



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

## Manual Addendum

# ***Models T320 and T320U*** ***N<sub>2</sub>O Analyzers*** **(Addendum to T300/T300M Manual, PN 06864)**

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# SAFETY MESSAGES

Important safety messages are provided throughout this manual. Please read these messages carefully.

A safety message alerts you to potential hazards that could hurt you or others. Each safety message is associated with a safety alert symbol. These symbols are found in the manual and inside the instrument. The definition of these symbols is described below:



WARNING: Electrical Shock Hazard



HAZARD: Strong oxidizer



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



CAUTION: Hot Surface Warning




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



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.



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

|   |  |
|---|--|
|  | <p style="text-align: center;"><b>CAUTION - General Safety Hazard</b></p> <p><b>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.</b></p> <p style="text-align: center;"><b>NEVER use any gas analyzer to sample combustible gas(es).</b></p> |
|---|--|

|  |
|--|
| <p style="text-align: center;"><b>Note</b></p> <p><b>Technical Assistance regarding the use and maintenance of the T320/T320U or any other Teledyne API product can be obtained by contacting Teledyne API's Customer Service Department:</b></p> <p style="text-align: center;"><b>Phone: 800-324-5190</b></p> <p style="text-align: center;"><b>Email: <a href="mailto:api-customerservice@teledyne.com">api-customerservice@teledyne.com</a></b></p> <p style="text-align: center;"><b>or by accessing various service options on our website at <a href="http://www.teledyne-api.com/">http://www.teledyne-api.com/</a>.</b></p> |
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# TABLE OF CONTENTS

|  |           |
|--|-----------|
| <b>1. INTRODUCTION</b> .....   | <b>5</b>  |
| 1.1. Reference Numbering Convention .....  | 5         |
| <b>2. SPECIFICATIONS, APPROVALS AND WARRANTY</b> .....                                 | <b>7</b>  |
| 2.1. Specifications .....  | 7         |
| 2.2. EPA Equivalency Designation .....   | 8         |
| 2.3. CE Mark Compliance .....  | 8         |
| 2.4. Warranty.....   | 8         |
| <b>3. GETTING STARTED</b> .....  | <b>9</b>  |
| 3.1. Unpacking the T320/T320U.....   | 9         |
| 3.2. Initial Operation of the T320/T320U .....   | 9         |
| 3.3. Functional Check.....   | 9         |
| 3.4. Initial Calibration.....  | 10        |
| 3.4.1. Calibration Gases .....   | 10        |
| 3.4.2. Pneumatic Connections to T320/T320U Basic Configuration:.....                   | 11        |
| 3.4.3. Pneumatic Connections to T320/T320U with Internal Valve Options Installed ..... | 12        |
| 3.4.4. Pneumatic Connections to T320/T320U in Multipoint Calibration Applications..... | 13        |
| <b>4. FREQUENTLY ASKED QUESTIONS &amp; GLOSSARY</b> .....                              | <b>15</b> |
| <b>5. OPTIONAL HARDWARE AND SOFTWARE</b> .....   | <b>17</b> |
| 5.1. Calibration Valve Options for the T320/T320U .....                                | 17        |
| 5.1.1. Zero/Span with common Shutoff valves (Option 50G).....                          | 18        |
| <b>6. BASIC OPERATION</b> .....  | <b>19</b> |
| 6.1. Test Functions.....   | 19        |
| 6.1.1. Selecting a Test Channel Function for Output A4.....                            | 20        |
| <b>7. ADVANCED FEATURES</b> .....  | <b>21</b> |
| <b>8. REMOTE OPERATION</b> .....   | <b>23</b> |
| 8.1.1. Hessen Protocol .....   | 23        |
| <b>9. CALIBRATION PROCEDURES</b> .....   | <b>25</b> |
| <b>10. EPA PROTOCOL CALIBRATION</b> .....  | <b>27</b> |
| <b>11. THEORY OF OPERATION</b> .....   | <b>29</b> |
| <b>12. MAINTENANCE SCHEDULE</b> .....  | <b>31</b> |
| <b>13. TROUBLESHOOTING &amp; REPAIR</b> .....  | <b>33</b> |

## LIST OF FIGURES

|  |    |
|--|----|
| Figure 3-1. Pneumatic Connections, Basic Configuration Using Gas Dilution Calibrator .....                 | 11 |
| Figure 3-2. Pneumatic Connections, Basic Configuration Using Bottled Span Gas .....                        | 11 |
| Figure 3-3. Pneumatics: Option Z/S Valve with Shutoff Valve for Pressurized Span and Atmospheric Zero..... | 12 |
| Figure 3-4. Pneumatics: Option Z/S without Shutoff Valve .....   | 12 |
| Figure 3-5. Pneumatics: Option Z/S Valve with Common Shutoff Valve for Pressurized Zero and Span.....      | 13 |
| Figure 5-1. Internal Pneumatic Flow, Option Zero/Span with Common Shutoff Valves .....                     | 18 |

## LIST OF TABLES

|   |    |
|---|----|
| Table 2-1. T320/T320U Basic Unit Specifications.....                                | 7  |
| Table 5-1. T320/T320U Available Valve Options .....                                 | 17 |
| Table 5-2. Zero/Span/Shutoff Valve Operating States for Option 50G .....            | 18 |
| Table 6-1. Test Functions Defined .....   | 19 |
| Table 6-2. Test Channels Functions Available on the T320/T320U's Analog Output..... | 20 |
| Table 8-1. T320/T320U Hessen GAS ID List .....                                      | 23 |
| Table 12-1. T320/T320U Test Function Record.....                                    | 31 |

# LIST OF APPENDICES

**APPENDIX A – MENU TREES and SOFTWARE DOCUMENTATION**

**APPENDIX B –SPARE PARTS LIST**

**APPENDIX C - REPAIR QUESTIONNAIRE**

**APPENDIX D - SCHEMATICS**

# 1. INTRODUCTION

The T320 and T320U are Gas Filter Correlation (GFC) analyzers that are designed to measure low level and trace level nitrous oxide ( $N_2O$ ), respectively. The primary difference between the models is their maximum operating range; 1000 ppm for the T320 and 200 ppm for the T320U. The T320 and T320U are designed to be used for monitoring background levels of  $N_2O$  in the atmosphere, byproducts of combustion products and contamination of bottled gases.

This addendum is a supplement to the T300/T300M manual (P/N 06864) to facilitate setup, operation, calibration, troubleshooting and repair of T320 and T320U nitrous oxide ( $N_2O$ ) analyzers. Most of the basic set up information, operating instructions as well as maintenance, troubleshooting and repair methods are the same for the T320/T320U and can be found in the T300/T300M manual (P/N 06864). The T320 is very similar to the T300M, and the T320U is very similar to the T300:

**T320 = T300M      T320U = T300**

When using the T300/T300M manual, it is necessary to substitute the words *nitrous oxide* for *carbon monoxide* and the chemical abbreviation  $N_2O$  for  $CO$ :

**Carbon Monoxide → Nitrous Oxide      CO →  $N_2O$**

There are six major differences between the T320/T320U and their counterpart models, T300M/T300:

- **Operating wavelength:** A different photo detector is used that closely matches the peak absorption wavelength of  $N_2O$ .
- **Gas Filter Correlation Filter (GFC) wheel:** The GFC wheel is filled with  $N_2O$  rather than  $CO$  to correlate properly with  $N_2O$ .
- **Software:** Display text strings, variable names and variable values reflect the difference in gas name and physical characteristic. Wherever “CO” is displayed on the T300/T300M “ $N_2O$ ” will be displayed on the T320/T320U.
- **Calibration Methods:** There are no specialized USEPA calibration methods since these methods currently do not exist.
- **Calibration Gases:** Since there are no readily available low cost  $N_2O$  scrubbers and traditional zero air generators like the TAPI model 701, which do not remove  $N_2O$ , zero gas must be either  $N_2$  or synthetic air - especially for the T320U.
- **Calibration Valve Options:** Due to there being no  $N_2O$  scrubbers or traditional zero air generators for either the T320 or the T320U, Options 51B and 51C for the T300M and T300 are not available for the T320 or T320U.

