METTLER TOLEDO

High Performance Dissolved Oxygen Sensors

52 201 067
52 201 209

Instruction manual

52 201 072 K
Printed in Switzerland

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Contents

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1 Introduction

This manual covers installation, operation and maintenance of the METTLER TOLEDO Thornton High Performance Dissolved Oxygen (DO) Sensors. For information on the measuring instruments, consult their respective manuals.

The dissolved oxygen measurement loop consists of:

- 52 201 067 analog DO Sensor or 52 201 209 ISM® DO Sensor
- 30 298 424 DO electrolyte pack (3 x 25 mL)
- 58 084 009 Flow housing with 1/4" NPT(F) ports
- VP cable with analog sensors or AK9 cable with ISM sensors

Sensor	Cable	Instrument
52 201 067	52 300 107 – 1 m cable 52 300 108 – 3 m cable 52 300 109 – 5 m cable 52 300 110 – 10 m cable	M300
52 201 209	59 902 167 – 1 m cable 59 902 193 – 3 m cable 59 902 213 – 5 m cable 59 902 230 – 10 m cable 52 300 204 – 20 m cable 52 300 393 – 30 m cable 52 300 394 – 50 m cable 52 300 395 – 80 m cable	M200/M300/ M800

These sensors are designed for monitoring low concentrations of dissolved oxygen in power plant, microelectronics, and pharmaceutical pure water samples and similar applications. They provide long-term operation with minimal maintenance.

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2 Important notes

2.1 Overview of operation

These DO sensors use a gas permeable membrane to separate the sample from the electrochemical cell inside. Oxygen diffuses through the membrane in direct proportion to the partial pressure of oxygen outside the sensor. The cathode and anode inside the sensor are polarized with a voltage to enable the electrochemical reaction of oxygen. Oxygen is reduced at the cathode while the anode is oxidized, producing a small current in direct proportion to the amount of oxygen reacting. The very small current developed by these sensors allows them to have a long life with low maintenance.

A guard ring electrode around the cathode prevents extraneous oxygen either from within the sensor or from the sides of the membrane from causing a response. This enables especially rapid response to low ppb samples after air calibration or other exposure to high oxygen concentrations.

Temperature compensation adjusts for the changing permeability of the membrane with temperature. In addition, the instrument uses the temperature value to convert the oxygen partial pressure signal to a dissolved oxygen concentration value by compensating for the changing solubility of oxygen with temperature.

For calibration, the sensor is normally removed from the flow housing for exposure to air which provides a standard oxygen partial pressure. An instrument setting accounts for differences in barometric pressure during calibration.

2.2 ISM models

52 201 209 model sensors include Intelligent Sensor Management with the measurement circuit, analog to digital conversion and extensive memory contained within the sensor. The integrated ISM functionality allows extensive monitoring of the sensor. Stored in the sensor are the serial number, type of sensor, order number, calibration data and temperature exposure data.

When starting up, the following processes are initiated automatically: digital communication, plug & measure, pre-calibration, predictive maintenance.

2.3 Safety instructions

These operating instructions contain all the information needed for safe and proper use of the sensor.

The operating instructions are intended for personnel entrusted with the operation and maintenance of the sensors. It is assumed that these persons are familiar with the equipment in which the sensor is installed.

Warning notices and symbols
This instruction manual identifies safety instructions and additional information by means of the following symbols:

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This symbol draws attention to **safety instructions and warnings of potential danger** which, if neglected, could result in injury to persons and/or damage to property.

This symbol identifies **additional information and instructions** which, if neglected, could lead to defects, inefficient operation and possible loss of production.

- Part 30 298 424, O_2-Electrolyte pack required for use with the 52 201 067 and 52 201 209 dissolved oxygen sensors includes a **Safety Data Sheet.** Maintain a copy of the SDS in your material safety file.
- The plant operator must be fully aware of the potential risks and hazards attached to operation of the particular process or plant. The operator is responsible for correct training of the workforce, for signs and markings indicating sources of possible danger, and for the selection of appropriate, state-of-the-art instrumentation.
- It is essential that personnel involved in the commissioning, operation or maintenance of this sensor or of any of the associated equipment (e.g. housings, transmitters, etc.) be properly trained in the process itself, as well as in the use and handling of the associated equipment. This includes having read and understood this instruction manual.
- The safety of personnel as well as of the plant itself is ultimately the responsibility of the plant operator. This applies in particular in the case of plants operating in hazardous zones.
- Oxygen sensors and associated components have no effect on the process itself and cannot influence it in the sense of any form of control system.
- Maintenance and service intervals and schedules depend on the application conditions, composition of the sample media, plant equipment and significance of the safety control features of the measuring system. Processes vary considerably, so that schedules, where such are specified, can only be regarded as tentative and must in any case be individually established and verified by the plant operator.
- Where specific safeguards such as locks, labels, or redundant measuring systems are necessary, these must be provided by the plant operator.
- A defective sensor must neither be installed nor put into service.
- Only maintenance work described in this operating instruction may be performed on the sensor.
- When changing faulty components, use only original spare parts obtainable from your METTLER TOLEDO supplier (see spare parts list, Section 8).
- No modifications to the sensors and the accessories are allowed. The manufacturer accepts no responsibility for damages caused by unauthorised modifications. The risk is borne entirely by the user.

