



**TELEDYNE**  
**ADVANCED POLLUTION INSTRUMENTATION**  
A Teledyne Technologies Company

## **ADDENDUM**

# ***MODEL T700U CALIBRATOR***

**(Addendum to the T700 Operation Manual, P/N 06873)**

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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](mailto: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 T700 Dynamic Dilution Calibrator Operation Manual, part number 06873.

## REVISION HISTORY

06 October 2010				
Document	PN	Rev	DCN	Change Summary
T700U Addendum	06876	A	5858	Initial Release

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APPENDIX – Spare Parts List

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# 1. OVERVIEW

This addendum supplements the T700 Operation Manual, PN 06873, with details specific to the operation of the T700U calibrator. The T700U is a modified version of the T700 calibrator, equipped with a special ozone generator capable of producing stable ozone concentrations for Gas Phase Titration (GPT) calibrations at much lower levels than the standard T700.

# 2. SPECIFICATIONS

Minimum GPT O <sub>3</sub> Output	20 PPB • LPM*
Maximum GPT O <sub>3</sub> Output	6000 PPB • LPM*
Minimum GPT O <sub>3</sub> Concentration (at any flow rate)	3 PPB
* PPB • LPM refers to the product of the total output flow and the ozone concentration. For example: 20 PPB • LPM is equivalent to 20 PPB @ 1 LPM and 10 PPB @ 2 LPM and so forth.	

All other specifications are as listed in the T700 operator's manual.

# 3. OPERATIONAL MODES

The new T700U ozone generator is designed to operate in two modes: a high range mode, which gives similar performance as a standard T700 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 T700U Generation modes:

- GTPS
- GPT
- GPTZ (accessed from the GEN menu, see the T700 operator's manual for more details.)

The selection of low range generator operation is made automatically by the T700U software, based on the O<sub>3</sub> concentration and total flow specified. For O<sub>3</sub> output < 500 PPB • LPM, the low range operation is invoked.

### 3.1. GPTPS (GPT PRE-SET)

The GPTPS mode is used to fine-tune the ozone generator calibration to improve the accuracy of the O<sub>3</sub> concentration during a subsequent GPT. This function is only available if the optional O<sub>3</sub> photometer is installed in the instrument.

During a GPTPS calibration, the internal photometer is used to measure the O<sub>3</sub> output and the O<sub>3</sub> GEN DRIVE value is adjusted to achieve the specified O<sub>3</sub> concentration. Once the concentration has stabilized (as indicated by the ACTIVE led switching from a blinking state to a constant on state), the instrument will store the updated O<sub>3</sub> 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 cal gas MFC at the same flow-rate that will be used during the GPT.
O <sub>3</sub> Concentration	O <sub>3</sub> 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 – O <sub>3</sub> 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 O<sub>3</sub> concentration point.

#### 3.1.1. GPTPS FREQUENCY

The GPTPS is an optional function used to increase the accuracy of the O<sub>3</sub> concentrations during a GPT. The GPTPS function is not required to be performed before each GPT; however, doing so will provide the best O<sub>3</sub> 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.

## 3.2. GPTZ (GPT ZERO)

The GPTZ mode is used for obtaining the baseline NO and NO<sub>x</sub> readings for calculating the NO<sub>x</sub> converter efficiency. These readings are referred to as [NO]<sub>orig</sub> and [NO<sub>x</sub>]<sub>orig</sub>, respectively in the EPA calibration guidelines.<sup>(1), (2)</sup>

During GPTZ, NO gas is generated in the same manner as a GPT calibration, except that the O<sub>3</sub> generator lamp is un-energized, thus producing no O<sub>3</sub>. This allows accurate measurement of the baseline NO and NO<sub>x</sub> readings from the instrument under test.

### 3.2.1. 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) O<sub>3</sub> generator. This flow is not directly measured by the calibrator. The O<sub>3</sub> generator flow is measured at the factory and programmed into the T700U 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 O<sub>3</sub> generator flow and the assumed flow that is used in the dilution calculations that the T700U 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, for span calibrations for instance, the AUTO mode should still be used.

### 3.2.2. GPT

The GPT mode is used for performing the actual NO + O<sub>3</sub> titration used to produce the NO<sub>2</sub> test gas. This mode allows for the measurement of the [NO]<sub>rem</sub> and [NO<sub>x</sub>]<sub>rem</sub> readings referred to in the EPA calibration guidelines<sup>(1), (2)</sup>.

