methods/equivalent-methods).

Schematic Diagram



Features

- Quiet, long-life internal air sampling pump
- Low power consumption (~8 watt)
- Internal data logger (EEPROM), logs 16,383 lines of data
- Real-time clock
- Both serial and user-scalable analog voltage outputs
- Flash card memory (SD card) for virtually unlimited, portable data storage
- Three 0-2.5 VDC analog inputs for logging other measurements, such as external temperature, pressure, and humidity
- Convenient user interface to microprocessor, including calibration parameters (gain and zero)
- Selectable measurement time of 2 s or data averaging times of 10 s, 1 min, 5 min and 1 hr (custom averaging times available)
- DewLine™ for elimination of any water vapor interference, a unique feature of 2B Tech instruments
- Dual beam feature allows for heightened precision and improved baseline stability for applications where high spatial resolution is required

Options

- External particle filter
- Serial-to-USB adapter
- Cold-weather package for operation to -20°C (pump, lamp heater)
- High-altitude upgrade for operation to 25 km (pressure sensor)
- Low-power option for even lower power consumption
- Rack-mount enclosure

Specifications

Measurement Principle	UV Absorption at 254 nm; Dual Beam
Certifications	Federal Equivalent Method (FEM), EQOA-0410-190 CE
Linear Dynamic Range	0 to 20 ppm
Resolution	0.1 ppb
Precision (1 σ ; rms noise)	Greater of 1.0 ppb or 2% of reading for 10-s average
Accuracy	Greater of 1.0 ppb or 2% of reading
Limit of Detection (2 σ)	2.0 ppb for 10-s average
NIST-Traceable Calibration	Yes
Measurement Interval	2 s (Data averaging options: 10 s, 1 min, 5 min, 1 hr)
Flow Rate (nominal)	~1.8 Liter/min
Flow Rate Requirement	>1.2 L/min
Baseline Drift	<1 ppb/day; <3 ppb/year
Sensitivity Drift	<1%/day; <3%/year
Measurement Time, Frequency	2 s, 0.5 Hz
Response Time, 100% of Step Change	4 s, 2 points
Measurement and Averaging Times	2 s, 10 s, 1 min, 5 min, 1 hr
Ozone Units	ppb, pphm, ppm, $\mu\text{g m}^{-3}$, mg m^{-3}
Pressure Units	mbar, torr
Temperature Units	°C, K
T and P Corrected	Yes
Operating Temperature Range	0 to 50°C standard; optional -20 to 50°C with low temperature modifications (pump and lamp heater cold-weather package)
Operating Altitude Range	~0-13.5 km (150-1,013 mbar) standard; optional ~0-25 km (30-1,013 mbar) with upgraded pressure sensor

Power Requirement; Supplied by battery or 110/220 VAC Power Pack	11-14 V DC or 120/240 V AC; nominally 650 mA at 12 V; ~8 watt (~7 watt with cell heater unplugged)
Size	3.7H × 8.5W × 11.8L inches (9.5 × 21.5 × 30 cm)
Weight	5.8 lb (2.6 kg); 3.1 lb (1.4 kg) without instrument case
Internal Data Logger Capacity	16,383 lines (2-s fast measurement mode = 9.1 hr; 10-s avg = 1.9 days; 1-min avg = 11 days; 5-min avg = 1.9 mo; 1-hr avg = 1.9 yr)
SD Card Logger Capacity	> 2 GB (> 5-year capacity for 10-s averaging mode)
Analog Inputs for Internal Logging of Other Instruments	3 Analog Inputs, 0-2.5 V; for example, could log external T, P, and RH
Data Outputs	RS232, 0-2.5 V Analog, LCD Display
Data Transfer Baud Rates	2400, 4800, 19200
Output Ranges	User-Defined Scaling Factor in Menu
DewLine™	Yes
Quiet, Long-Life Internal Air Pump	Yes
Flow Meter	Yes
Options	External Particle Filter Serial-to-USB Adapter Cold-Weather Package, -20 to 50°C (pump, lamp heater) High-Altitude Upgrade, ~0-25 km (pressure sensor) Rack-Mount Case

System Includes

- Model 205 Ozone Monitor
- Quiet, Long-Life Internal Air Pump
- AC Power Adapter (100-240 VAC to 12 VDC) with Country-Specific Plug
- Zeroing Cartridge
- Flash Card Memory for virtually unlimited, portable data storage
- SD Card (> 2 GB) and SD Card Reader
- Operation Manual on USB Stick
- Calibration Data and NIST-Traceable Calibration Certificate
- Instrument Birth Certificate
- One-Year Warranty

Personal Ozone Monitor™ (POM™)

EPA Federal Equivalent Method (FEM)

The World's Smallest Ozone Monitor



2B Tech has taken the next step in miniaturization of UV-based ozone monitors by developing the Personal Ozone Monitor or "POM." The basic POM unit has dimensions of 4 × 3 × 1.5 inches and weighs only 0.8 lb / 1.0 lb without / with battery (340 g / 450 g). It has a built-in GPS so that ozone measurements may be logged continuously along with geographic location. By folding the optical path in the shape of a "U," it was possible to achieve the same path length in the POM as in the Models 202, 205, and 106-L and thus have similar precision and accuracy (~1.5 ppb).