## 1.1. REFERENCE NUMBERING CONVENTION

Unless otherwise specified, section, section, figure and table reference numbers referred to herein are relative to this addendum.

- EXAMPLE: “Table 2-1” refers to the table within this document.
- EXAMPLE: “Figure 6-1 of the T300/T300M Operators Manual (P/N 06864)” refers to that figure in the main operation manual.

**NOTE**

**The information contained in this addendum is relevant to T320/T320U analyzers, some of which may not be applicable to the current version of software.**



## 2. SPECIFICATIONS, APPROVALS AND WARRANTY

This section provides the specifications for the T320 and the T320U analyzers, and references approvals and warranty.

### 2.1. SPECIFICATIONS

Specifications differ between the T320 and the T320U analyzers for Ranges, Noise, Lower Detectable Limit and Drift.

**Table 2-1. T320/T320U Basic Unit Specifications**

| Parameter                             | Model T320  | Model T320U  |   |
|---------------------------------------|---|--|---|
| Ranges                                | Min:  | 0-1 ppm Full scale   | 0-200 ppb Full scale  |
|                                       | Max:  | 0-1000 ppm Full scale (selectable, dual ranges and auto ranging supported) | 0-200 ppm Full scale (selectable, dual ranges and auto ranging supported) |
| Measurement Units                     | ppb, ppm, $\mu\text{g}/\text{m}^3$ , $\text{mg}/\text{m}^3$ (selectable)  |  |   |
| Zero Noise <sup>1,2</sup>             | < 0.02 ppm (RMS)  | < 5 ppb (RMS)  |   |
| Span Noise <sup>1,2,3</sup>           | < 0.5% of reading RMS over 8 ppm  | < 0.5% of reading RMS over 2 ppm   |   |
| Lower Detectable Limit <sup>1,2</sup> | < 0.04 ppm  | < 10 ppb   |   |
| Zero Drift (24 hours) <sup>2</sup>    | < 0.1 ppm   | < 25 ppb   |   |
| Span Drift (24 hours) <sup>2,4</sup>  | < 0.5% of reading   | < 0.5% of reading  |   |
| Lag Time <sup>1</sup>                 | <10 sec   |  |   |
| Rise/Fall Time <sup>1</sup>           | <60 sec to 95%  |  |   |
| Linearity <sup>6</sup>                | 1% of full scale  |  |   |
| Precision <sup>1,5</sup>              | 0.5% reading  |  |   |
| Sample Flow Rate                      | 800 $\text{cm}^3/\text{min}$ . $\pm$ 10%  |  |   |
| Voltage Coefficient                   | < 0.05 % of reading per V   |  |   |
| Power Requirements                    | 100V-120V, 220V-240V, 50/60 Hz  |  |   |
| Analog Output Ranges                  | 10V, 5V, 1V, 0.1V (selectable)  |  |   |
| Recorder Offset                       | $\pm$ 10%   |  |   |
| Analog Output Resolution              | 1 part in 4096 of selected full-scale voltage   |  |   |
| Included I/O                          | 1 Ethernet: 10/100Base-T<br>2 RS-232 (300 – 115,200 baud)<br>2 USB device ports<br>8 opto-isolated digital status outputs<br>6 opto-isolated digital control inputs<br>4 analog outputs |  |   |
| Optional I/O                          | 1 USB com port<br>1 RS485<br>8 analog inputs (0-10V, 12-bit)<br>4 digital alarm outputs<br>Multidrop RS232<br>3 4-20mA current outputs  |  |   |

| Parameter  | Model T320  | Model T320U |
|--|---|-------------|
| Temperature Range  | 5 - 40°C operating  |             |
| Humidity Range   | 0-95% RH, Non-Condensing  |             |
| Dimensions (HxWxD)                                       | 7" x 17" x 23.5" (178 mm x 432 mm x 597 mm)   |             |
| Weight   | 50 lb (22.7 kg)   |             |
| Environmental Conditions                                 | Installation Category (Over voltage Category) II Pollution Degree 2   |             |
| Certifications   | CE: IEC 61010-1:2001<br>North American: cNEMKO (Canada): CAN/CSA-C22.2 No. 61010-1-04<br>NEMKO-CCL (US): UL No. 61010-1 (2 <sup>nd</sup> Edition) |             |
| <sup>1</sup> As defined by the USEPA                     | <sup>4</sup> Or 10 ppb, whichever is greater  |             |
| <sup>2</sup> At constant temperature and sample pressure | <sup>5</sup> Or LDL whichever is greater  |             |
| <sup>3</sup> Or 20 ppb, whichever is greater             | <sup>6</sup> For values greater than twice the LDL  |             |

## 2.2. EPA EQUIVALENCY DESIGNATION

There is no US EPA reference method for the measurement of nitrous oxide; therefore, neither the T320 nor the T320U are designated as reference or equivalent methods. Hence, Section 10 of the Model T300/T300M Operation Manual does not apply.

## 2.3. CE MARK COMPLIANCE

See the CE Mark Compliance section of the T300/T300M manual (P/N 06864).

## 2.4. WARRANTY

See the Warranty page of the T300/T300M manual (P/N 06864).

### 3. GETTING STARTED

#### 3.1. UNPACKING THE T320/T320U

Follow the unpacking directions in the Getting Started section of the T300/T300M manual (P/N 06864); note that the *Final Test and Validation Data Sheet* for the T320 or the T320U are unique.

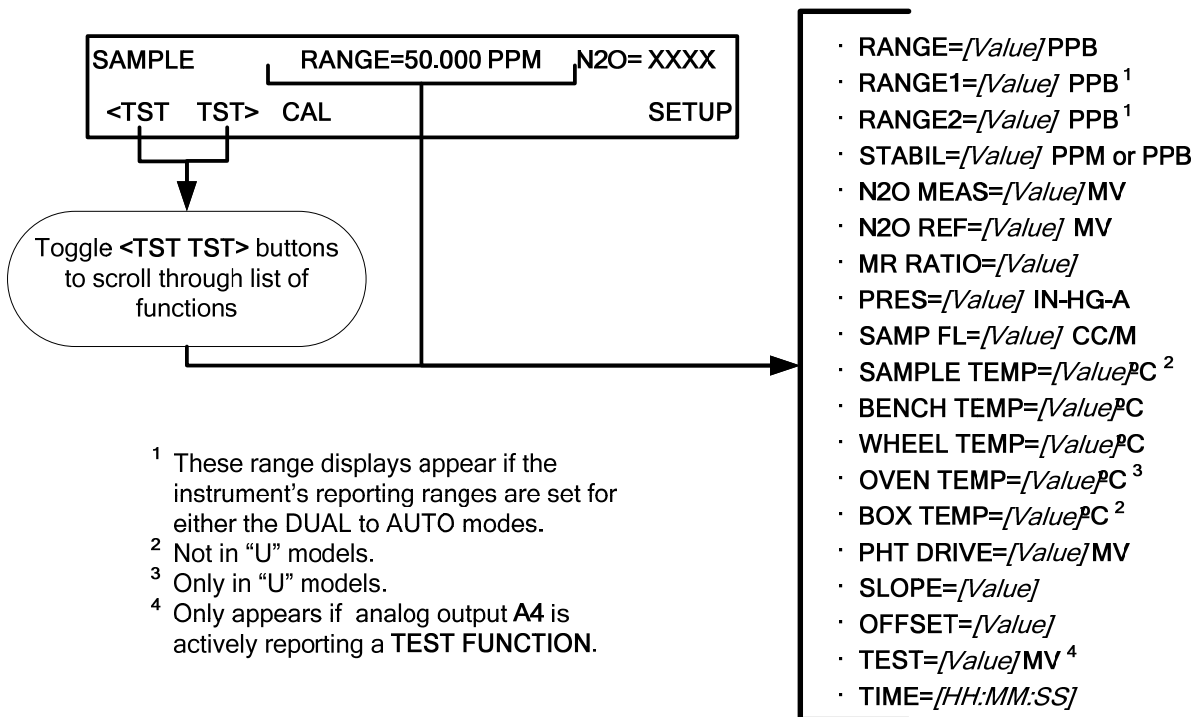
#### 3.2. INITIAL OPERATION OF THE T320/T320U

