



TELEDYNE
ADVANCED POLLUTION INSTRUMENTATION
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ADDENDUM

MODEL T750U CALIBRATOR

(Addendum to the T750 Operation Manual, P/N 08070)

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SAFETY MESSAGES

Important safety messages are provided throughout this manual for the purpose of avoiding personal injury or instrument damage. Please read these messages carefully. Each safety message is associated with a safety alert symbol, and are placed throughout this manual and inside the instrument. The symbols with messages are defined as follows:



WARNING: Electrical Shock Hazard



HAZARD: Strong oxidizer



GENERAL WARNING/CAUTION: Read the accompanying message for specific information.



CAUTION: Hot Surface Warning



Do Not Touch: Touching some parts of the instrument without protection or proper tools could result in damage to the part(s) and/or the instrument.



Technician Symbol: All operations marked with this symbol are to be performed by qualified maintenance personnel only.



Electrical Ground: This symbol inside the instrument marks the central safety grounding point for the instrument.

CAUTION



This instrument should only be used for the purpose and in the manner described in this manual. If you use this instrument in a manner other than that for which it was intended, unpredictable behavior could ensue with possible hazardous consequences.

NEVER use any gas analyzer to sample combustible gas(es).

Note

Technical Assistance regarding the use and maintenance of this instrument or any other Teledyne API product can be obtained by contacting Teledyne API's Customer Service Department:

Telephone: 800-324-5190

Email: api-customerservice@teledyne.com

or by accessing various service options on our website at <http://www.teledyne-api.com/>

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ABOUT THIS MANUAL

This manual is intended for use in conjunction with the Model T750 Dynamic Dilution Calibrator Operation Manual, part number 08070.

REVISION HISTORY

Date	Rev	DCN	Change Summary
2015 Jan 30	A	7051	Initial Release

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1. OVERVIEW

This addendum supplements the T750 Operation Manual, PN 08070, with details specific to the operation of the T750U portable calibrator. The T750U is a modified version of the T750 portable calibrator, equipped with a special ozone generator capable of producing stable ozone concentrations for Gas Phase Titration (GPT) calibrations and Ozone generation at much lower levels than the standard T750.

2. T750U SPECIFICATIONS

Table 2-1: Dilution System

Parameter	Specification
Flow Measurement Accuracy	± 1.0% full Scale
Repeatability of Flow Control	± 0.2% full Scale
Linearity of Flow Measurements	± 0.5% full Scale
Flow Range of Diluent Air	0 to 10 SLPM
Flow Range of Cylinder Gases	0 to 200 cc/min
Zero Air Requirements	10 SLPM @ 30 psi Optional: 20 SLPM @ 30 psi
CAL Gas Input Port	1 (configurable)
Diluent Gas Input Port	1

Table 2-2: NO₂ Generation (GPT modes)

Parameter	Specification
Minimum Output	20 ppb LPM
Minimum Concentration:	3 ppb
Precision	± 2.0% (with GPTPS)

Table 2-3: Ozone Generator Module

Parameter	Specification
Maximum Output	4.5 ppm LPM
Minimum Output	20 ppb LPM
Minimum Ozone Concentration	3 ppb
Response Time	180 seconds to 98%
Optical Feedback	Standard

Table 2-4: UV Photometer Option

Parameter	Specification
Range	100 ppb to 10 ppm (selectable)
Precision	1.0 ppb
Linearity	1.0% of reading
Rise/Fall Time	<20 seconds (photometer response)
Response Time	180 seconds to 95% (system response)
Zero Drift	<1.0 ppb / 24 hours