The POM is designated by the US EPA as a Federal Equivalent Method for ozone: [EQOA-0815-227](#). Use it in applications such as:

- Personal exposure monitoring for studies of health effects of air pollutants
- Health and safety monitoring at industrial sites using ozone
- Vertical profiling using balloons, kites, RPVs, and light aircraft where space and weight are highly limited
- Long-term monitoring at remote locations where power is highly limited
- Urban arrays of ground-based detectors

Read our paper published on the POM: [Miniature Personal Ozone Monitor Based on UV Absorbance](#), P.C. Andersen, C.J. Williford and J.W. Birks, *Analytical Chemistry* **82**, 7924-7928 (2010).

Features

- Small (palm-sized)
- Lightweight (~1 lb)
- Same measurement principle (UV absorbance) and similar precision (~1.5 ppb) as much larger instruments
- Approved as a Federal Equivalent Method ([EQOA-0815-227](#))
- Measure ozone up to 10,000 ppb (10 ppm)
- Belt clip and compact Lithium Ion battery pack in side bracket for extreme portability
- Low power requirement: 3 watt
- Adapters enable AC or 12V battery operation
- Internal data logger
- Built-in GPS logs location along with ozone measurements
- Fast 2-s or 10-s measurements
- User-selected averaging times of 1 min, 5 min, or 1 hr
- Serial or USB connections for data downloading

Specifications

Measurement Principle	UV Absorption at 254 nm
Federal Equivalent Method (FEM)	Yes, EQOA-0815-227
Linear Dynamic Range	0 ppb to 0.5 ppm
Resolution	0.1 ppb
Precision (1σ; rms noise)	Greater of 1.5 ppb or 2% of reading (10-s measurement mode, with default adaptive filter settings)
Limit of Detection (2σ)	3.0 ppb (10-s measurement mode, with default adaptive filter settings)
Accuracy	Greater of 1.5 ppb or 2% of reading
NIST-Traceable Calibration	Yes
Measurement Intervals	Measurement mode: 10 s Fast mode: 2 s
Flow Rate (nominal)	~0.8 Liter/min
Flow Rate Requirement	>0.5 L/min
Baseline Drift	<2 ppb/day; <5 ppb/year
Sensitivity Drift	<1%/day; <3%/year

Measurement Time, Frequency	10 s, 0.1 Hz (Fast mode: 2 s, 0.5 Hz)
Response Time, 100% of Step Change	For 10-s output: 20 s, 2 points For 2-s output: 4 s, 2 points
Averaging Times	1 min, 5 min, 1 hr
Data Storage	8,192 lines (2-s fast mode ~4.6 hrs; 10-s meas. mode ~1 day; 1-min avg ~6 days; 5-min ~1 mo; 1-hr avg ~1 yr)
Outputs	RS232, USB
Ozone Units	ppb
Pressure Units	torr
Temperature Units	K
T and P Corrected	Yes
Operating Temperature Range	0 to 50°C
Operating Altitude / Pressure Ranges	~0-13.5 km (150-1,013 mbar)
Power Requirement; Supplied by battery or 110/220 VAC Power Pack	7-12 V dc, nominally 250 mA at 12 V, 3.0 watt
External Battery	7.4 Volt, 1.6 amp hour, Lithium Ion Battery, 5-8 hr
Size	With GPS: 5.0 × 3.0 × 1.5 inches (12.7 × 7.6 × 3.8 cm) Without GPS: 4.0 × 3.0 × 1.5 inches (10.2 × 7.6 × 3.8 cm)
Weight	With battery: 1.0 lb (0.45 kg) Without battery: 0.8 lb (0.36 kg)
Data Transfer Baud Rate	19200
DewLine™	Yes
GPS	Yes
Certification	CE
Options	Wall-mount bracket

System Includes

- POM™ Personal Ozone Monitor™
- AC Power Adapter (100-240 VAC to 12 VDC) with Country-Specific Plug
- 7.4 V Lithium Ion Battery
- Battery Charger
- Serial Port Cable
- USB Cable
- Zeroing Cartridge
- Global Positioning System (GPS)
- USB stick with Operation Manual, 2B Display Software and USB Driver
- Instrument Birth Certificate
- Calibration Data and NIST-Traceable Calibration Certificate
- One-Year Warranty

HERMES Personal Mercury Monitor™



2B Tech has taken the next step in miniaturization of UV-based mercury monitors by developing the HERMES Personal Mercury Monitor or "PMM." It has a built in GPS so that mercury measurements may be logged continuously along with geographic location. By folding the optical path in the shape of a "U," it was possible to achieve a path length of 15 cm in the HERMES, enabling extremely sensitive measurements of mercury in the atmosphere ($\sim 0.2 \mu\text{g}/\text{m}^3$ detection limit for Hg, linear dynamic range of 0 to $2000 \mu\text{g}/\text{m}^3$ Hg with $0.1 \mu\text{g}/\text{m}^3$ Hg resolution).

The HERMES is small ($4 \times 3 \times 1.5$ inches, $10.2 \times 7.6 \times 3.9$ cm), lightweight (0.75 lb., 340 g) and has a low power consumption (3.0 watt) relative to conventional instruments and is therefore well suited to applications such as:

- Monitoring of exposure to individuals in the workplace
- Monitoring and control of mercury in industrial settings
- Personal exposure monitoring for studies of health effects of air pollutants
- Long-term monitoring at remote locations where power is highly limited