The analyzer should be started and allowed to warm up; a functional check followed by calibration should be performed. The process for starting and warming up the T320/T320U is identical to that described in the Initial Operation Section of the T300/T300M Operators Manual (P/N 06864).

#### 3.3. FUNCTIONAL CHECK

The functional check information also in the Initial Operation section of the T300/T300M Operators Manual (P/N 06864) is applicable to the T320/T320U with the following exception(s).

The Test functions available from the front panel of the T320 or T320U are:



## 3.4. INITIAL CALIBRATION

### 3.4.1. CALIBRATION GASES

The information found in Section 3.6.1 of the T300/T300M Operators Manual (P/N 06864) is applicable to the T320/T320U with the following exceptions:

#### ZERO GAS

Zero gas is similar in chemical composition to the atmosphere that is to be measured but scrubbed of all components that might affect the analyzers readings, in this case  $N_2O$  and water vapor. For the T320/T320U this gas **MUST** be synthetic air, ultra zero air or nitrogen ( $N_2$ ).

#### NOTE

**Zero air created by a Zero Air Generator like the T-API Model T701 should not be used since the T701 does not scrub  $N_2O$ . Likewise since there are no effective and convenient catalytic, absorptive or reactive scrubbers for  $N_2O$ , T-API does not offer a zero scrubber cartridge.**

#### SPAN GAS

Span gas is specifically mixed to match the chemical composition of the type of gas being measured at near full scale of the desired measurement range. In this case,  $N_2O$  measurements made with the T320/T320U analyzer, it is recommended that you use a span gas with a  $N_2O$  concentration equal to 80% of the measurement range for your application.

EXAMPLE: If the application is to measure between 0 ppm and 500 ppm, an appropriate span gas concentration would be 400 ppm  $N_2O$  in  $N_2$ .

Some applications require a multipoint calibration procedure where span gases of different concentrations are applied to the analyzer under test. We recommend using a bottle of calibrated  $N_2O$  gas of higher concentration in conjunction with a gas dilution calibrator such as a Teledyne Instruments Model T700. This type of calibrator precisely mixes a high concentration gas from with zero gas (both supplied externally as either synthetic air or  $N_2$ ) to accurately produce span gas of the correct concentration. Linearity profiles can be automated with this model and run unattended over night.

Currently there are no Standard Reference Material (SRM)  $N_2O$  gases available off-the-shelf from NIST (National Institute of Standards and Technology) therefore it is essential that span gas be purchased from a reputable supplier and that the gas be traceable to a reputable national standards laboratory.

### 3.4.2. PNEUMATIC CONNECTIONS TO T320/T320U BASIC CONFIGURATION:

The information found in the Pneumatic Connections section of the T300/T300M Operators Manual (P/N 06864) is applicable to the T320/T320U with the following changes:

- Synthetic air, ultra-zero air or N<sub>2</sub> should be used as the zero gas rather than a Zero Gas Generator like the TAPI Model 701. The following figures document this difference.

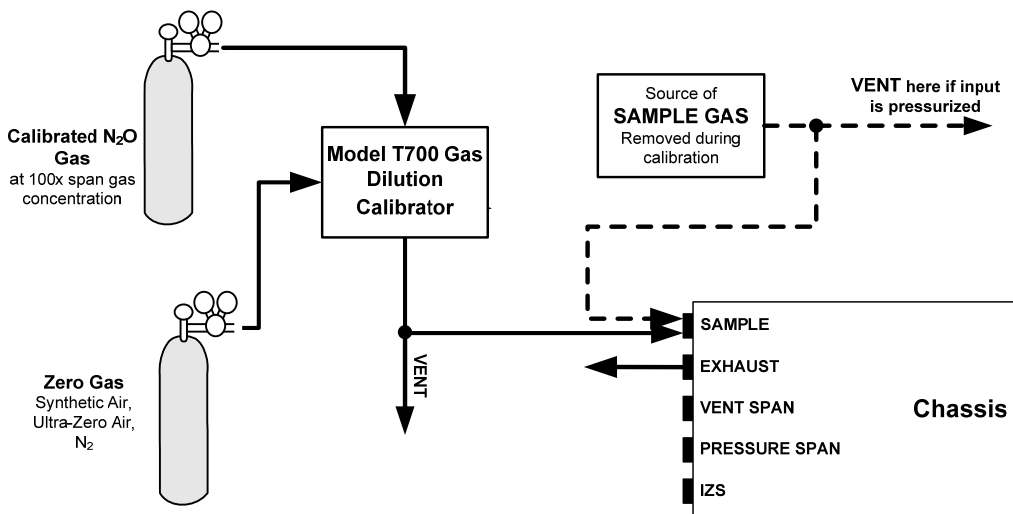


Figure 3-1. Pneumatic Connections, Basic Configuration Using Gas Dilution Calibrator

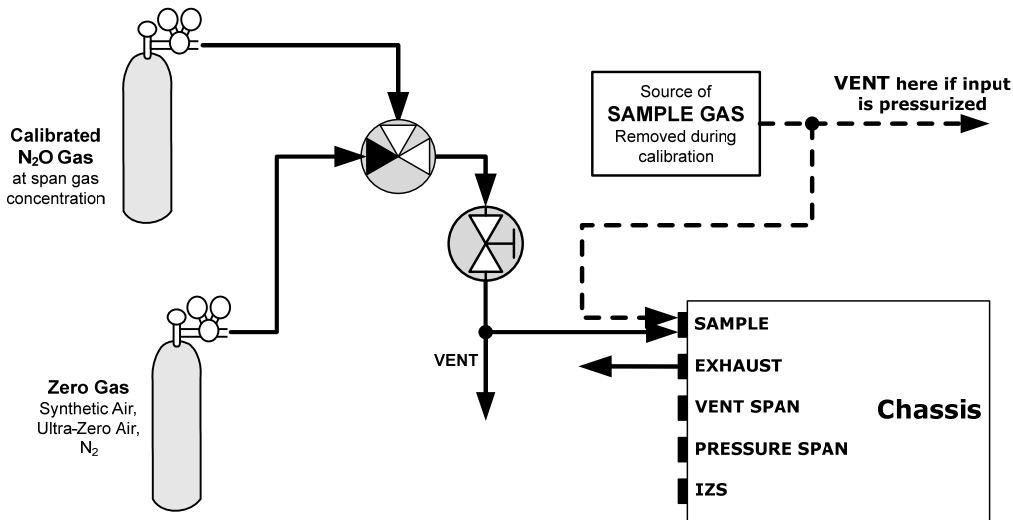


Figure 3-2. Pneumatic Connections, Basic Configuration Using Bottled Span Gas

### 3.4.3. PNEUMATIC CONNECTIONS TO T320/T320U WITH INTERNAL VALVE OPTIONS INSTALLED

- The following figures show the pneumatic set up for T320/T320U analyzers with one of the three available internal valve options installed. For more information on these options see Section 5 of this addendum.

