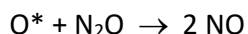
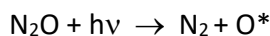


Model 714 NO₂/NO/O₃ Calibration Source



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](#)). 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.



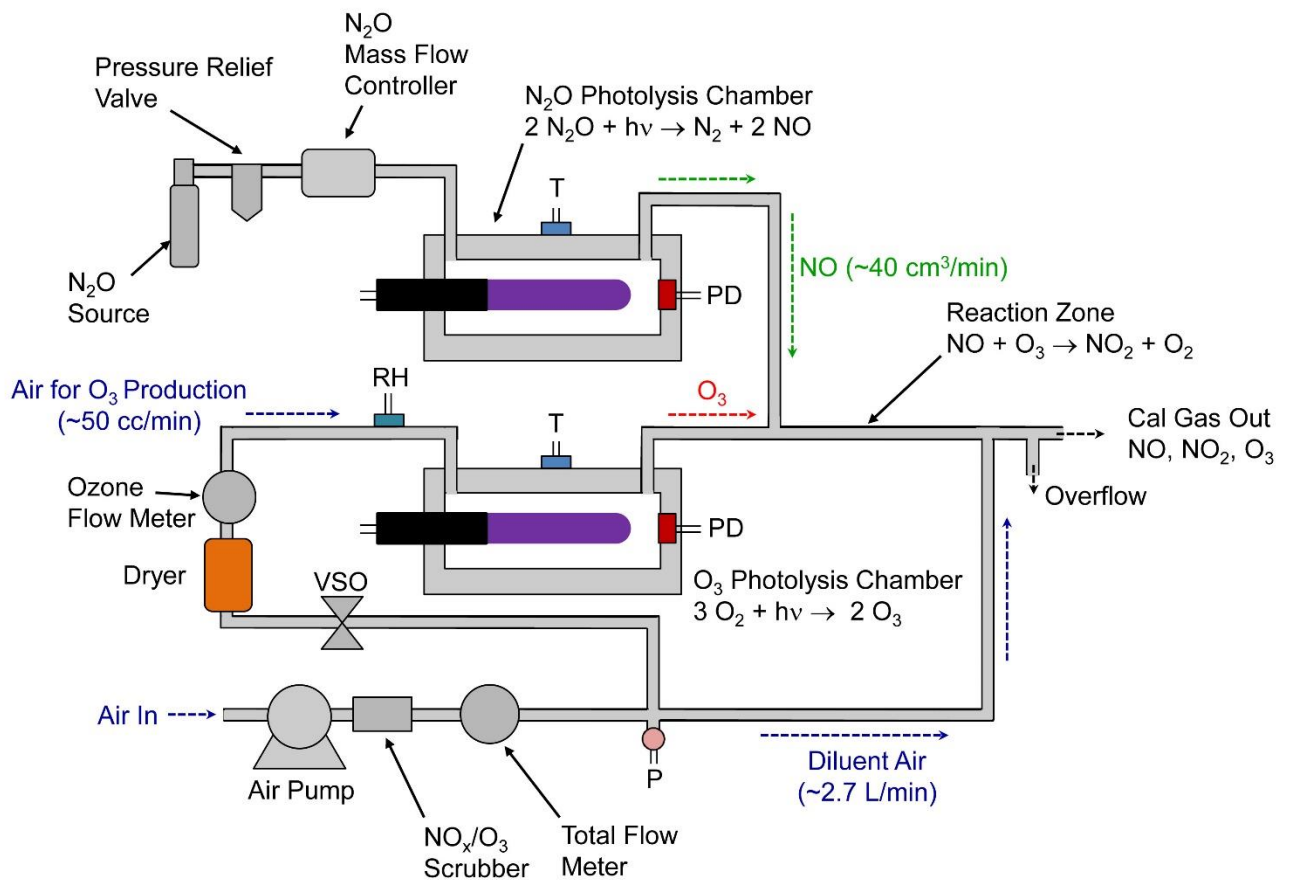
Small and inexpensive N₂O cartridges for your calibrations!

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 O₃ Production	UV photolysis of Oxygen (O ₂) at 185 nm
Method of NO₂ Production	Reaction of O ₃ with excess NO (gas-phase titration, GPT)
NO₂ Concentration Range	0–500 parts per billion by volume (ppb)
O₃ 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

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 ($\sim 59\%$) 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