Specifications

Measurement Principle	UV Absorption at 254 nm
Linear Dynamic Range	0-2,000 $\mu\text{g}/\text{m}^3$
Resolution	0.1 $\mu\text{g}/\text{m}^3$
Precision (1 σ ; rms noise)	Greater of 0.1 $\mu\text{g}/\text{m}^3$ or 2% of reading
Accuracy	Greater of 0.5 $\mu\text{g}/\text{m}^3$ or 5% of reading
Limit of Detection (2 σ)	0.2 $\mu\text{g}/\text{m}^3$
NIST-Traceable Calibration	Yes
Measurement Intervals	Measurement mode: 10 s Fast mode: 2 s
Flow Rate (nominal)	~0.8 Liter/min
Flow Rate Requirement	>0.5 L/min
Baseline Drift	<0.1 $\mu\text{g}/\text{m}^3/\text{day}$; <0.3 $\mu\text{g}/\text{m}^3/\text{year}$
Sensitivity Drift	<1%/day; <3%/year
Measurement Times, Frequencies	Measurement mode: 10 s, 0.1 Hz Fast mode: 2 s, 0.5 Hz
Response Time, 100% of Step Change	For 10-s output: 20 s, 2 data points For 2-s output: 4 s, 2 data points
Averaging Times	1 min, 5 min, 1 hr
Data Storage	8,192 lines (2-s fast mode ~4.6 hr; 10-s meas. mode ~1 day; 1-min avg ~6 days; 5-min avg ~1 mo; 1-hr avg ~1 yr)
Mercury Units	ppb, $\mu\text{g}/\text{m}^3$
Pressure Units	torr
Temperature Units	K
T and P Corrected	Yes
Operating Temperature Range	0 to 50 °C
Operating Altitude Range	~0-13.5 km (150-1,013 mbar)

Power Requirement; Supplied by Battery or 110/220 VAC Power Pack	7-24 V dc, nominally 250 mA at 12 V, 3.0 watt
External Battery	7.4 Volt, 1.6 amp hour, Lithium Ion Battery, 5-8 hr
Size	4.0 × 3.0 × 1.5 inches (10.2 × 7.6 × 3.8 cm)
Weight	0.75 lb. (0.34 kg)
Data Transfer Baud Rate	19200
DewLine™	Yes
GPS	Yes
Certification	CE
Options	Wall-mount bracket

System Includes

- HERMES PMM™ Personal Mercury Monitor™
- AC Power Adapter (100-240 VAC to 12 VDC) with Country-Specific Plug
- 7.4 V Lithium Ion Battery
- Battery Charger
- Serial Port Cable
- USB Cable
- Zeroing Cartridge
- USB stick with Operation Manual, 2B Data Display Software, and USB Driver
- Instrument Birth Certificate
- Calibration Data and NIST-Traceable Calibration Certificate
- One Year Warranty

Model 405 nm NO₂/NO/NO_x Monitor™

Direct Measurement of NO₂ by Absorbance

Federal Equivalent Method (FEM) for NO₂



The Model 405 nm NO_x Monitor ("nm" for "nanometer" and for "NO_x Monitor") is designed for the direct measurement of atmospheric nitrogen dioxide (NO₂), nitric oxide (NO) and total reactive oxides of nitrogen (NO_x = NO + NO₂) in the concentration range 0-10,000 ppb (0-10 ppm) for NO₂ and 0-2,000 ppb (0-2 ppm) for NO with high precision and accuracy. In this instrument NO₂ is measured directly by absorbance at 405 nm. NO is measured by selective conversion with ~100% efficiency using the highly selective reaction of NO with ozone (O₃). Total NO_x is obtained by addition of NO and NO₂.

Unlike chemiluminescence instruments where NO₂ must be converted to NO using either a molybdenum or photolytic converter with highly variable efficiency, in the Model 405 NO_x Monitor nitrogen dioxide is measured directly by absorbance, analogous to an ozone monitor. Because NO₂ has a much lower absorption cross section than ozone, a folded cell with corner mirrors is used to produce a long absorbance path of ~2 m to achieve approximately the same sensitivity for NO₂ as we do for ozone in our UV-absorbance-based ozone monitors. (See our [published paper](#) on the folded tubular photometer.) The wavelength of 405 nm was chosen because no other species found in ambient air has significant absorbance at that wavelength, making the Model 405 nm extremely selective for NO₂.

The Model 405 nm NO_x Monitor is approved as a U.S. EPA Federal Equivalent Method (FEM) for the criteria pollutant NO₂, [EQNA-0217-243](#). SD card data logging is now a standard feature.

Theory of Operation

The following figure is a simplified schematic diagram of the Model 405 nm NO_x Monitor. Sample air is continuously drawn through the instrument by an air pump at a flow rate of ~2 L/min. The Scrubber Valve alternately bypasses and sends the sample air through a NO₂ scrubber to remove all NO₂ in the sample, thus allowing the measurement of a light intensity in the absence (*I*₀) of NO₂ and presence (*I*) of NO₂. The Beer-Lambert Law is then used to calculate the concentration of NO₂ from *I* and *I*₀.