## 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, O<sub>3</sub> concentration and NO gas bottle concentration.

These guidelines assume that the user has already established the target O<sub>3</sub> 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. <sup>(1)</sup>

- Target O<sub>3</sub> Concentration

The output flow must be chosen to keep the O<sub>3</sub> generator output above the minimum specification of 20 PPB□LPM. The minimum flow rate (FT) 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<sup>(1) (2)</sup> that the residence time in the GPT reaction chamber be less than two minutes, the NO flow rate should be **greater than 45 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 T700U. Note that this example assumes that a zero and span calibration has already been performed on the NO<sub>x</sub> analyzer per EPA guidelines <sup>(1)</sup>.

### Gas Bottle: 1.0 PPM NO

Step	Generation Mode		Notes	Values Obtained for Converter Efficiency Calculations <sup>(1)</sup>
<b>1</b>	<b>GEN-GTPS</b>		Optional step. Used to increase the accuracy of the O <sub>3</sub> concentration during GPT generation mode.	N/A
	NO Conc	10 PPB		
	O <sub>3</sub> Conc	8 PPB		
	Total Flow	8 SLPM		
	Target NO Flow (calculated by T700U)	80 SCCM		
<b>2</b>	<b>GEN-AUTO-ZERO</b>		Optional step. Used to verify zero calibration of NO <sub>x</sub> analyzer.	N/A
	Total Flow	8 SLPM		
<b>3</b>	<b>GEN-AUTO-GPT</b>		Produces NO <sub>2</sub> test gas using GPT with the ozone generator ON. The O <sub>3</sub> lamp drive value is used from the previous GTPS.	[NO] <sub>rem</sub> , [NO <sub>x</sub> ] <sub>rem</sub>
	NO Conc	10 PPB		
	O <sub>3</sub> Conc	8 PPB		
	Total Flow	8 SLPM		
	Target NO Flow (calculated by T700U)	80 SCCM		
<b>4</b>	<b>GEN-AUTO-GPTZ</b>		Delivers NO gas only for determining baseline (“orig”) NO and NO <sub>x</sub> values. Ozone generator is OFF.	[NO] <sub>orig</sub> , [NO <sub>x</sub> ] <sub>orig</sub>
	NO Conc	10 PPB		
	O <sub>3</sub> Conc	8 PPB		
	Total Flow	8 SLPM		
	Target NO Flow (calculated by T700U)	80 SCCM		

## 5. TYPICAL NO<sub>x</sub> ANALYZER RESPONSE

The chart below shows the typical response of a low level NO<sub>x</sub> analyzer, such as a T200U, when subjected to the GPT sequence described above.