Table 2-5: Electrical and Physical Specifications

Parameter	Specification	
AC Power	Rating 100-240 V~ 50/60 Hz, 1.5 A	Typical Power Consumption 115 V: 76 W 230 V: 80 W
Analog Outputs	1 user configurable output	
Analog Output Ranges (Test Channel)	10V, 5V, 1V, 0.1V (selectable)	
Analog Output Resolution	1 part in 4096 of selected full-scale voltage (12 bit)	
Standard I/O	1 Ethernet: 10/100Base-T 2 RS-232 (300 – 115,200 baud) 2 USB device ports 12 digital control outputs 12 digital control inputs 8 digital status outputs	
Optional I/O	1 USB com port 1 RS485 Multidrop RS232	
Operating Temperature Range	5-40°C	
Humidity Range	0 - 95% RH, non-condensing	
Environmental Conditions	Installation Category (Over Voltage Category) II Pollution Degree 2 Intended for Indoor Use Only at Altitudes ≤ 2000m	
Dimensions (H x W x D)	9" x 17" x 21" (229 mm x 432 mm x 533 mm)	
Weight	46.6 lbs (21.14 kg) 3MFC 45.1 lbs (20.46 kg) 2MFC	

2.1. APPROVALS AND CERTIFICATIONS

The Teledyne API Model T750U portable calibrator was tested and certified for Safety and Electromagnet Compatibility (EMC). This section presents the compliance statements for those requirements and directives.

2.1.1. SAFETY

IEC/EN 61010-1:2010 (3rd Edition), Safety requirements for electrical equipment for measurement, control, and laboratory use.

CE: 2006/95/EC, Low-Voltage Directive

2.1.2. EMC

IEC/EN 61326-1, Class A Emissions/Industrial Immunity

EN55011 (CISPR 11), Group 1, Class A Emissions

FCC 47 CFR Part 15B, Class A Emissions

CE: 2004/108/EC, Electromagnetic Compatibility Directive

2.1.3. OTHER TYPE CERTIFICATIONS

For additional certifications, please contact Technical Support.

3. OPERATIONAL MODES

The T750U ozone generator is designed to operate in two modes: a high range mode, which gives similar performance as a standard T750 ozone generator, and a low range, or “fractional” mode for producing low levels of ozone during a GPT calibration.

The low range mode is supported in the following T750U Generation (GEN) modes:

- AUTO (when generating ozone)
- GPTPS
- GPT
- GPTZ (accessed from the GEN menu, see the T750 operator’s manual for more details.)

The selection of low range generator operation is made automatically by the T750U software, based on the O₃ concentration and total flow specified. For O₃ output < 500 PPB • LPM, the low range operation is invoked.

3.1. AUTO

The AUTO mode can be used to generate ozone as a calibration gas for performing calibrations and calibration checks on ambient ozone analyzers.

When generating very low levels of ozone, ensure that the concentration-flow product is kept above the 20 ppb*LPM minimum value. This value is the target concentration (in ppb) multiplied by the total flow value.

Example: To determine the minimum flow rate required to generate 3 ppb:

$$3 \text{ ppb} * X \text{ LPM} > 20 \text{ ppb} * \text{LPM}$$

or

$$X \text{ LPM} > (20 \text{ ppb} * \text{LPM}) / (3 \text{ ppb}) = 6.7 \text{ LPM}$$

Therefore, the flow rate should be a minimum of 6.7 LPM to generate 3 ppb.

These equations can be used to determine the minimum flow rate for any desired concentration.

3.2. GPTPS (GPT PRE-SET)

The GPTPS mode is used to fine-tune the ozone generator calibration to improve the accuracy of the O₃ concentration during a subsequent GPT. This function is only available if the optional O₃ photometer is installed in the instrument.

During a GPTPS calibration, the internal photometer is used to measure the O₃ output and the O₃ GEN DRIVE value is adjusted to achieve the specified O₃ concentration. Once the concentration has stabilized (as indicated by the ACTIVE LED switching from blinking to a solid lit state), the instrument will store the updated O₃ GEN DRIVE value for later use when performing an actual GPT.