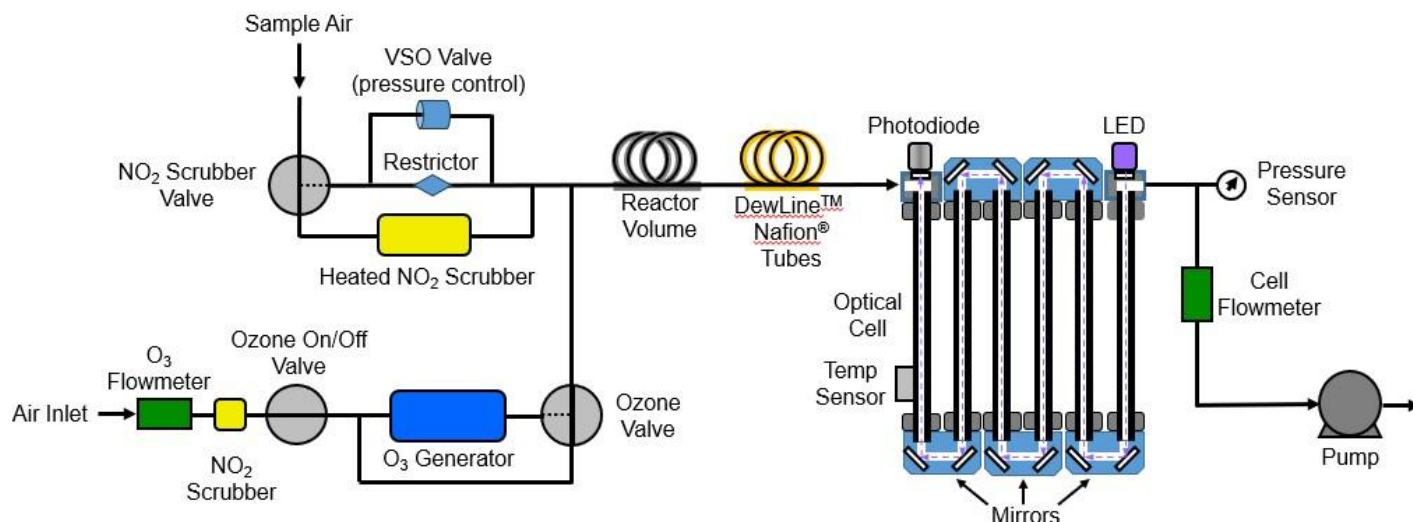


Fig. 1. Simplified schematic diagram of the Model 405 nm NO₂/NO/NO_x Monitor.

Nitric oxide is measured by bypassing the NO₂ Scrubber and measuring the light intensity while adding (*I*) or not adding (*I*₀) ozone to convert NO to NO₂ according to the reaction:



As in our ozone monitors, a Nafion tube (the DewLine™) is used to equilibrate humidity during *I* and *I*₀ measurements, so that any water vapor interference due to refractive effects is eliminated.

NO_x is obtained by adding the measurements of NO₂ and NO. The instrument may be operated in continuous NO₂, or NO mode, or in a mode where NO₂ and NO are alternately measured, once every 20 seconds.

Features

- Direct measurement of NO₂ (absorbance at 405 nm) gives extreme selectivity for NO₂
- Measurement of NO₂ over the range 0-10 ppm, NO over the range 0-2 ppm, and NO_x
- FEM for NO₂ over the range 0-500 ppb and 20-30°C operating temperature range
- Three measurement modes: NO₂ only; NO only; NO, NO₂, and NO_x
- Power consumption: ~16 watts after warmup
- Long-life pump (~15,000 hours)
- Flash memory (SD card) for virtually unlimited, portable data logging
- Internal data logger (EEPROM) logs 8,192 lines of data
- Both serial and user-scalable analog voltage outputs for NO and NO₂
- Convenient user interface to microprocessor, including calibration parameters (gain and zero)
- Selectable measurement time of 5 s or data averaging times of 1 min, 5 min and 1 hr
- Selectable units for NO₂, NO, NO_x
- DewLine™ for elimination of any water vapor interference, a unique feature of 2B Tech instruments

Specifications

Principle of Measurement	Direct absorbance of NO ₂ at 405 nm
Certifications	U.S.: EPA Federal Equivalent Method (FEM) for NO ₂ (0-500 ppb, 20-30°C), EQNA-0217-243 CE
Measurement Modes	NO ₂ only; NO only; NO, NO ₂ and NO _x
Linear Dynamic Range	0-10,000 ppb (0-10 ppm) for NO ₂ ; 0-2,000 ppb (0-2 ppm) for NO. FEM-approved for 0-500 ppb NO ₂ from 20-30°C.
Resolution	0.1 ppb
Precision (1σ; rms noise)	< 0.5 ppb or 0.5% of reading (with adaptive filter ¹)
Accuracy	Greater of 2 ppb or 2% of reading
Limit of Detection (2σ)	< 1 ppb (with adaptive filter ¹)
Flow Rate (nominal)	1.5 Liter/min
Flow Rate Requirement	Minimum: 1.4 Liter/min; Maximum: 1.6 Liter/min
Response Time, 100% of Step Change	10 s for 5-s averaging 20 s with adaptive filter ¹
Measurement Frequency	0.2 Hz (once every 5 s)
Averaging Times	5 s, 1 min, 5 min, 1 hr
SD Data Logger Capacity	Minimum 2 GB (>2-year capacity for 5-s measurement mode)

Internal Data Logger Capacity	8,192 lines (5-s avg = 0.47 days; 1-min avg = 5.7 days; 5-min avg = 1.0 mo; 1-hr avg = 0.94 yr)
Concentration Units	ppb, pphm, ppm
Pressure, Temperature Units	mbar, °C
T and P Corrected	Yes
Operating Temperature Range	10 to 50°C (FEM approval for NO ₂ for 20-30°C)
Power Requirement	11-14 V dc or 120/240 V ac, 1.4 A at 12 V, 17 watt Max: 2.9 A at 12 V, 35 watt (warmup)
Size	Rackmount: 17" w × 14.5" d × 5.5" h (43 × 37 × 14 cm)
Weight	18.6 lb. (8.4 kg)
Data Outputs	LCD; RS232; SD card; 0-2.5 V Analog Outputs for NO and for NO ₂
Data Transfer Baud Rates	2400, 4800, 19200
Output Ranges	User-defined scaling factor in menu
DewLine™	Yes
Long Life Pump	Yes: 15,000 hr, 1.7 yr of continuous operation
Flow Meter	Yes

¹ An adaptive filter may be selected from the menu, making signal averaging similar to competing NO_x monitors. Specifications above are for default parameters: Change Difference = 40 ppb, Change Percent = 10%, Short Filter = 4 pts (20 s), Long Filter = 36 pts (3 min). Adaptive filter parameters may be adjusted by the user.