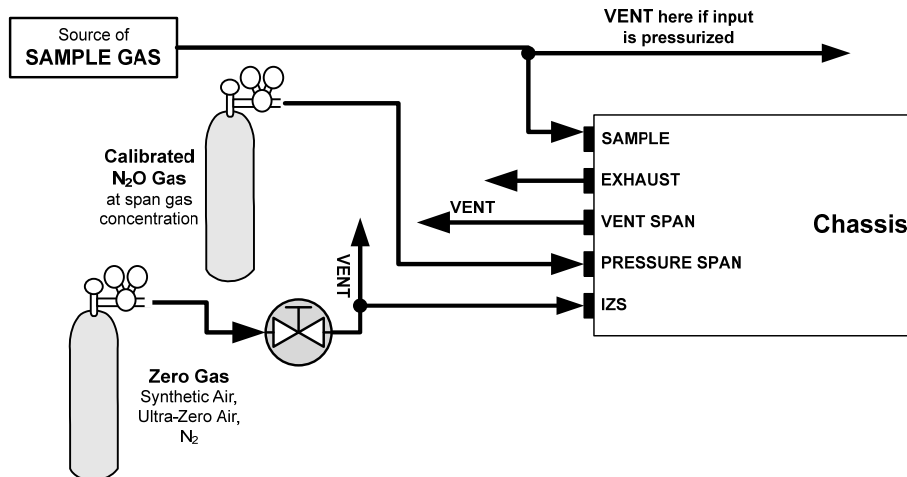


Figure 3-3. Pneumatics: Option Z/S Valve with Shutoff Valve for Pressurized Span and Atmospheric Zero

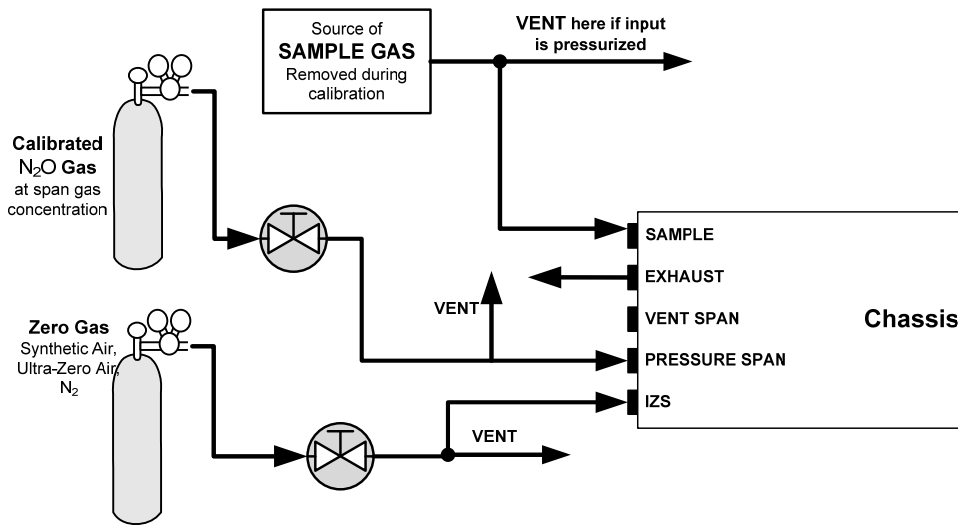


Figure 3-4. Pneumatics: Option Z/S without Shutoff Valve

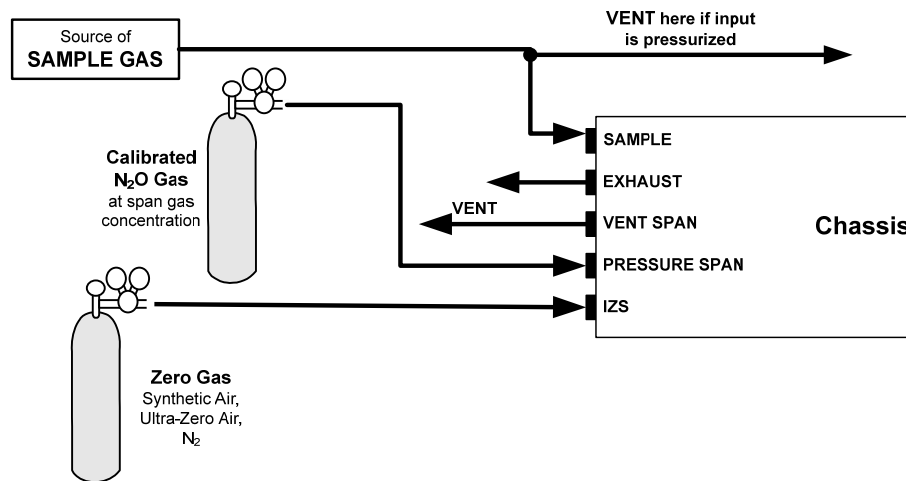


Figure 3-5. Pneumatics: Option Z/S Valve with Common Shutoff Valve for Pressurized Zero and Span

#### 3.4.4. PNEUMATIC CONNECTIONS TO T320/T320U IN MULTIPOINT CALIBRATION APPLICATIONS

Some applications require multipoint calibration checks where Span gas of several different concentrations is needed. We recommend using high-concentration, certified, calibration gas supplied to the analyzer through a gas dilution calibrator such as a Teledyne API T700. This type of calibrator precisely mixes span gas and zero air to produce max concentration levels between 0 ppm and the concentration of the certified gas. This means that both the source of zero air and span gas must be connected to the calibrator whose output is then connected to the span inlet on the rear panel of the instrument.

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## **4. FREQUENTLY ASKED QUESTIONS & GLOSSARY**

The information found in Section 4 of the T300/T300M Operators Manual (P/N 06864) is applicable to the T320/T320U.

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## 5. OPTIONAL HARDWARE AND SOFTWARE

Not all options are available for the T320 and T320U as are available for the T300 and T300M.

### 5.1. CALIBRATION VALVE OPTIONS FOR THE T320/T320U

There three valve options available for the T320 and T320U analyzers

**Table 5-1. T320/T320U Available Valve Options**

| OPTION NO.            | DESCRIPTION  |
|-----------------------|--|
| <b>VALVES AND IZS</b> |  |
| 50A                   | Ambient Zero/Ambient Span Valves   |
| 50B                   | Zero / Span Valve with shut-off valve (Ambient Zero/ Pressurized Span)     |
| 50G                   | Zero / Span Valves with Shut-off Valve (Pressurized Zero/Pressurized Span) |

For descriptions of options 50A and 50B and their use please see Section 5 of the T300/T300M Operators Manual (P/N 06864) but noting that wherever a zero air generator like the TAPI 701 is shown, synthetic air, ultra-zero air, or N<sub>2</sub> should be substituted. For a description of option 50G please see Section 5.1.1 of this addendum.