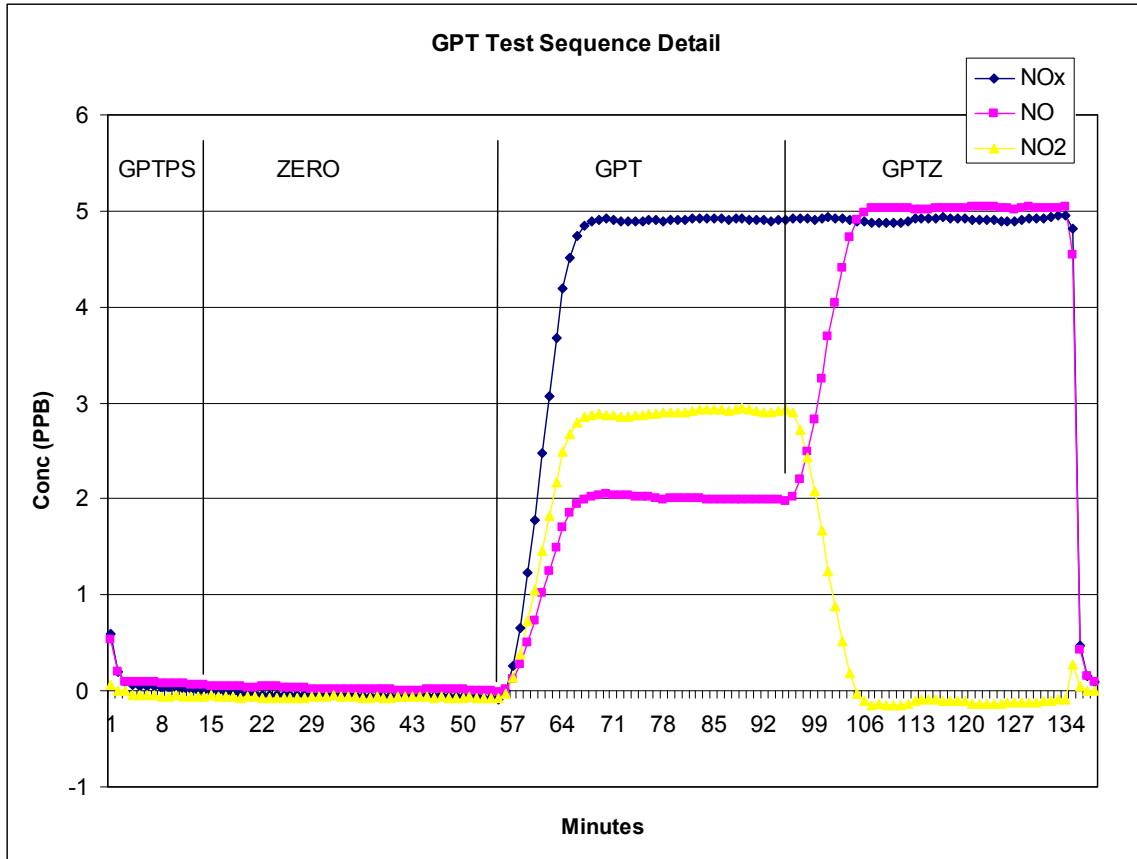


Figure 1. NO<sub>x</sub> Analyzer Typical Response to GPT Test Sequence

## 6. PNEUMATIC DIAGRAMS

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

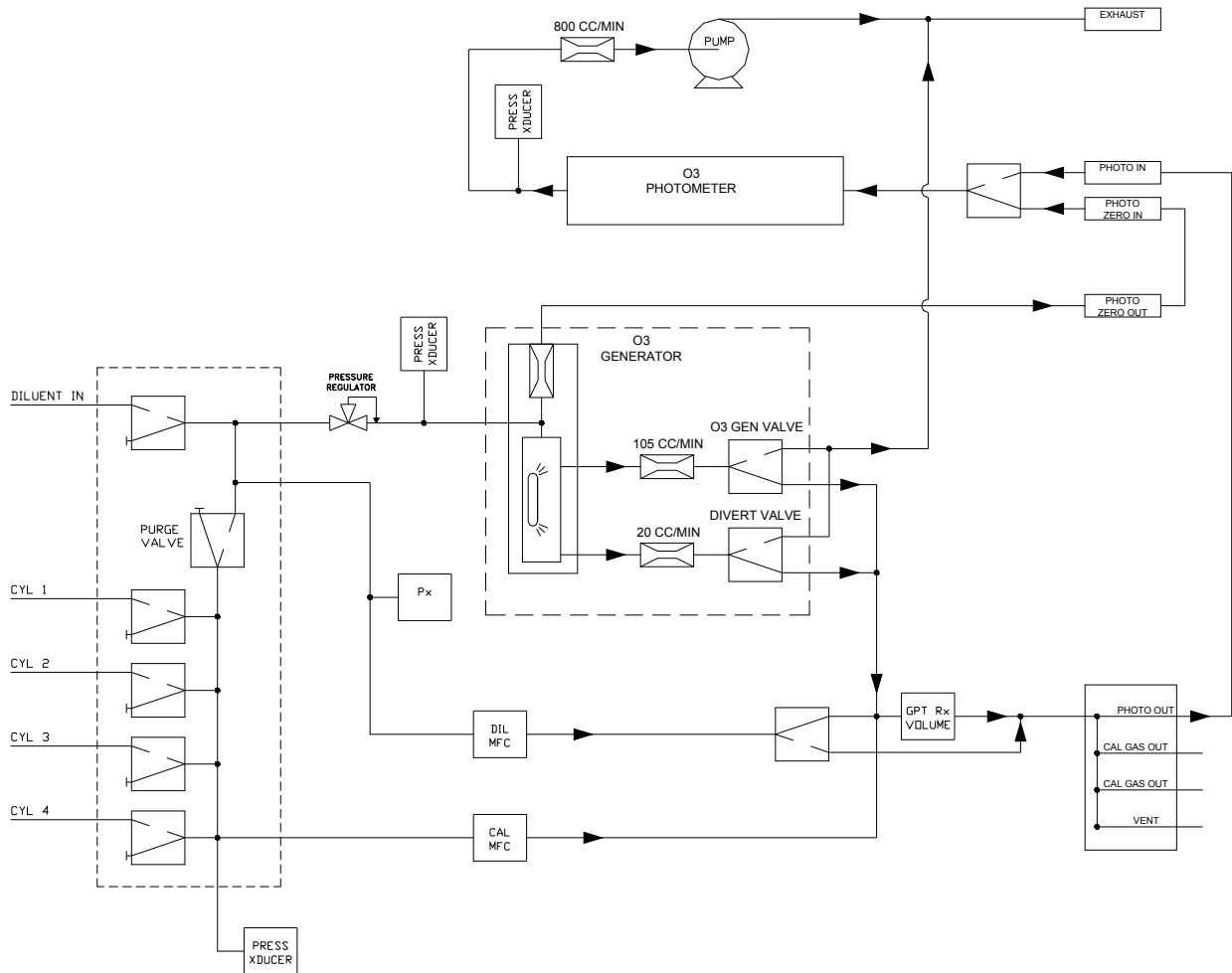


Figure 2. T700U Pneumatic Diagram, Base Configuration

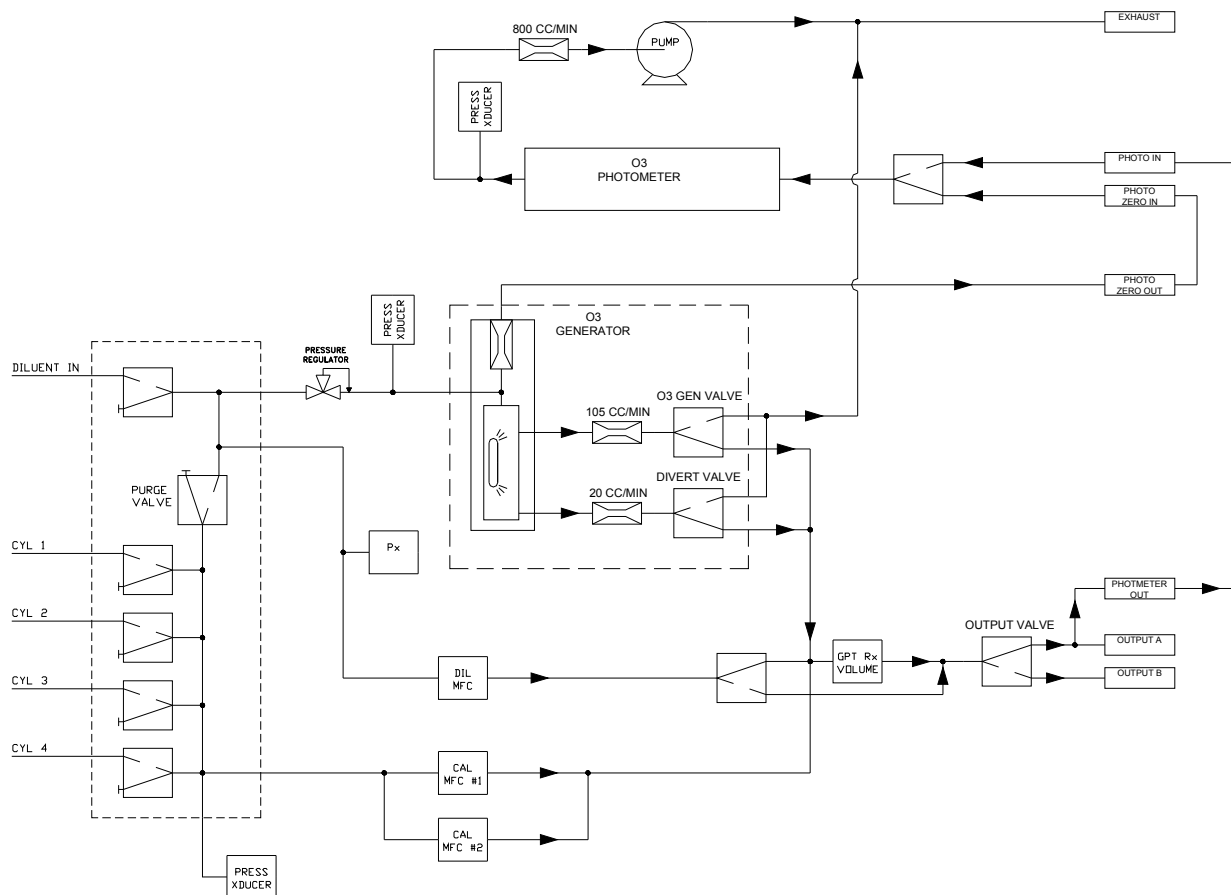


Figure 3. T700U Pneumatic Diagram, with Dual Output and Three MFC Options

## 7. 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.

## **APPENDIX - Spare Parts**

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**Note** Use of replacement parts other than those supplied by T-API may result in non compliance with European standard EN 61010-1.

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**Note** Due to the dynamic nature of part numbers, please refer to the Website or call Customer Service for more recent updates to part numbers.