The following parameters must be entered for GPTPS:

Parameter	Definition	Notes
NO Concentration (ppb)	NO concentration that will be used in subsequent GPT	During the GPTPS, there is no NO gas generated. Instead, zero air is allowed to flow through the dilution MFC at an increased flow rate to mimic the amount that would otherwise come from the Cal MFC. This is equivalent to the flow-rate that will be used during the GPT.
O3 Concentration	O3 concentration target	
Total Flow	Total output flow rate for subsequent GPT	The Total Flow parameter is used to calculate the Diluent flow required as follows: Diluent flow = Total Flow – O3 Gen Flow – NO Cal Gas Flow

The parameters entered for the GPTPS should be identical to the parameters that will be entered for the GPT. If a multi-point GPT is to run, then a separate GPTPS should be run for each O₃ concentration point.

3.2.1. GPTPS FREQUENCY

The GPTPS is an optional function used to increase the accuracy of the O₃ concentrations during a GPT. The GPTPS function is not required to be performed before each GPT; however, doing so will provide the best O₃ accuracy possible. If somewhat less precision can be tolerated from one GPT calibration to the next, then the GPTPS function can be run less frequently. The operator will need to determine the appropriate frequency based on their requirements.

3.3. GPTZ (GPT ZERO)

The GPTZ mode is used for obtaining the baseline NO and NO_x readings for calculating the NO_x converter efficiency. These readings are referred to as [NO]_{orig} and [NO_x]_{orig}, respectively in the EPA calibration guidelines.^{(1), (2)}

During GPTZ, NO gas is generated in the same manner as a GPT calibration, except that the O₃ generator lamp is un-energized, thus producing no O₃. This allows accurate measurement of the baseline NO and NO_x readings from the instrument under test.

3.3.1. GPTZ VS AUTO GENERATION MODES

It may appear that the GPTZ and AUTO Generation modes are performing the same function: generating NO cal gas at a specified concentration and flow rate. However, there is an important difference in the flow configuration of these two modes.

In GPTZ mode, the total flow includes flow from the (un-energized) O₃ generator. This flow is not directly measured by the calibrator. The O₃ generator flow is measured at the factory and programmed into the T750U and assumed to be constant thereafter. Since pressure and temperature changes between the factory cal and the customer's ambient conditions cannot be accounted for, there may be small discrepancies between the actual O₃ generator flow and the assumed flow that is used in the dilution calculations that the T750U performs. Since these small flow discrepancies are present in both the GPTZ and GPT modes, they do not affect the accuracy of the converter efficiency calculations.

For the best overall dilution accuracy, such as for span calibrations, the AUTO mode should still be used.

3.3.2. GPT

The GPT mode is used for performing the actual NO + O₃ titration used to produce the NO₂ test gas. This mode allows for the measurement of the [NO]_{rem} and [NO_x]_{rem} readings referred to in the EPA calibration guidelines^{(1), (2)}.

4. GPT SETUP

Careful consideration must be given to the various parameters involved in the setup of a GPT calibration, such as total flow, NO flow, NO concentration, O₃ concentration and NO gas bottle concentration.

These guidelines assume that the user has already established the target O₃ and NO concentrations based on other criteria.

4.1. FLOW SETUP

The following requirements should be used for determining total flow:

- Instrument's Flow Demand

The number and flow rate requirements of the instruments sampling from the output of the calibrator. The flow demand of all instruments connected to the test manifold, even those not directly involved in the testing, must be taken into account. The minimum output flow rate should be calculated as the sum of all instrument demand flows plus 10% minimum excess. ⁽¹⁾

- Target O₃ Concentration

The output flow must be chosen to keep the O₃ generator output above the minimum specification of 20 PPB LPM. The minimum flow rate (F_T) can then be calculated using the following equation:

$$F_T \geq \frac{20 \text{ppb} \cdot \text{LPM}}{O_3 \text{Conc}}$$

- NO Flow Requirements

To achieve a reasonable response time during the GPT and to satisfy the EPA requirement^{(1) (2)} that the residence time in the GPT reaction chamber be less than two minutes, the NO flow rate should be **greater than 40 cc/min**. Therefore, larger dilution flows may be required to achieve low concentrations of NO. An appropriate NO gas bottle concentration must be used in order to achieve this flow rate.