For assistance with ordering these options, please contact the Sales department of Teledyne Advanced Pollution Instrumentation at:

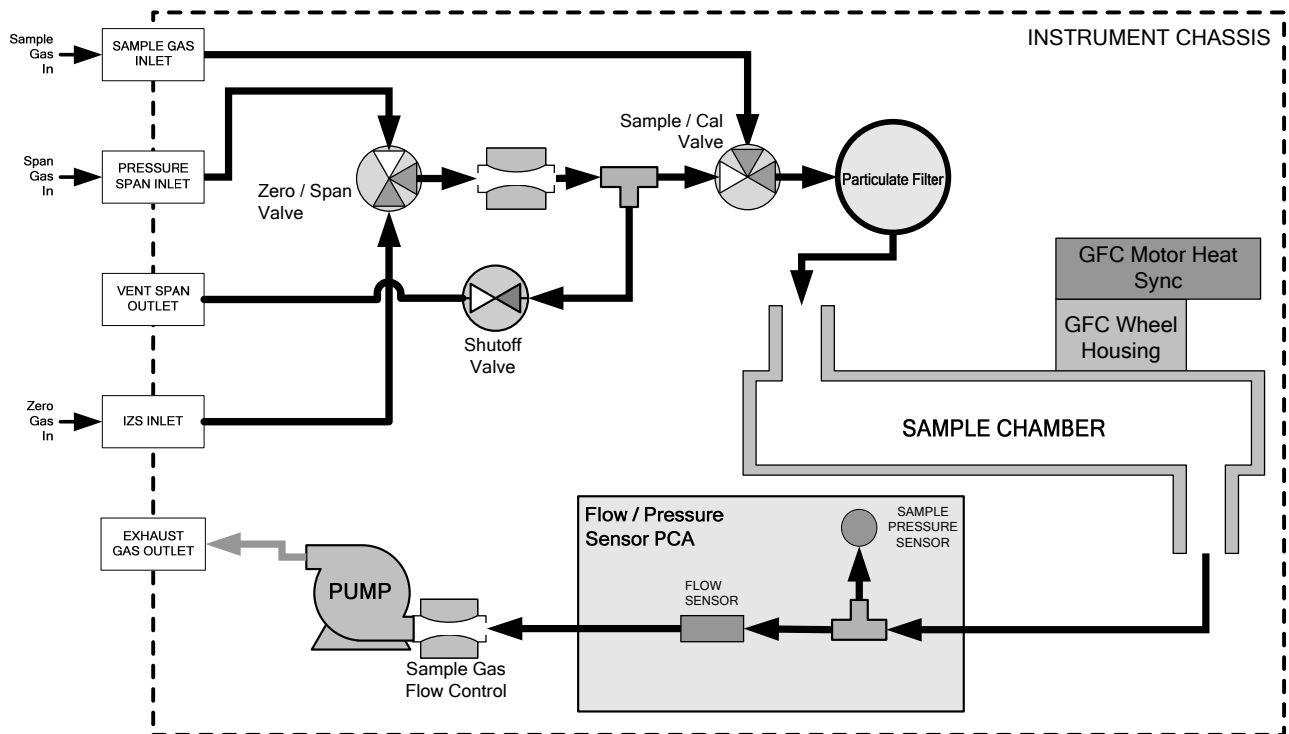
**TOLL-FREE: 800-324-5190**  
**FAX: 858-657-9816**  
**TEL: 858-657-9800**  
**E-MAIL: [api-sales@teledyne.com](mailto:api-sales@teledyne.com)**  
**WEB SITE: [www.teledyne-api.com](http://www.teledyne-api.com)**

### 5.1.1. ZERO/SPAN WITH COMMON SHUTOFF VALVES (OPTION 50G)

Option 50G is operationally and pneumatically similar to Option 50B (see T300/T300M manual), except that both the zero and span gases are applied to the analyzer under pressure. This option is designed to be used with bottled zero and span gases. A shutoff valve is used to stop flow from the bottles during sample mode and a common vent is used to bring the pressure of the calibration gas down to local ambient pressure.

**Table 5-2. Zero/Span/Shutoff Valve Operating States for Option 50G**

| MODE                            | VALVE         | CONDITION                       |
|---------------------------------|---------------|---------------------------------|
| <b>SAMPLE</b><br>(Normal State) | Sample/Cal    | Open to SAMPLE inlet            |
|                                 | Zero/Span     | Open to internal ZERO AIR inlet |
|                                 | Shutoff Valve | Closed                          |
| <b>ZERO CAL</b>                 | Sample/Cal    | Open to ZERO/SPAN valve         |
|                                 | Zero/Span     | Open to ZERO AIR inlet          |
|                                 | Shutoff Valve | Open to ZERO/SPAN valve         |
| <b>SPAN CAL</b>                 | Sample/Cal    | Open to ZERO/SPAN valve         |
|                                 | Zero/Span     | Open to SPAN inlet              |
|                                 | Shutoff Valve | Open to ZERO/SPAN valve         |



**Figure 5-1. Internal Pneumatic Flow, Option Zero/Span with Common Shutoff Valves**

## 6. BASIC OPERATION

### 6.1. TEST FUNCTIONS

The information found in Section 6.2.1 of the T300/T300M Operators Manual (P/N 06864) is applicable to the T320/T320U with the following exception(s):

- The following table supersedes Table 6-2 of the T300/T300M Operators Manual (P/N 06864).

**Table 6-1. Test Functions Defined**

| Parameter                            | Display Title     | Units                | Meaning  |
|--------------------------------------|-------------------|----------------------|--|
| RANGE<br>--<br>RANGE1<br>RANGE2      | <b>RANGE</b>      | PPB, PPM<br>UGM, MGM | The full-scale limit at which the output range of the analyzer's Analog Outputs is currently set.<br><ul style="list-style-type: none"> <li><b>THIS IS NOT</b> the Physical Range of the instrument. See Section 6.6.1 of the T300/T300M Operators Manual (P/N 06864) for more information.</li> </ul> If <b>DUAL</b> or <b>AUTO</b> Range modes have been selected, two <b>RANGE</b> functions will appear, one for each range. |
| Stability                            | <b>STABIL</b>     | PPB, PPM<br>UGM, MGM | Standard deviation of N <sub>2</sub> O concentration readings. Data points are recorded every ten seconds using the last 25 data points.   |
| N <sub>2</sub> O Measure             | <b>MEAS</b>       | MV                   | The demodulated, peak IR detector output during the measure portion of the GFC Wheel cycle.  |
| N <sub>2</sub> O Reference           | <b>REF</b>        | MV                   | The demodulated, peak IR detector output during the reference portion of the GFC wheel cycle.  |
| Measurement / Reference Ratio        | <b>MR Ratio</b>   | –                    | The result of <b>N2O MEAS</b> divided by <b>N2O REF</b> based on readings taken during the normal sample measurement portion of the <b>A-REF</b> cycle.<br>This ratio is the primary value used to compute N <sub>2</sub> O concentration. The value displayed is not linearized.  |
| Sample Pressure                      | <b>PRES</b>       | In-Hg-A              | The absolute pressure of the Sample gas as measured by a pressure sensor located inside the sample chamber.  |
| Sample Flow                          | <b>SAMPLE FL</b>  | cm <sup>3</sup> /min | Sample mass flow rate as measured by the flow rate sensor in the sample gas stream,  |
| Bench Temperature                    | <b>BENCH TEMP</b> | °C                   | Optical bench temperature.   |
| Wheel Temperature                    | <b>WHEEL TEMP</b> | °C                   | GFC wheel temperature.   |
| Box Temperature                      | <b>BOX TEMP</b>   | °C                   | The temperature inside the analyzer chassis.   |
| Photo-detector Temp. Control Voltage | <b>PHT DRIVE</b>  | mV                   | The drive voltage being supplied to the thermoelectric coolers of the IR photo-detector by the sync/demod Board.   |
| Slope                                | <b>SLOPE</b>      | –                    | The sensitivity of the instrument as calculated during the last calibration activity. The <b>SLOPE</b> parameter is used to set the span calibration point of the analyzer.  |
| Offset                               | <b>OFFSET</b>     | –                    | The overall offset of the instrument as calculated during the last calibration activity. The <b>OFFSET</b> parameter is used to set the zero point of the analyzer response.   |
| Test Channel Output                  | <b>TEST</b>       | mV                   | The raw voltage being output on the analyzer's A4 analog output. Only appears when the test channel is assigned a function.  |
| Current Time                         | <b>TIME</b>       | –                    | The current time. This is used to create a time stamp on DAS readings, and by the <b>AUTOCAL</b> feature to trigger calibration events.  |