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3 Installation

The sensor location should be in a protected indoor area with reasonably stable and uniform temperature with no radiant sources of heat such as steam pipes nearby.

Sample line design and installation must preserve the integrity of the very low DO concentrations to be measured. Fittings, flowmeters and all connections must be gas tight to prevent aspirating traces of air which would cause erroneous readings.

Stainless steel sample lines are recommended to prevent permeation of oxygen into the sample. If a length of flexible line must be used, make it as short as possible (<3 ft, 1 m), thick walled and of a material with low permeability such as PVDF, polypropylene or Nylon. Silicone and PVC (Tygon) are NOT recommended for low ppb samples.

⚠ **IMPORTANT:** Before installation, the sensor electrolyte solution must be replaced to correct for any drying in storage and to achieve full response and stability. Follow the Service Procedure.

The sample system should be able to provide between 50 and 1000 mL/min flowrate.

1. Mount the flow housing, allowing room above the sensor for convenient removal for calibration as shown in Section 3.1.
2. Flush the upstream sample line at high flowrate to remove any debris and/or corrosion products before connecting the flow housing.
3. Install appropriate fittings to the 1/4" NPT(F) ports of the flow housing using PTFE tape or pipe sealant.

⚠ **CAUTION:** Tighten fittings only one turn past hand tight. Do not over-tighten or the flow housing tapered pipe threads may be stripped.

4. Connect the sample line and drain to the fittings. **The bottom port is the inlet.**

⚠ **CAUTION:** Use a second wrench when connecting the sample line to a compression fitting to prevent over-tightening the pipe thread into the flow housing and possibly stripping the threads.

⚠ 5. **IMPORTANT:** Be sure the electrolyte solution has been replaced in the sensor before proceeding. Connect the cable to the connector of the sensor by rotating until they are aligned and the parts slide together. Tighten the connector by hand only.

6. Remove the protective cap and Install the sensor in the flow housing. Set the sample flowrate at 50–1000 mL/min. Save the cap for protection when the sensor is removed from the flow housing.
7. After at least 6 hours of powered operation including at least an hour of acclimation to the process sample, perform an air calibration as described in chapter 4.

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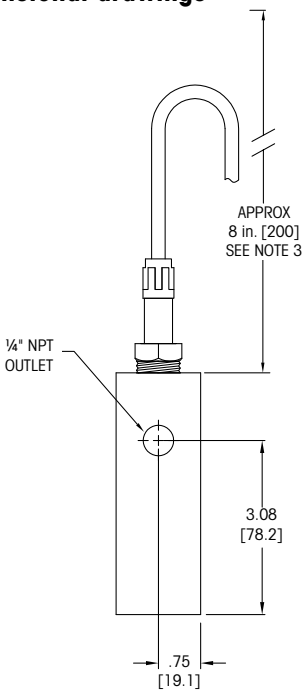
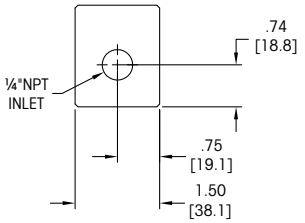
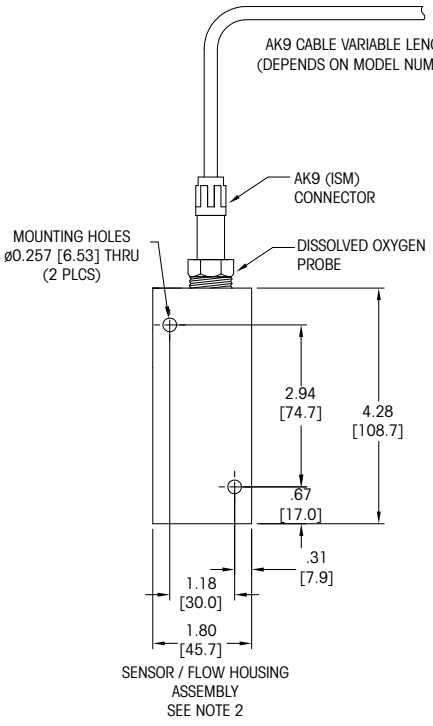
3.1 Dimensional drawings