System Includes

- Model 405 nm NO₂/NO/NO_x Monitor
- 5A Power Adapter (5 amp, 100-240 VAC to 12 VDC) with select power cord
- Serial Port Cable (9PinF-9PinF)
- External (Zero) Nafion Assembly
- SD Card and SD Card Reader
- Operation Manual on USB Stick
- Calibration Data and NIST-Traceable Calibration Certificate
- Instrument Birth Certificate
- One-Year Warranty

Model 306 Ozone Calibration Source™



The 2B Technologies Model 306 Ozone Calibration Source™ is a portable source of ozone that allows you to calibrate any ozone monitor - not just those manufactured by 2B Tech. The instrument scrubs ozone from ambient air and produces any mixing ratio of ozone in the range 30 to 1,000 ppbv. The desired ozone concentration is chosen from the easy-to-use menu using a rotary select switch. The total output flow rate is in the range 3.0–3.2 L/min volumetric, and the ozone mixing ratio is controlled so as to be independent of ambient temperature, pressure, and humidity. You can attach the Ozone Calibration Source (OCS™) output directly to the inlet of any ozone monitor; the excess flow is vented through an ozone scrubber internal to the OCS. Although the instrument comes calibrated against a NIST-traceable ozone standard, the menu allows the user to change the calibration parameters of the ozone output if desired. For example, if you maintain an ozone reference instrument in the lab, you can use the OCS as a transfer standard for calibrating ozone instruments in the field relative to your lab standard. A scheduler feature allows you to schedule an autocalibration once daily.

The Ozone Cal Source™ is housed in the same small, rugged instrument case as the 2B Technologies Model 202 and Model 205 Ozone Monitors™.

Some applications of the Model 306 Ozone Calibration Source™ include:

- Calibration of ozone monitors in the field. This highly portable transfer standard is especially useful for maintaining the calibrations of networks of ozone monitors.
- Testing of materials such as rubber, plastics, and paint for effects of ozone exposure.
- Studies of the effect of ozone on plants where a calibrated source of ozone is required.

Example Data

Data were obtained for the calibration of a Model 202 Ozone Monitor, which had previously been calibrated against our NIST-traceable standard instrument. New target ozone concentrations were entered into the Ozone Cal Source every 5 minutes. As can be seen from the data, the new ozone concentrations are reached within 3 data points (30 s). Concentrations were stepped up and down twice to produce 4 calibration plots. Target ozone mixing ratios were 0, 50, 100, 200, 400, 600, 800 and 1,000 ppbv. There is an extra measurement at 150 ppbv in the rise side of the first set of "stairs."