**NOTE**

Upper span limit setting for the individual range modes are shared. Resetting the span limit in one mode also resets the span limit for the corresponding range in the other modes as follows:

**NOTE**

Concentrations displayed in mg/m<sup>3</sup> and ug/m<sup>3</sup> use 0°C , 760 mmHg for Standard Temperature and Pressure (STP). Consult your local regulations for the STP used by your agency.

**NOTE**

Once the units of measurement have been changed, the unit **MUST** be recalibrated, as the “expected span values” previously in effect will no longer be valid. Simply entering new expected span values without running the entire calibration routine is not sufficient.

The following equations give approximate conversions between volume/volume units and weight/volume units:

$$\text{N}_2\text{O ppb} \times 2.052 = \text{N}_2\text{O ug/m}^3$$

$$\text{N}_2\text{O ppm} \times 2.052 = \text{N}_2\text{O mg/m}^3$$

### 6.1.1. SELECTING A TEST CHANNEL FUNCTION FOR OUTPUT A4

This section supplements Section 7.4.6 of the T300/T300M Operators Manual (P/N 06864)

The Test Functions available to be reported on analog output **A4** are:

**Table 6-2. Test Channels Functions Available on the T320/T320U's Analog Output**

| TEST CHANNEL    | DESCRIPTION  | ZERO                   | FULL SCALE                |
|-----------------|--|------------------------|---------------------------|
| NONE            | TEST CHANNEL IS TURNED OFF   |                        |                           |
| N2O MEAS        | The raw output of the optical bench's IR detector during the measure phase of the m/r cycle                      | 0 mV                   | 5000 mV                   |
| N2O REF         | The raw output of the optical bench's IR detector during the reference phase of the m/r cycle                    | 0 mV                   | 5000 mV                   |
| SAMPLE PRESSURE | The pressure of gas in the optical bench's sample chamber  | 0" Hg                  | 40" Hg-In-A               |
| SAMPLE FLOW     | The gas flow rate through the optical bench's sample chamber   | 0 cm <sup>3</sup> /min | 1000 cm <sup>3</sup> /min |
| BENCH TEMP      | The temperature of optical bench's itself  | 0 C°                   | 70 C°                     |
| WHEEL TEMP      | The temperature of GFC wheel   | 0 C°                   | 70 C°                     |
| BOX TEMP        | The temperature of the circulating air inside the convection oven section of the T320/T320U's interior.          | 0 C°                   | 70 C°                     |
| PHT DRIVE       | The drive voltage being supplied to the thermoelectric coolers of the IR photo-detector by the sync/demod Board. | 0 mV                   | 5000 mV                   |

Once a function is selected, the instrument not only begins to output a signal on the analog output, but also adds **TEST** to the list of Test Functions viewable via the Front Panel Display.

# 7. ADVANCED FEATURES

The information found in Section 7 of the T300/T300M Operators Manual (P/N 06864) is applicable to the T320 and T320U we recommend that you read this section before continuing.

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# 8. REMOTE OPERATION

The information found in Section 8 of the T300/T300M Operators Manual (P/N 06864) is applicable to the T320 and T320U we recommend that you read that section before continuing.

## 8.1.1. HESSEN PROTOCOL

The information found in Section 8.5 of the T300/T300M Operators Manual (P/N 06864) is applicable to the T320/T320U with the following exception(s):

- There is only one default gas type programmed into the T320/T320U. The following table replaces the gas type and gas ID from Section 8.5.6 of the T300/T300M Operators Manual (P/N 06864).

**Table 8-1. T320/T320U Hessen GAS ID List**

| GAS DEFAULT | HESSEN GAS ID |
|-------------|---------------|
| N2O         | 320           |

- The list of Hessen status flags for the T320/T320U is the same as that of the T300/T300M. Please see Table 8-8 of the T300/T300M Operators Manual (P/N 06864) for the specific assignments.

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## 9. CALIBRATION PROCEDURES

Calibration of the T320/T320U should be performed according to the procedures described in Section 9 of the T300/T300M Manual - P/N 06864 with the following notes and exceptions:

- Delivering span and zero gases for the higher resolution the T320/T320U can be difficult. Attention must be paid to the quality of the gases, the level of contaminants in the gases as well as the history and conditioning of the gas delivery components.
- The analyzer must be continually operating with an adequate flow of sample gas, for 2 hours prior to performing a calibration (12 hours is recommended for the initial calibration).
  - DO NOT calibrate the analyzer if it has been turned off or if no sample gas has been flow though it within the last 2 hours.
- After this stabilization period is complete and just prior to performing the initial calibration, force the instrument to perform an auto-reference measurement.

### REQUIRED EQUIPMENT, SUPPLIES AND EXPENDABLES

- Gas lines to and from the analyzer should be PTFE or FEP Teflon, glass, or stainless steel only.
- Zero-air source which must be synthetic air, ultra-zero air or nitrogen (N<sub>2</sub>). A zero air generator like a T-API M701 should not be used.
- Span gas source (defined in Section 9.1.2.2 of the T300/T300M Operators Manual; but use N<sub>2</sub>O instead of CO).
- A recording device such as a strip-chart recorder and/or data logger (optional). Data recording device should be capable of bi-polar operation so that negative readings can be recorded.
- For electronic documentation, the internal data acquisition system can be used.

### NOTE

If any problems occur while performing the following calibration procedures, refer to Section 11 of this manual for troubleshooting tips.

### MANUAL CALIBRATION

The information found in Section 9.2 of the T300/T300M Operators Manual (P/N 06864) is applicable to the T320/T320U with the following exception(s).

- **STEP3 – ZERO/SPAN CALIBRATION**
  - Set the display to show the **N2OSTB** test rather than the **CO STB** function mentioned in the T300/T300M operator's manual).

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## 10. EPA PROTOCOL CALIBRATION

The information found in Section 10 of the T300/T300M Operators Manual (P/N 06864) does not apply to the T320/T320U as there are no USEPA reference methods for the measurement of N<sub>2</sub>O.

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# 11. THEORY OF OPERATION

The information found in Section 11 of the T300/T300M Operators Manual (P/N 06864) is applicable to the T320 and T320U (we recommend that you read this section before continuing) with the following exception:

The wavelength of operation is 4.58 $\mu$ m versus 4.7 $\mu$ m for the T300/T300M.

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# 12. MAINTENANCE SCHEDULE

The information found in Section 12 of the T300/T300M Operators Manual (P/N 06864) is applicable to the T320/T320U with the following exception(s):

- Since a catalytic zero scrubber is not available for the T320 or T320U there is no replacement schedule for the scrubber material.
- The Test record below should be used in place of the one included with the T300/T300M manual.