4.2. EXAMPLE GPT SEQUENCE

The following example shows the steps performed for a typical GPT calibration using the T750U. Note that this example assumes that a zero and span calibration has already been performed on the NO_x analyzer per EPA guidelines (1).

Gas Bottle: 1.0 PPM NO

Step	Generation Mode		Notes	Values Obtained for Converter Efficiency Calculations ⁽¹⁾
1	GEN-GPTPS		Optional step. Used to increase the accuracy of the O ₃ concentration during GPT generation mode.	N/A
	NO Conc	10 PPB		
	O ₃ Conc	8 PPB		
	Total Flow	8 SLPM		
	Target NO Flow (calculated by T750U)	80 SCCM		
2	GEN-AUTO-ZERO		Optional step. Used to verify zero calibration of NO _x analyzer.	N/A
	Total Flow	8 SLPM		
3	GEN-AUTO-GPT		Produces NO ₂ test gas using GPT with the ozone generator ON. The O ₃ lamp drive value is used from the previous GPTPS.	[NO] _{rem} , [NO _x] _{rem}
	NO Conc	10 PPB		
	O ₃ Conc	8 PPB		
	Total Flow	8 SLPM		
	Target NO Flow (calculated by T750U)	80 SCCM		
4	GEN-AUTO-GPTZ		Delivers NO gas only for determining baseline (“orig”) NO and NO _x values. Ozone generator is OFF.	[NO] _{orig} , [NO _x] _{orig}
	NO Conc	10 PPB		
	O ₃ Conc	8 PPB		
	Total Flow	8 SLPM		
	Target NO Flow (calculated by T750U)	80 SCCM		

4.3. TYPICAL NO_x ANALYZER RESPONSE

The chart below shows the typical response of a low level NO_x analyzer, such as a T200U, when subjected to the GPT sequence described above.