NOTES:

1. DIMENSIONS: INCHES [MM]
2. SENSOR / FLOW HOUSING ASSEMBLY MUST BE IN UPRIGHT POSITION AS SHOWN
3. ALLOW AT LEAST 8 IN. [200] CLEARANCE TO REMOVE SENSOR

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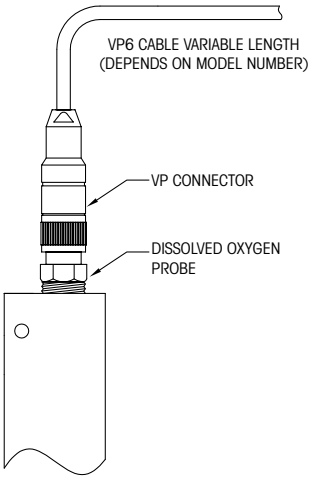

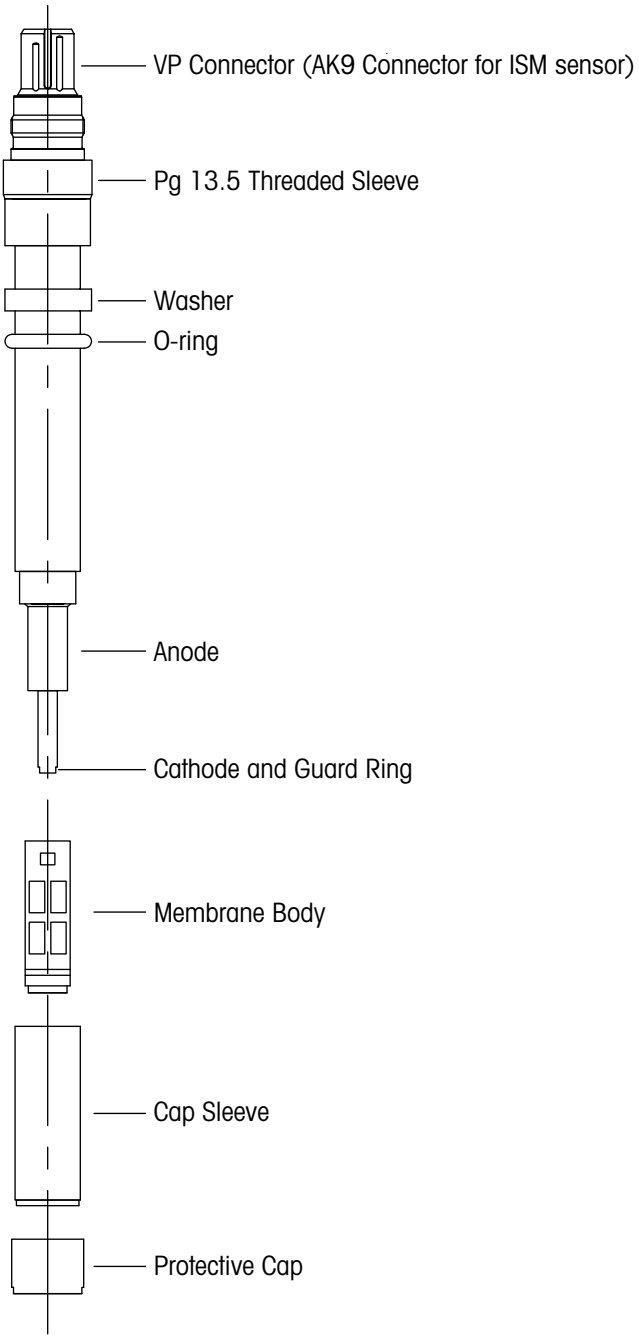

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4 Calibration

Calibration of the sensor calculates new calibration constants for the sensor—an Offset (zero) and a Slope. The Offset is normally near zero, accounting primarily for zero offset in the electronics. The Slope is nominally –350 nA and is recomputed whenever an air calibration is performed.

Calibration data for the 52 201 067 sensors used with the M300 transmitter is accessed via the CAL \ Calibrate Sensor \ Edit mode.