**Table 12-1. T320/T320U Test Function Record**

| FUNCTION  | OPERATING MODE       | DATE RECORDED |  |  |  |  |  |
|-----------|----------------------|---------------|--|--|--|--|--|
|           |                      |               |  |  |  |  |  |
| STABILITY | ZERO CAL             |               |  |  |  |  |  |
| N2O MEAS  | ZERO CAL             |               |  |  |  |  |  |
| N2O REF   | ZERO CAL             |               |  |  |  |  |  |
| MR RATIO  | ZERO CAL             |               |  |  |  |  |  |
|           | SPAN CAL             |               |  |  |  |  |  |
| PRES      | SAMPLE               |               |  |  |  |  |  |
| PHT DRIVE | SAMPLE AFTER WARM-UP |               |  |  |  |  |  |
| SLOPE     | SPAN CAL             |               |  |  |  |  |  |
| OFFSET    | ZERO CAL             |               |  |  |  |  |  |
| BOX TEMP  | SAMPLE               |               |  |  |  |  |  |

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# 13. TROUBLESHOOTING & REPAIR

The information found in Section 13 of the T300/T300M Operators Manual (P/N 06864) is applicable to the T320 and T320U. It is recommended that you read this section before continuing.

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## **APPENDIX A – Menu Trees and Software Documentation**

Please refer to Appendix A of the T300/T300M Operation Manual, PN 06864.

Note that not all variables or parameters apply to the T320 or T320U, and footnotes specify such instances.

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## APPENDIX B - Spare Parts

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**Note** Use of replacement parts other than those supplied by Teledyne Advanced Pollution Instrumentation (TAPI) 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 TAPI Website at <http://www.teledyne-api.com> or call Customer Service at 800-324-5190 for more recent updates to part numbers.

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## T320U Spare Parts List


(Reference: 07383, 03/15/2011 10:11 a.m.)

| <b>PARTNUMBER</b> | <b>DESCRIPTION</b>                       |
|-------------------|--|
| 000940600         | CD, ORIFICE, .010 BROWN                  |
| 000940700         | CD, ORIFICE, .005 YELLOW                 |
| 000941000         | CD, ORIFICE, .013 BLUE/GREEN             |
| 001760400         | ASSY, FLOW CTL, 800CC, 1/4" CONN-B       |
| 003291500         | ASSY, THERMISTOR, BENCH/WHEEL            |
| 009450300         | ASSY, ZERO/SPAN VALVES, CO               |
| 009550500         | ASSY, SOURCE                             |
| 009560701         | GF WHEEL, N2O (90%CO2/10%N2O, 90%CO2/10% |
| 009600400         | AKIT, EXPENDABLES, CO                    |
| 009690000         | AKIT, TFE FLTR ELEM (FL6 100=1) 47mm     |
| 009690100         | AKIT, TFE FLTR ELEM (FL6, 30=1) 47mm     |
| 009840300         | ASSY, SHUT-OFF VALVE, (KB)               |
| 010790000         | INPUT MIRROR, REPLICATED(KB)             |
| 010800000         | OUTPUT MIRROR, REPLICATED(KB)            |
| 016290000         | WINDOW, SAMPLE FILTER, 47MM (KB)         |
| 016300600         | ASSY, SAMPLE FILTER, 47MM, ANG BKT, 5UM  |
| 016910000         | AKIT, EXP KIT, CO CATALYST               |
| 033520100         | MIRROR, OBJECT, GOLD, 32 PASS            |
| 033560100         | MIRROR, FIELD, GOLD, 32 PASS             |
| 036020800         | ASSY, SENSOR, N2O                        |
| 037250000         | ASSY, STRIP HEATER                       |
| 037860000         | ORING, TEFLON, RETAINING RING, 47MM (KB) |
| 039250000         | MASK, FILTER WHEEL (KB)                  |
| 039260301         | DETECTOR, N2O, w/BANDPASS FILTER         |
| 040010000         | ASSY, FAN REAR PANEL                     |
| 040030100         | PCA, PRESS SENSORS (1X), w/FM4           |
| 041350000         | PCA, RELAY BOARD, CO                     |
| 042410100         | ASSY, PUMP, INT, (CO) W/ 800CC FLOW      |
| 042680000         | ASSY, VALVE (SS)                         |
| 042690000         | ASSY, VALVE , 2-WAY, 12V                 |
| 043250100         | ASSY, PWR CONF, 100-120V/60HZ, CO        |
| 043250300         | OPTION, PWR CONF, 220-240V/50HZ, CO      |
| 043250400         | OPTION, PWR CONF, 220-240V/60HZ, CO      |
| 049600000         | ASSY, PURMAPURE DRYER, DR7               |
| 050320000         | PCA, OPTO-INTERRUPTER                    |
| 052830200         | ASSY, MOTOR HUB, MR7                     |
| 055010000         | ASSY, MTR WHL HEATER w/THERM, 200W       |
| 055100200         | ASSY, OPTION, PUMP, 240V *               |
| 057650100         | ASSY, CARTRIDGE, CO SCRUBBER             |
| 058021100         | PCA, MOTHERBD, GEN 5-ICOP                |
| 058770000         | ASSY, BLOWER, 50MM                       |
| 058780000         | ASSY, BLOWER 75MM                        |
| 058800000         | ASSY, THERMISTOR, OVEN                   |
| 058820000         | ASSY, HEATER, BLOWER w/THERM, 50W        |
| 066970000         | PCA, INTRF. LCD TOUCH SCRIN, F/P         |
| 067240000         | CPU, PC-104, VSX-6154E, ICOP *(KB)       |
| 067300000         | PCA, AUX-I/O BD, ETHERNET, ANALOG & USB  |
| 067300100         | PCA, AUX-I/O BOARD, ETHERNET             |

## T320U Spare Parts List

(Reference: 07383, 03/15/2011 10:11 a.m.)

| <b>PARTNUMBER</b> | <b>DESCRIPTION</b>                      |
|-------------------|---|
| 067300200         | PCA, AUX-I/O BOARD, ETHERNET & USB      |
| 067900000         | LCD MODULE, W/TOUCHSCREEN(KB)           |
| 068810000         | PCA, LVDS TRANSMITTER BOARD             |
| 069500000         | PCA, SERIAL & VIDEO INTERFACE BOARD     |
| 072150000         | ASSY. TOUCHSCREEN CONTROL MODULE        |
| 073810100         | DOM, w/SOFTWARE, T320U2*                |
| 073820000         | KIT, T320U2 MANUAL                      |
| CN0000073         | POWER ENTRY, 120/60 (KB)                |
| CN0000458         | PLUG, 12, MC 1.5/12-ST-3.81 (KB)        |
| CN0000520         | PLUG, 10, MC 1.5/10-ST-3.81 (KB)        |
| FL0000001         | FILTER, SS (KB)                         |
| HW0000005         | FOOT                                    |
| HW0000020         | SPRING                                  |
| HW0000036         | TFE TAPE, 1/4" (48 FT/ROLL)             |
| HW0000101         | ISOLATOR                                |
| HW0000685         | LATCH, MAGNETIC, FRONT PANEL            |
| KIT000219         | AKIT, 4-20MA CURRENT OUTPUT             |
| KIT000278         | RETROFIT, SYNC DMOD w/DETECTOR, M320EU  |
| OP0000009         | WINDOW (KB)                             |
| OR0000001         | ORING, 2-006VT *(KB)                    |
| OR0000034         | ORING, 2-011V FT10                      |
| OR0000039         | ORING, 2-012V                           |
| OR0000041         | ORING, 2-136V                           |
| OR0000088         | ORING, 2-011S, 40 DURO                  |
| OR0000094         | ORING, 2-228V, 50 DURO VITON(KB)        |
| PS0000011         | PWR SUPPLY, SW, +5V, +/-15V, 40W (KB)   |
| PS0000024         | COVER ENCLOSURE KIT,LPX 40/60 (KB)      |
| PS0000025         | PWR SUPPLY, SW, 12V, 40W (KB)           |
| RL0000015         | RELAY, DPDT, (KB)                       |
| SW0000025         | SWITCH, POWER, CIRC BREAK, VDE/CE *(KB) |
| SW0000055         | SWITCH, THERMAL, 80C                    |
| WR0000008         | POWER CORD, 10A(KB)                     |