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**T700U Spare Parts List**  
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Part Number	Description
000940100	ORIFICE, 3 MIL, O3 GEN
003290000	THERMISTOR, BASIC (VENDOR ASSY)(KB)
006120100	ASSY, UV LAMP, OZONE GENERATOR
014540300	CONTROLLER, MFC, HFC-212, 100SCCM *
014550300	CONTROLLER, MFC, HFC-212, 10 SLM *
014570100	ASSY, INLET MANIFOLD, (KB)
014900000	ASSY, GPT
016590100	ASSY, GPT VALVE
022710000	ABSORPTION TUBE, QUARTZ, (KB)
024710000	ASSY, TUBING, CLEAR FEP 1/8" (TU1), 6FT
024720000	ASSY, TUBING, (B/F) TU0000002, 6FT
024730000	ASSY, TUBING, TU0000005, 6FT
024750000	ASSY, TYGON TUBING (B/F) TU0000009, 6FT
040010000	ASSY, FAN REAR PANEL
040030500	PCA, PRESS SENSORS (2X)
040030600	PCA, PRESS SENSORS (1X), OZONE OPT
041200000	PCA, DET PREAMP w/OP20
041200200	PCA, DET PREAMP w/OP20
041240001	MANIFOLD, DETECTOR, (KB)