Calibration data for the 52 201 209 sensor used with the M300/M800 transmitters is stored in non-volatile memory and can be viewed under the ISM / Calibration Data menu for the appropriate channel.

Calibration data for the 52 201 209 sensor used with the M200 transmitter is accessed via the INFO \ Calibration Data mode.

For most applications, air provides the most reliable standard for calibration. Its composition is consistent and requires compensation only for barometric pressure. Because the electrical zero of the sensor coincides very closely with zero DO concentration, a one-point air calibration is normally sufficient.

The sensor is exposed to air which provides a standard oxygen partial pressure. An instrument setting accounts for differences in barometric pressure during calibration.

NOTE: For rated stability, the sensor must be connected to a powered instrument for at least 6 hours before calibrating or measuring to assure full polarization of the internal electrodes. If this is not possible, calibrate at startup and again after 6 hours.

When the equipment will be used as portable instrumentation and power is frequently disconnected, use an accessory Polarization Module to maintain sensor polarization while power is off.

4.1 Air calibration procedure

1. For highest accuracy with a METTLER TOLEDO Transmitter, determine the atmospheric pressure existing on site based on an accurate barometer.
2. Shut off the sample flow to the flow housing.
3. Remove the sensor from the housing by loosening the red threaded sleeve and blot the tip of the sensor dry with a soft lint-free tissue.
4. Hang the sensor in open air, away from heat sources and wait for stable DO and temperature readings—typically about 10 minutes.
5. Step through the instrument Calibration menu to set the barometric pressure. Perform a one-point air (Slope) calibration.
6. When complete, reinstall the sensor in the flow housing and tighten the threaded sleeve.

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7. Cycle the sample flow on and off to remove any retained bubbles. Restore flow to 50 – 1000 mL/min.

4.2 System zero calibration procedure

System zero calibration is rarely required with this sensor which has its electrical zero very close to zero concentration. If system zero calibration is attempted, a true zero calibration standard is required.

☞ **NOTE:** Improper zero calibration is a frequent source of measurement error. The best standard is nitrogen of 99.995% purity which can be slowly fed through the flow housing in place of the sample. Sulfite solutions may not reach a true zero—see the Zero Verification section following.

1. Be sure the instrument and sensor have been powered for at least 6 hours previous to calibration.
2. Shut off the sample flow to the flow housing.
3. Connect pure nitrogen to the inlet of the flow housing.
4. Wait for a completely stable reading—typically an hour. Verify that the reading is acceptably close to zero.
5. Step through the instrument Calibration menu to perform a zero (Offset) calibration.
6. When complete, disconnect the nitrogen and perform an air calibration if needed.
7. Reinstall the sensor in the flow housing and restore sample flow.

4.3 Zero verification

A zero verification may be performed with a sulfite solution. It is not recommended to calibrate in this solution since it sometimes produces a concentration of 1–3 ppb rather than a true zero. Use the same procedure as for nitrogen zero calibration except use the following zero solution in a narrow-mouth flask or bottle in which the DO sensor has been immersed.

A stock solution of 500 mg/L of cobalt chloride ($CoCl_2$) in deionized or distilled water may be made and stored up to 2 years.

The final zero DO solution consists of adding 10 grams of sodium sulfite (Na_2SO_3) to 200 mL of the above stock solution. This must be made up fresh within 60 minutes of use since air will oxidize and deactivate it.

4.4 Calibration diagnostics

The Offset is recalculated whenever a zero calibration is performed. The displayed value is in nanoAmps and is typically within ± 0.5 for a functioning sensor. The slope is recalculated whenever an air calibration is performed and is typically within –250 to –460 nA for a functioning sensor.

The instrument manual describes how to display the raw sensor current in normal operation, which is nominally near –350 nA in air.

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5 Sensor storage

Store the sensor at room temperature with the protective cap in place. For long term storage, more than 3 months, remove the electrolyte and rinse internal parts with deionized water. Allow to dry and re-assemble. The electrolyte must then be replaced before reinstalling.

6 Service

6.1 Cleaning

Any accumulation of solids on the membrane surface or in the flow housing should be washed off or cleaned briefly with an agent suitable for removing it. If physical cleaning is needed, use a lint-free cloth or tissue that will not clog the protective membrane screen. The frequency of cleaning will vary widely, depending on the content of the sample and must be established by experience.

WARNING: USE STANDARD PRE-CAUTIONARY MEASURES IN HANDLING ANY ACIDS USED FOR CLEANING.