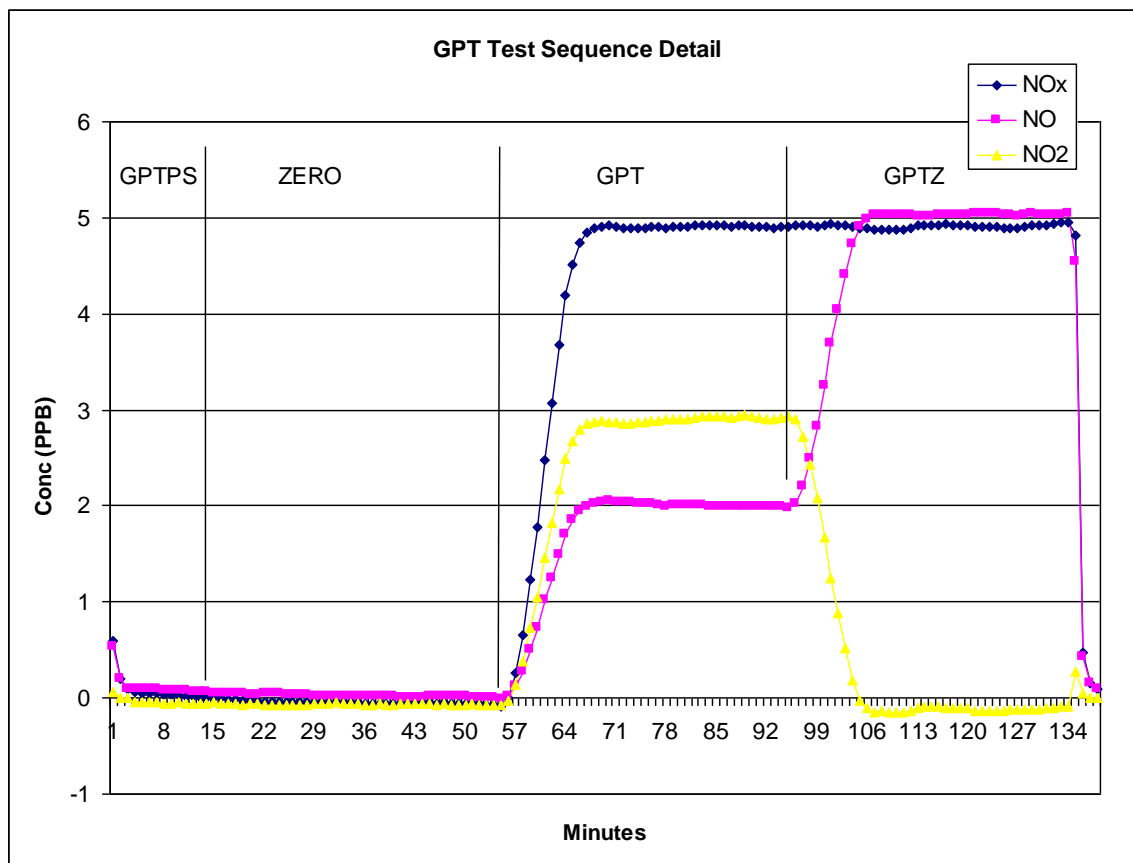


Figure 1. NO_x Analyzer Typical Response to GPT Test Sequence

5. PNEUMATIC DIAGRAMS

The pneumatic diagrams shown below can be used as an aid for troubleshooting.