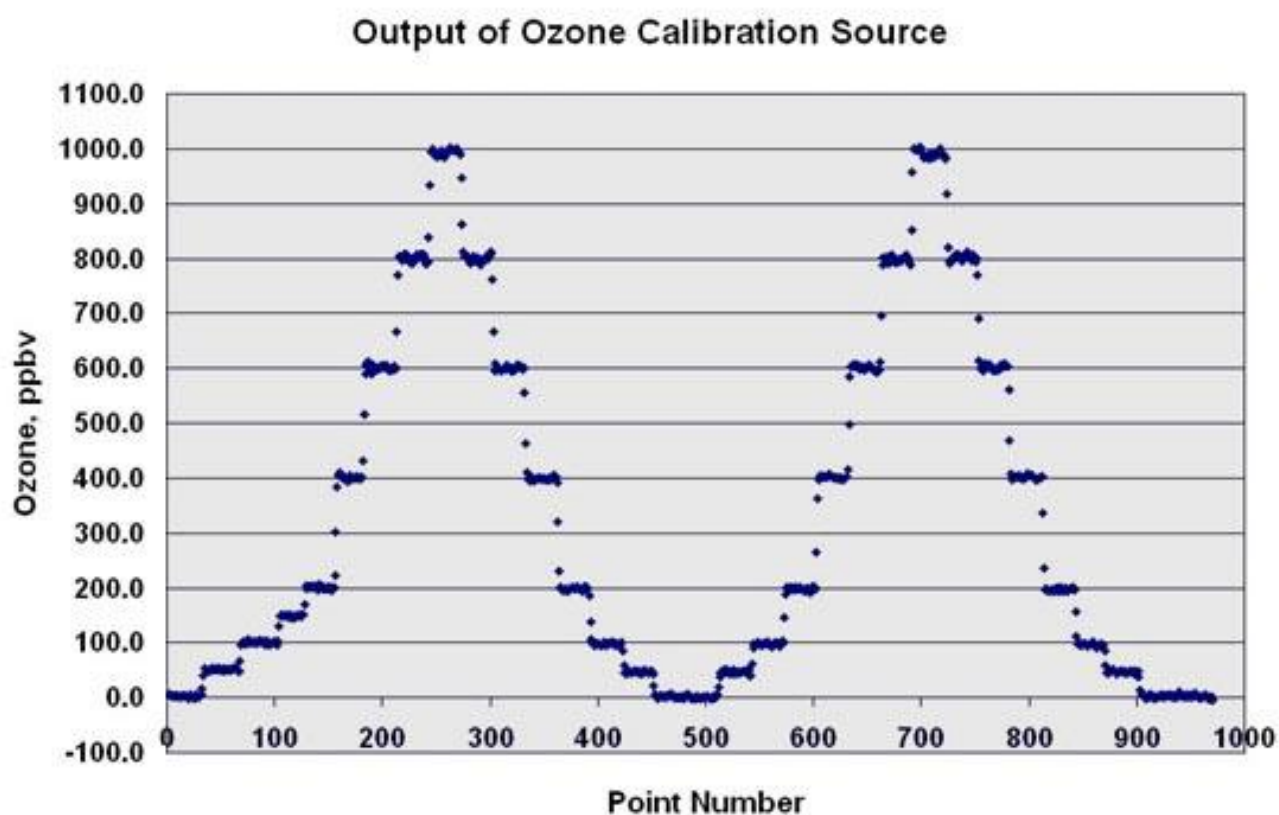


Fig.1. Measured ozone concentrations for "stair step" changes in Ozone Calibration Source Output.

The following figure shows the four calibration curves produced from the four sets of increasing and decreasing ozone concentrations. The data points and lines for the 4 least squares fits, which are plotted in different colors, overlap so well that it is difficult to distinguish them. The equations for the linear regressions show that the slopes of the four individual calibration curves agree to better than $\pm 1\%$ and the intercepts agree to ± 2 ppbv. Correlation coefficients (R^2) are all 0.9999 or 1.0000. Please also see our [published paper](#) on the Model 306.

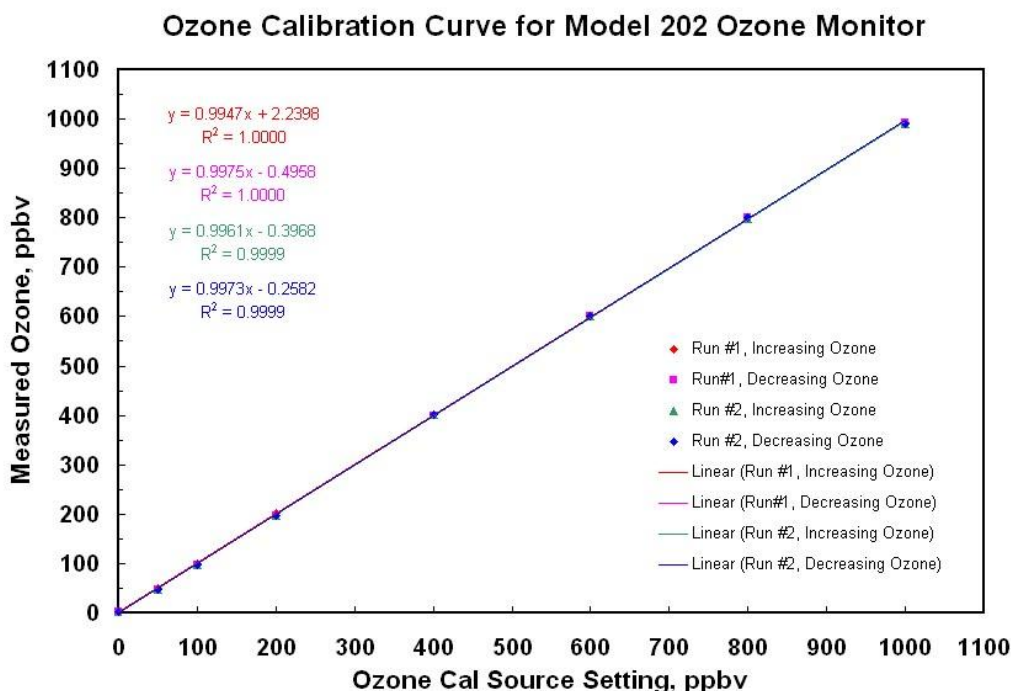


Fig. 2. Calibration curves established from data of Fig. 2. Click [here](#) for an enlarged image.

Specifications

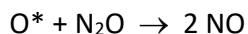
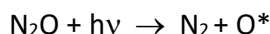
Method of Ozone Production	UV Photolysis of O ₂ at 185 nm
Ozone Concentration Range	0 ppbv and 30 ppbv to 1,000 ppbv
Precision and Accuracy of Output	Greater of 2 ppbv or 2% of ozone concentration
Response Time for Change in Ozone Output Concentration	30 s to reach 95% of concentration change
Flow Rate Range	3.0–3.2 Liter/min volumetric
Power Requirements	12 V dc or 120/240 V ac, 18 watt
Size	3.5 × 8.5 × 11 inches (9 × 21 × 29 cm)
Weight	5.6 lb (2.6 kg)
Autocalibration Scheduler	Yes; once-daily autocalibration function
Certification	CE

Model 714 NO₂/NO/O₃ Calibration Source



Calibrate 3 Gases Using One Convenient Instrument

The Model 714 NO₂/NO/O₃ Calibration Source™ combines our Model 408 Nitric Oxide Calibration Source™ with our Model 306 Ozone Calibration Source™ to provide a highly portable transfer standard for three pollutant gases without the need for a compressed cylinder of nitric oxide. Calibrated concentrations of O₃ are produced by photolysis of oxygen in scrubbed ambient air, and calibrated concentrations of NO are produced by photolysis of nitrous oxide, N₂O, via a patented process,



where O* is electronically excited oxygen atoms, O(¹D₂) ([U.S. Patent No. 10,207,927](https://www.uspto.gov/patent/publications/10207927)). In addition, calibrated concentrations of NO₂ are produced by gas phase titration (GPT) of NO with O₃ using the same method as conventional GPT NO/NO₂ calibrators. The concentrations of all three pollutant gases are directly traceable to the NIST photometric standard for ozone – eliminating uncertainties associated with the stability of nitric oxide standards.