6.2 Service indications

The electrolyte should be replaced at startup or later if response to a near-zero solution or gas is not low enough or fast enough. After 2 minutes in a very low oxygen sample, the reading should drop below 10% of the air reading. After 10 minutes, the reading should drop below 1%. (e.g. readings in air are near 8000 ppb so in 10 minutes, response should be below 80 ppb.)

The membrane body and electrolyte should be replaced if a visual inspection shows signs of mechanical damage. They should also be replaced if the sensor has a slow response, shows instability or if the sensor cannot be calibrated.

The complete sensor should be replaced if a visual inspection shows a crack in the glass of the interior body or if the sensor shows leakage current. (With electrolyte and membrane body removed and the internal body carefully dried there should be a zero reading.)

6.3 Service procedure

WARNING: THE DO SENSOR CONTAINS A FEW DROPS OF ALKALINE ELECTROYTE. CONTACT OF ELECTROLYTE WITH MUCOUS MEMBRANE OR EYES IS TO BE AVOIDED. THEREFORE WEAR SAFETY GLASSES FOR DISASSEMBLY. IF SUCH CONTACT OCCURS, THE AFFECTED AREA SHOULD BE WELL RINSED WITH WATER. IN THE CASE OF ACCIDENT, OR SHOULD ADVERSE SIGNS APPEAR, GET IMMEDIATE MEDICAL ATTENTION.

Perform sensor disassembly only in a clean work area.

1. Unscrew the cap sleeve from the sensor shaft and carefully pull it off the sensor.

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2. Eject the membrane body from the cap sleeve by pushing it from the end with the flat finger tip. (Before electrolyte is refilled, the membrane body must be removed from the cap sleeve.)
3. Rinse the interior body with demineralized water and carefully dab it dry with a paper tissue.
4. Examine the O-rings visually for mechanical defects, and replace if necessary.
5. Half-fill the membrane body with electrolyte.

NOTE: The electrolyte bottle is equipped with a special pouring system. To ensure proper functioning, hold the bottle vertically, upside-down.

6. Make sure that all air bubbles are removed from the membrane body. Air bubbles can be removed by carefully tapping on the membrane body.
7. Slip the membrane body over the interior body while holding the sensor in a vertical position. The excess electrolyte will be displaced and must be absorbed with a paper tissue.

NOTE: No electrolyte, sample media or contamination may be present between the membrane body and the cap sleeve. Be sure both parts are clean and dry.

8. Carefully slip the cap sleeve over the fitted membrane body, holding the sensor in a vertical position and screw it tight.
9. After changing electrolyte or membrane body, the sensor must be repolarized for 6 hours and recalibrated.
10. Place the system in operation. Because of the major disturbance of this service, stable measurement in the low ppb (µg/L) range may require several hours to achieve.

After a day, re-calibrate to restore full accuracy.

6.4 Troubleshooting

One of the most common problems with DO measurement is air leaks into the sample. This results in higher than actual, flow-sensitive readings. A simple test for this is to raise the flowrate about 50%. If the DO reading decreases significantly, this is evidence of a leak since the higher flowrate dilutes the leak. If this is observed, check and tighten all fittings, flowmeters, valves, etc. upstream of the sensor.

Decreasing DO reading with increasing flowrate may also occur if an excessively gas-permeable sample line is used. Shorten the gas-permeable length or change materials of the sample line.

An increase in DO reading at higher flowrate may indicate the original flowrate was inadequate or the membrane was coated. Clean the membrane as described in the Service/Cleaning section.

Refer to the Calibration Diagnostics section for information on acceptable sensor signal range.

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7 Specifications

Sample Flowrate:	50 – 1000 mL/min
Sample Temperature:	0–60 °C (32–140 °F) for compensation; can tolerate 100 °C (212 °F)
Sample Pressure:	0–5 bar (0–72 psig)
Sample Connections:	1/4" NPT(F)
Wetted Materials:	polyacetal flow housing, polyphenylene sulfide sensor, PTFE membrane (reinforced with stainless steel mesh and silicone rubber), FKM and silicone rubber O-rings
Cable Length:	M300 & 52 201 067: up to 10 m (33′)
	M200/M300/M800 & 52 201 209: up to 80 m (264′)
Weight:	1 kg (2.2 lb.)
System Accuracy:	±1% of reading or 1 ppb, whichever is greater
Response Time:	98% response in 90 seconds
Measurement Range:	0–10,000 ppb (µg/L) with autoranging