|  |   |  |
|--|---|--|
| <b>Models</b><br><b>T320, T320U,</b><br><b>320E, 320EU</b> | <b>Appendix C</b><br><b>Warranty/Repair</b><br><b>Questionnaire</b><br>(Reference: 06449B, DCN6123) |  <b>TELEDYNE</b><br><b>ADVANCED POLLUTION INSTRUMENTATION</b><br><small>A Teledyne Technologies Company</small> |
|--|---|--|

CUSTOMER: \_\_\_\_\_ PHONE: \_\_\_\_\_

CONTACT NAME: \_\_\_\_\_ FAX NO. \_\_\_\_\_

SITE ADDRESS: \_\_\_\_\_

MODEL TYPE: \_\_\_\_\_ SERIAL NO.: \_\_\_\_\_ FIRMWARE REVISION: \_\_\_\_\_

Are there any failure messages? \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

(Continue on back if necessary)

PLEASE COMPLETE THE FOLLOWING TABLE:

| PARAMETER                              | DISPLAYED AS            | OBSERVED VALUE | UNITS                | NOMINAL RANGE          |                     |
|--|-------------------------|----------------|----------------------|------------------------|---------------------|
|  |                         |                |                      | M320E                  | M320EU              |
| Range                                  | <b>RANGE</b>            |                | PPM, MGM<br>PPB, UGM | 1 – 1000 PPM           | 1 – 200 PPM         |
| Stability                              | <b>STABIL</b>           |                | PPB, PPM             | <1.0 PPM with<br>N2    | <200 PPB with<br>N2 |
| N2O Measure                            | <b>N2O MEAS</b>         |                | mV                   | 3600 – 4800 MV with N2 |                     |
| N2O Reference                          | <b>N2O REF</b>          |                | mV                   | 3000 – 4000MV with N2  |                     |
| Measure/Reference Ratio                | <b>MR RATIO</b>         |                | –                    | 1.2 – 1.5 with N2      |                     |
| Pressure                               | <b>PRES</b>             |                | In-Hg-A              | Ambient +0"/-2"        |                     |
| Sample Flow                            | <b>SAMP FL</b>          |                | cm3/min              | 800 ± 20%              |                     |
| Sample Temp <sup>1</sup>               | <b>SAMPLE TEMP</b>      |                | °C                   | 48 ± 4                 |                     |
| Bench Temp                             | <b>BENCH TEMP</b>       |                | °C                   | 48 ± 2                 |                     |
| Wheel Temp                             | <b>WHEEL TEMP</b>       |                | °C                   | 56 ± 2                 |                     |
| Oven Temp <sup>2</sup>                 | <b>OVEN TEMP</b>        |                | °C                   | 46 ± 1                 |                     |
| Box Temp <sup>1</sup>                  | <b>BOX TEMP</b>         |                | °C                   | Ambient ± 10           |                     |
| Photo Drive                            | <b>PHT DRIVE</b>        |                | mV                   | 250 mV – 4750 mV       |                     |
| Slope of N2O Measurement               | <b>N2O SLOPE</b>        |                | –                    | 1.0 ± .3               |                     |
| Offset of N2O Measurement              | <b>N2O OFFSET</b>       |                | PPM                  | 0 ± 0.3                |                     |
| Dark Cal Reference Signal <sup>3</sup> | <b>REF DARK OFFSET</b>  |                | mV                   | 125 ± 50 mV            |                     |
| Dark Cal Measure Signal <sup>3</sup>   | <b>MEAS DARK OFFSET</b> |                | mV                   | 125 ± 50 mV            |                     |
| Electric Test <sup>3</sup>             |                         |                | PPM                  | 40 ± 2 PPM             |                     |

<sup>1</sup> Not in "U" models

<sup>2</sup> In "U" models only

<sup>3</sup> Located in DIAG menu

**TELEDYNE API CUSTOMER SERVICE**

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FAX: (858) 657-9816

**Models**  
T320, T320U,  
320E, 320EU

**Appendix C**  
**Warranty/Repair**  
**Questionnaire**  
(Reference: 06449B, DCN6123)



Have you performed a leak check and flow check? \_\_\_\_\_

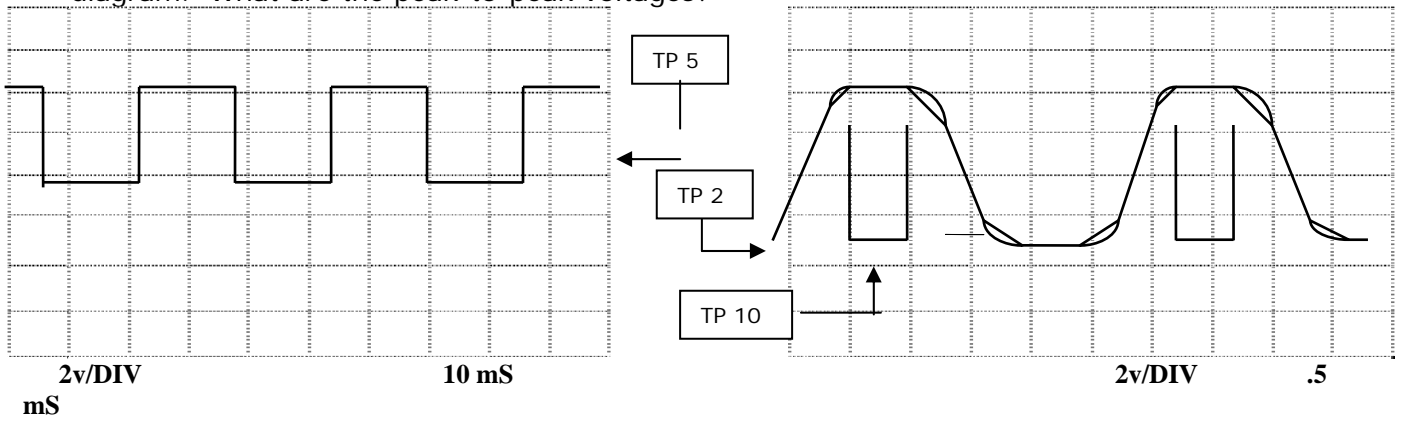
What are the failure symptoms? \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

What test have you done trying to solve the problem? \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

Please check these signals and verify the correctness. Look for the signals annotated on the diagram. What are the peak-to-peak voltages?



If possible, please include a portion of a strip chart pertaining to the problem. Circle pertinent data.

THANK YOU FOR PROVIDING THIS INFORMATION. YOUR ASSISTANCE ENABLES TELEDYNE API TO RESPOND FASTER TO THE PROBLEM THAT YOU ARE ENCOUNTERING.

**OTHER NOTES:** \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

TELEDYNE API CUSTOMER SERVICE  
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## **APPENDIX D – Wire List and Electronic Schematics**

Please refer to Appendix D of the T300/T300M Operation Manual, PN 06864 for schematics.

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