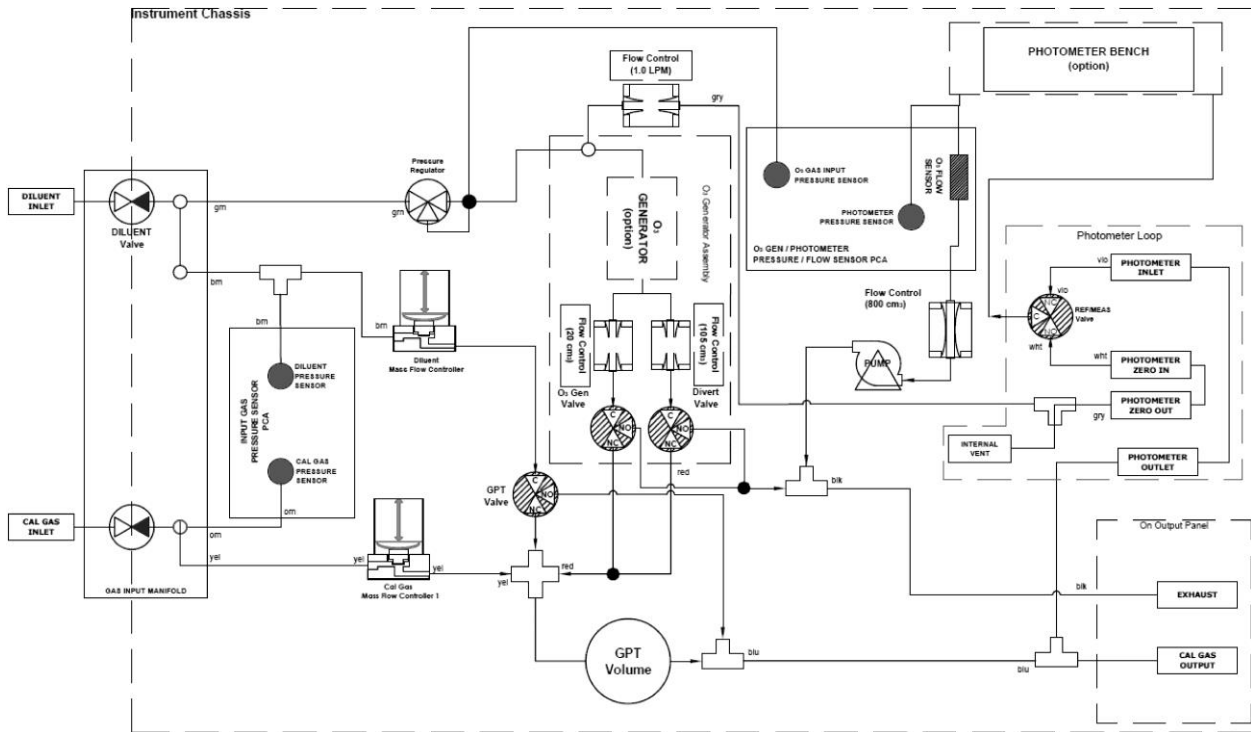


Figure 2. T750U Pneumatic Diagram, Base Configuration

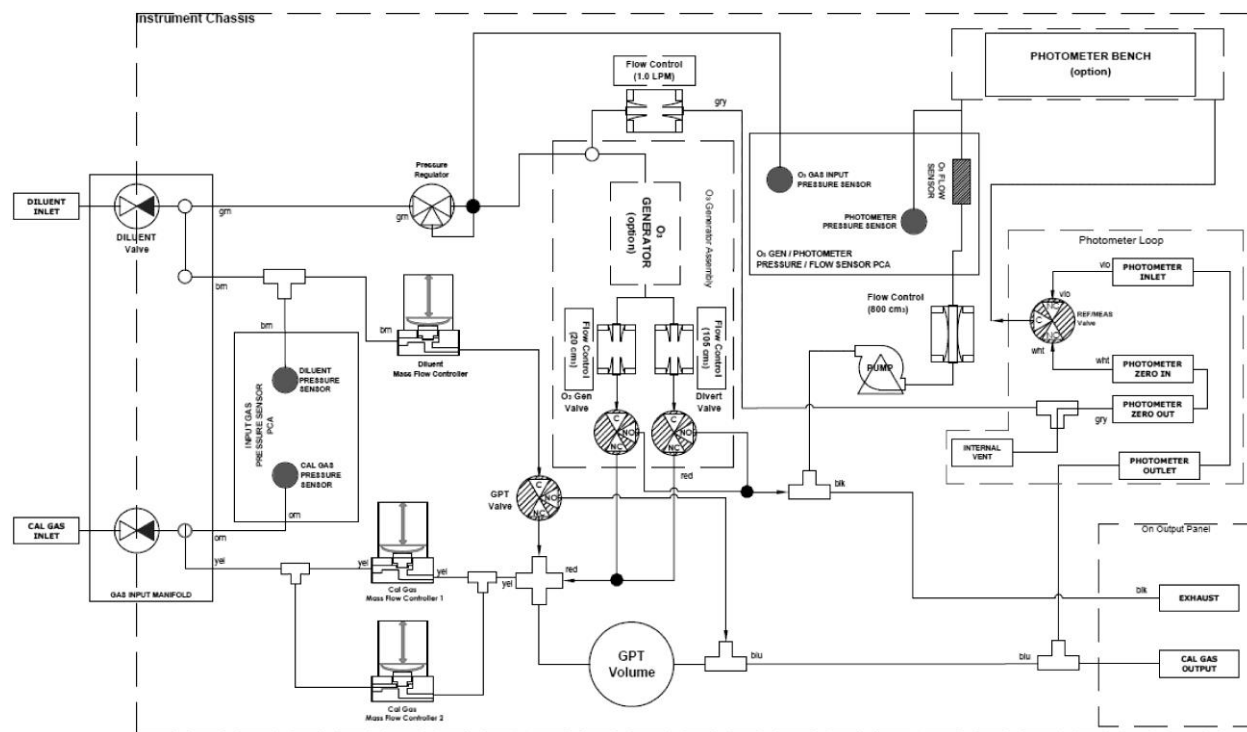


Figure 3. T750U Pneumatic Diagram, with Three MFC Option

6. REFERENCES

1. 40 CFR part 50 Appendix F, “Measurement Principle and Calibration Procedure for the Measurement of Nitrogen Dioxide in the Atmosphere (Gas Phase Chemiluminescence)”
2. E. C. Ellis, “Technical Assistance Document for the Chemiluminescence Measurement of Nitrogen Dioxide,” EPA-E600/4-75-003, Environmental Monitoring and Support Laboratory, Research Triangle Park, NC 27711.