Nitrous oxide is provided by disposable 8 or 16 oz cartridges typically used for making whipped cream, eliminating the requirement for a compressed gas cylinder and thereby enhancing safety and portability. The Model 714 is designed to accompany sales of our new FEM Model 405 nm NO₂/NO/NO_x Monitor and replace current calibration systems for all ozone, NO and NO₂ monitors. The Model 714, which has an intuitive touch screen user interface and capability for remote operation, is provided in a rack mount-sized instrument case matching that of the Model 405 nm.



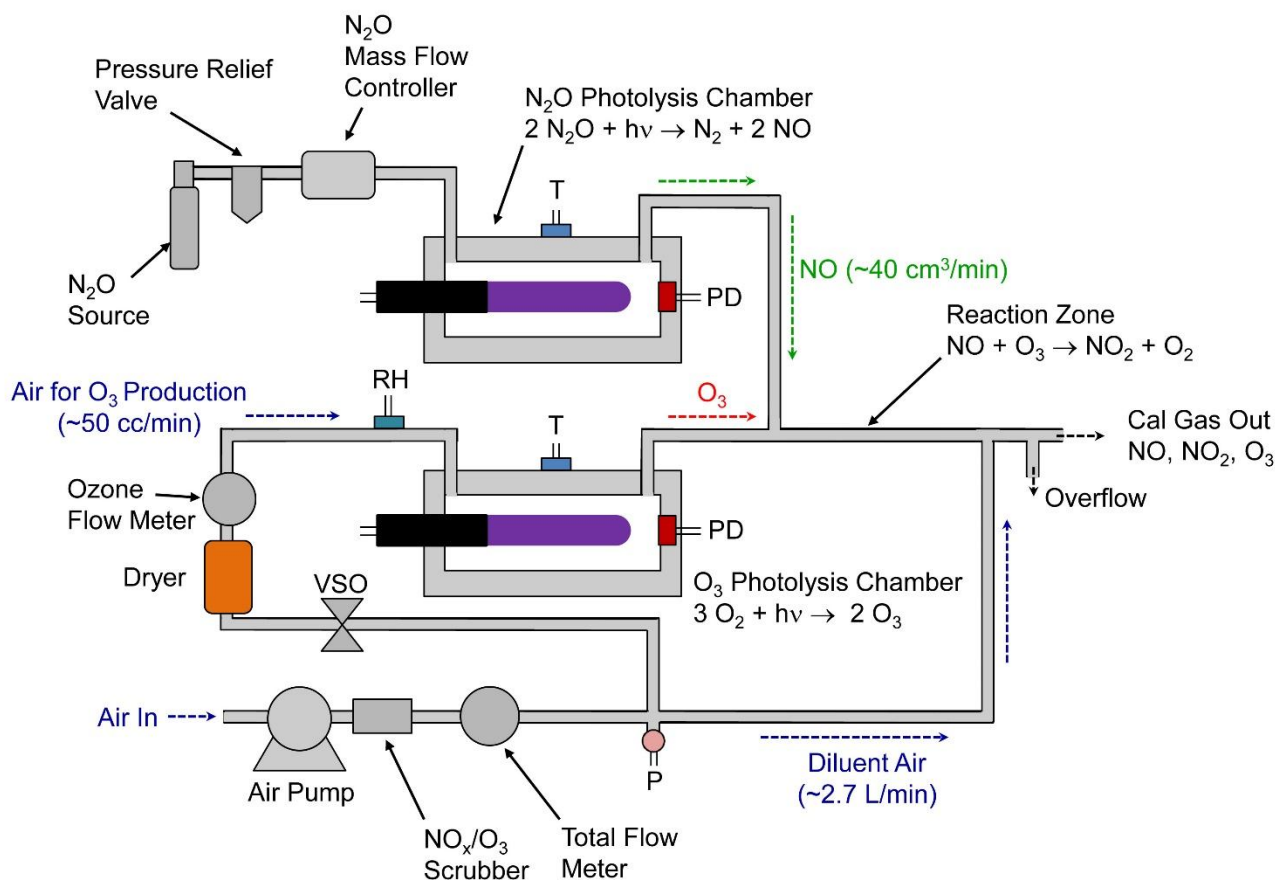
Small and inexpensive N₂O cartridges for your calibrations!

Specifications: Model 714 NO₂/NO/O₃ Calibration Source

Method of NO Production	UV photolysis of Nitrous Oxide (N ₂ O) at 185 nm
Method of O ₃ Production	UV photolysis of Oxygen (O ₂) at 185 nm
Method of NO ₂ Production	Reaction of O ₃ with excess NO (gas-phase titration, GPT)
NO ₂ Concentration Range	0–500 parts per billion by volume (ppb)
O ₃ Concentration Range	0–500 ppb
NO Concentration Range	0–1000 ppb
Output Flow Rate	~2.0 to 2.7 L/min volumetric (2.5–2.7 typical)
Precision and Accuracy	Greater of 2.0 ppb or 2.0% of NO or O ₃ concentration
Response Time for Change in Calibrant Gas Output Concentration	< 30 s to reach 95% of selected concentration
Input and Output	Touch Screen LCD Display
Dimensions	Rackmount: 17" w × 14.5" d × 5.5" h (43 × 37 × 14 cm)
Weight	16.6 lb (7.53 kg)
Power Requirements	120/240 V AC with 5-amp power pack, or 12V DC; Run, O ₃ channel: 0.91–2.79 A at 12V, 11–34 watt Run, NO channel: 1.16–3.10 A at 12 V, 14–38 watt Warmup Max: 3.38 A at 12V, 40.6 watt
Programmable Calibrated Gas Output	Yes, up to 99 different repeatable sequences may be specified by the user for NO, NO ₂ or O ₃ output, with up to 15 steps for each sequence from 0 to 500 ppb for O ₃ and NO ₂ (1000 ppb for NO); stored in internal memory
Remote Operation Capability	Yes, Modbus, via Ethernet TCP/IP and 2B Tech software tool
Transportation and Temperature Storage Ranges	–20°C to 60°C
Certifications	CE