041270000	LAMP BLOCK, (KB)
041280000	LAMP SPACER, (KB)
041300000	EXHAUST MANIFOLD, (KB)
041440000	PCA, DC HEATER/TEMP SENSOR, OPTICAL BENCH
041660100	PCA, UV LAMP P/S, O3 GEN, *
042010000	ASSY, SAMPLE THERMISTOR
045230100	PCA, RELAY CARD
046740000	ASSY, PUMP, 12VDC (OP63)
048190300	ASSY, RELAY/PS, CAL
049290000	CLIP, THERMISTOR HOLDER
050490000	ASSY, O3 GENERATOR W/BRKT & REG
050500000	ASSY, O3 GENERATOR, 5LPM
052400000	ASSY, BENCH UV LAMP, (BIR), CR *
052910200	ASSY, OPTICAL BENCH, CAL
054690000	PCA, VALVE DRIVER
055020000	ASSY, INLET MANIFOLD W/PCA
055210000	OPTION, PHOTOMETER, (KB)
055220000	ASSY, VALVE, PHOTOMETER
055240000	OPTION, OZONE, CAL (KB)
055270000	ASSY, EXHAUST MANIFOLD, (KB)
055560000	ASSY, VALVE, VA59 W/DIODE, 5" LEADS
056440000	ASSY, VALVE (VA23)
056450000	ASSY, VALVE (VA32)
056970000	PCA, EXT O/P ADPTR, LDS, (OPT)
057230000	PCA, SINGLE VALVE DRIVER (OPTION)