8 Spare parts

Replacement sensor (analog)	52 201 067
Replacement ISM sensor	52 201 209
Electrolyte (3 x 25 mL bottle)	30 298 424
Membrane kit including electrolyte, 4 membranes and O-ring sets	52 200 024
Single membrane body	52 200 071
Replacement Cap Sleeve	52 206 210
Replacement flow housing	58 084 009
Replacement VP cables for M300 transmitters	
1 m	52 300 107
3 m	52 300 108
5 m	52 300 109
10 m	52 300 110
Replacement AK9 cables for M200/M300/M800 transmitters	
1 m	59 902 167
3 m	59 902 193
5 m	59 902 213
10 m	59 902 230
20 m	52 300 204
30 m	52 300 393
50 m	52 300 394
80 m	52 300 395
Accessory Polarization Module (analog sensor)	52 200 893

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9 Oxygen solubility

Air-saturated water at 1 atmosphere, 760 mmHg

Temperature (°C)	Oxygen Concentration (mg/L)
0	14.57
1	14.17
2	13.79
3	13.43
4	13.08
5	12.74
6	12.42
7	12.11
8	11.82
9	11.53
10	11.26
11	11.00
12	10.75
13	10.50
14	10.27
15	10.05
16	9.84
17	9.63
18	9.43
19	9.24
20	9.06
21	8.89
22	8.72
23	8.55
24	8.39
25	8.24
26	8.10
27	7.95
28	7.82
29	7.68
30	7.55
31	7.43
32	7.31
33	7.19
34	7.07
35	6.96
36	6.85
37	6.74
38	6.63
39	6.53
40	6.43
41	6.33
42	6.23
43	6.13
44	6.04
45	5.94
46	5.85
47	5.76
48	5.66
49	5.57
50	5.48

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10 Altitude vs. Pressure

If calibration is performed at high elevations and a barometer is not available, this table provides an approximate atmospheric pressure setting.

Altitude		Atmospheric Pressure (mmHg)
(ft)	(m)	
–500	–152	773
0	0	760
500	152	747
1000	305	734
2000	610	708
3000	914	682
4000	1219	666
5000	1524	642
6000	1829	619

11 Environmental protection

Waste electrical products should not be disposed of with household waste. Please recycle where facilities exist. Check with your Local Authority or retailer for recycling advice.

12 Warranty

METTLER TOLEDO warrants this product to be free from significant deviations in material and workmanship for a period of one year from the date of purchase. If repair is necessary and not the result of abuse or misuse within the warranty period, please return by freight pre-paid and amendment will be made without any charge. METTLER TOLEDO's Customer Service Dept. will determine if the product problem is due to deviations or customer abuse. Out-of-warranty products will be repaired on an exchange basis at cost.

The above warranty is the only warranty made by METTLER TOLEDO and is lieu of all other warranties, expressed or implied, including, without limitation, implied warranties of merchantability and fitness for a particular purpose. METTLER TOLEDO shall not be liable for any loss, claim, expense or damage caused by, contributed to or arising out of the acts or omissions of the Buyer or Third Parties, whether negligent or otherwise. In no event shall METTLER TOLEDO's liability for any cause of action whatsoever exceed the cost of the item giving rise to the claim, whether based in contract, warranty, indemnity, or tort (including negligence).

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产品中有害物质的名称及含量 Toxic and hazardous substance name and containment in product						
部件名称 Part Name	有毒有害物质或元素 Toxic and hazardous substances					
	铅 Lead (Pb)	汞 Mercury (Hg)	镉 cadmium (Cd)	六价铬 Hexavalent chromium (Cr6+)	多溴联苯 Polybrominated biphenyls (PBB)	多溴二苯醚 Polybrominated diphenyl ethers (PBDE)
插头 Elect. Connector	×	○	○	○	○	○
电路板[a] PCBA [a]	×	○	○	○	○	○

本表依据SJ/T 11364的规定编制。 本产品符合以下标志规范：
Table composed in accordance with SJ/T 11364 (CN). This product is bearing the following symbol:

○：表示该有害物质在该部件所有均质材料中的含量均在GB/T 26572规定的限量要求以下
○：Indicates that the content of the hazardous substance in all homogeneous materials of the part is below the limit specified in GB / T 26572

×：表示该有毒物质至少在该部件的某一均质材料中的含量超出GB/T 26572规定的限量要求。
×：Indicates that the content of the toxic substance in at least one of the homogeneous materials of the part exceeds the limits specified in GB/T 26572.

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