Theory of Operation

The Model 714 NO₂/NO/O₃ Calibration Source combines the 2B Technologies Model 306 Ozone Calibration Source™ and the Model 408 Nitric Oxide Calibration Source™ to produce calibrated sources of O₃, NO and NO₂. The Model 714 makes use of two low-pressure mercury lamps, one to photolyze oxygen to produce O₃, and a second lamp to photolyze nitrous oxide (N₂O) to produce NO. Nitrogen dioxide is produced in the stoichiometric reaction of O₃ with excess NO to convert NO to NO₂. We recently [published a journal article](#) describing the Model 714 NO₂/NO/O₃ Calibration Source: Portable calibrator for NO based on the photolysis of N₂O and a combined NO₂/NO/O₃ source for field calibrations of air pollution monitors, *Atmospheric Measurement Techniques* (2020), **13**, 1001-1018. A schematic of the Model 714 is shown below:



For the production of ozone, a small flow of scrubbed and dried ambient air is directed into the O₃ photolysis chamber (lower part of the diagram). The vacuum UV emission lines of a low-pressure mercury lamp near 185 nm are absorbed by O₂ to produce oxygen atoms, and the oxygen atoms rapidly attach to O₂ via a collisionally stabilized reaction to form O₃. The well-known mechanism, which also is responsible for the presence of Earth's protective ozone layer, is as follows:



where $h\nu$ symbolizes a photon of light and M is any molecule (e.g., N_2 , O_2 , H_2O , Ar) that removes the energy released in reaction (2). The concentration of O_3 produced in a flowing stream of air depends on the intensity of the photolysis lamp, the concentration of oxygen (determined by pressure and temperature), and the residence time in the photolysis cell (determined by volumetric flow rate and cell volume). By holding these parameters constant, it is possible to produce a flow of air containing a constant concentration of O_3 , and the concentration of O_3 produced can be varied most conveniently by varying the lamp intensity. An in-line dryer reduces the humidity of the air stream and enables more precise control of ozone produced in the photolysis chamber.

For the production of NO, a mass flow controller (MFC) directs a ~40 cc/min flow of nitrous oxide from an N_2O cartridge or gas cylinder into the N_2O photolysis chamber (upper part of diagram). The vacuum UV emission lines of a low-pressure mercury lamp near 185 nm are absorbed by N_2O to produce electronically excited oxygen atoms, $\text{O}(^1\text{D}_2)$. A large fraction (~59%) of these highly energetic oxygen atoms react with N_2O to form NO:



where the term $h\nu$ represents a photon of light. As for ozone, and the concentration of NO produced can be varied most conveniently by varying the lamp intensity. The nitrous oxide can be supplied by a 16-g or 8-g disposable cartridge (e.g., Whip-It or other whipped cream charger) in the Model 714's Portable N_2O Source, thereby eliminating the need for a compressed gas cylinder. (A compressed gas cylinder can be used if desired.)

For the production of nitrogen dioxide, a known concentration of O_3 is reacted with a large excess of NO according to the reaction:



The NO stream combines with the O_3 stream in the Reaction Zone. In order to avoid complications from secondary reactions, nitric oxide is always generated in excess to completely consume all of the O_3 . The concentration of NO_2 produced is equal to the initial ozone concentration. This method of producing known amounts NO_2 equal to the amount of ozone added has long been referred to as the "gas phase titration" (GPT) method. The calibrated NO_2 stream will therefore also contain the excess NO.

By powering the appropriate lamp, one can choose to produce only a calibrated amount of NO, only a calibrated amount of O_3 , or one can power both lamps simultaneously to produce a calibrated amount of NO_2 .

Remote operation of the Model 714 can be accomplished via a Modbus TCP/IP interface through an Ethernet connection to a computer. A free software tool developed by 2B Tech is used in implementing remote operation, a feature that makes it possible for the user to adjust the parameters of the Model 714 during runtime and carry out calibrations without being co-located with the instrument.

Features

- Calibrate for NO, NO₂, or O₃ using one instrument
- Low average power consumption
- Lightweight (~16.6 lb, 7.53 kg), standard rack-mount size
- Convenient touch screen user interface
- Program up to 99 different sequences, stored in internal memory
- A sequence can have up to 15 steps and can be repeated up to 99 times
- Portable N₂O Source eliminates the need for compressed gas cylinders
- Economical, replacing the use of multiple other commercially available instruments
- Capability for remote operation, enabling adjustments and calibrations when not co-located with the instrument

System Includes

- Model 714 NO₂/NO/O₃ Calibration Source
- Power Adapter (5 amp, 100–240 VAC to 12 VDC) with select power cord
- [Patented](#) Portable N₂O Source
- Model 714 Dryer
- External Overflow Scrubber
- Operation Manual on USB Stick
- Downloadable Software Tool for Remote Operation
- Calibration Data and NIST-Traceable Calibration Certificate
- Instrument Birth Certificate
- One-Year Warranty