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Part Number	Description
057360000	ASSY, 3/8" VENT ADAPTER
057400001	FRONT FERRULE,SS,1/4",SILCOSTEEL
057520001	FRONT FERRULE,SS, 1/8",SILCOSTEEL
057630000	ASSY, DUAL OUTPUT VALVE
058021400	PCA, E-SERIES MTHRBRD, M700E, GEN 5-I (ACCEPTS ACROSSER OR ICOP CPU)
058430001	FT 40 FITTING BODY, SILCOSTEEL COATED
058440001	FT 36 FITTING BODY, SILCOSTEEL COATED
060340001	FT 85 FITTING BODY, SILCOSTEEL COATED
061630000	ASSY, FILTER, DFU, DESORBER (SOAKED)
063110000	PCA, DC HEATER/THERM, 100W
064130000	ASSY, DC HEATER/THERM PCA, O3 GEN
066970000	PCA, INTRF. LCD TOUCH SCRIN, F/P
067240000	CPU, PC-104, VSX-6154E, ICOP *
067300000	PCA, AUX-I/O BD, ETHERNET, ANALOG & USB
067300100	PCA, AUX-I/O BOARD, ETHERNET
067300200	PCA, AUX-I/O BOARD, ETHERNET & USB
067900000	LCD MODULE, W/TOUCHSCREEN
068300100	DOM, w/SOFTWARE, T700U *
068810000	PCA, LVDS TRANSMITTER BOARD
069500000	PCA, SERIAL & VIDEO INTERFACE BOARD
072150000	ASSY. TOUCHSCREEN CONTROL MODULE
072860000	KIT, T700U MANUAL
CN0000073	POWER ENTRY, 120/60 (KB)
CN0000458	CONNECTOR, REAR PANEL, 12 PIN
CN0000520	CONNECTOR, REAR PANEL, 10 PIN
CN0000640	CONNECTOR, REAR PANEL, 14 PIN
FM0000004	FLOWMETER (KB)
FM0000007	REGULATOR, PRESSURE, 0-30PSI(KB)
FT0000013	CONNECTOR-M, T, 1/8" (KB)
FT0000036	TEE-TTT, SS, 1/4" (HK)
FT0000040	UNION, BULKHEAD, SS, 1/4" (HK)
FT0000056	TEE-TTT, SS, 1/8" (HK)
FT0000085	PORT CONNECTOR, SS, 1/4" (HK)
FT0000134	BLKHD, UNION, REDUCING, SS, 1/4-1/8 (HK)
FT0000151	UNION, CROSS, TFE, 2-1/4", 2-1/8" KB
FT0000192	ELBOW, B, 1/8 X 1/4 TUBING
FT0000278	FEMALE COUPLING, 10-32, BRASS
FT0000279	HEX EXTENSION, B, 10-32 M-F
FT0000321	PORT CONNECTOR, SS, 1/8" (HK)
FT0000330	FITTING, PHOTOMETER FLOW, 13 MIL
FT0000332	FITTING, 9 MIL, ZERO AIR FLOW
FT0000364	.003 ORIFICE, 10-32 X 10-32 W/ORING, BRA
HW0000005	FOOT
HW0000120	SHOCKMOUNT, GROMMET ISOLATOR
HW0000149	SEALING WASHER, #10
HW0000327	HEATSINK CLIP, TO-220

**T700U Spare Parts List**  
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Part Number	Description
HW0000328	INSULATING THERMAL PAD, TO-220
HW0000356	PAD, THERMAL, TO-220, W/ ADHV
HW0000453	SUPPORT, CIRCUIT BD, 3/16" ICOP
KIT000253	ASSY & TEST, SPARE PS37
KIT000289	AKIT, UV LAMP P/S PCA, 041660100
KIT000290	AKIT, UV LAMP P/S PCA, 041660500
OP0000014	LAMP WINDOW, OPTICAL BENCH
OP0000031	WINDOW, OPTICAL BENCH & OZONE GEN FEEDBACK
OR0000001	ORING, SAMPLE FLOW & OZONE GENERATOR
OR0000013	ORING, 2-112V
OR0000026	ORING, ABSORPTION TUBE
OR0000039	ORING, OPTICAL BENCH & OZONE GEN FEEDBACK
OR0000046	ORING, 2-019V
OR0000048	ORING, OZONE GEN UV LAMP
OR0000077	ORING, 2-018V
OR0000089	ORING, OPTICAL BENCH
PS0000039	PS, SWITCHING, 12V/7.5A (KB)
PS0000040	PS,EXT,AC/DC (90-264V/47-63HZ),12V/3.75A
SW0000025	SWITCH, POWER, CIRC BREAK, VDE/CE *
WR0000008	POWER CORD, 10A(KB)