OX-TRAN®
Model 2/12 R
Operator's Manual

Revision L

mocon® / AMETEK®

Gas-Detection
LAUPER INSTRUMENTS

Lauper Instruments AG
Irisweg 16 B
CH-3280 Murten
Tel. +41 26 672 30 50
info@lauper-instruments.ch
www.lauper-instruments.ch

Part Number 143-204

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About This Manual

This manual explains how to set up and use the OX-TRAN Model 2/12 R Oxygen Transmission Rate System.

This manual is designed for viewing electronically. Most references to other sections or chapters in this document are hyperlinks which can be used to navigate to the referenced section.

Please use the following guide to get started with the system.

If You Want To Set Up the OX-TRAN Model 2/12 R

1. Prepare your test site.

   See Appendix A "Site Preparation Instructions" starting on page A-1 in this manual.

2. Install the OX-TRAN components.

   See Chapter 2 "Setting Up" starting on page 2-1 in this manual.

If You Want Some Background on How the System Works:

1. Get an overview of the system.

   See Chapter 1 "Introduction" on page 1-1 in this manual.

2. Learn how the OX-TRAN measures oxygen transmission.

   See Appendix D "Theory of Operation" on page D-1 in this manual.

3. Learn about the software.

   See Chapter 4 "Using the Instrument Software" starting on page 4-1 in this manual.

If You Want To Get Started Measuring Oxygen Transmission Rate:

See Chapter 3 "Preparing for a Test" beginning on page 3-1, Chapter 6 "Testing Flat Films" on page 6-1 and Chapter 7 "Testing Packages" on page 7-1.

If You Have Problems Operating the System:

1. If an error message appears on instrument screen see Chapter 9 "Troubleshooting" beginning on page 9-1 in this manual.

2. If no error message appears but you have other problems, see Chapter 9 "Troubleshooting" beginning on page 9-1 in this manual.

SERVICE NOTE:

Please do not hesitate to call MOCON in the USA at (763) 493-6370. We want you to receive the best in product support services.

Safety Information

Be sure to read and understand this section and all other applicable chapters of the Operator's Manual and all on-product safety signs before setting up, operating, and maintaining this analyzer.

Safety signs appear in this manual and on the analyzer. All safety signs are identified by the words **WARNING** and **CAUTION**. These words signify the following:

- **WARNING** indicates a potentially hazardous situation which, if not avoided, could result in death or serious personal injury.
- **CAUTION** indicates a potentially hazardous situation which, if not avoided, may result in moderate personal injury and/or possible damage to the analyzer and its components.

To avoid personal injury and equipment damage, observe the following precautions:

Installation Precautions

- Use appropriate precautions when lifting or moving the instrument. A two-person lift is recommended.
- The maximum pressure applied to the instrument from the Carrier and Test Gas supplies must not exceed 29 psi (2 bar), or damage to the instrument will occur.

Operating Precautions

- To avoid plumbing contamination use only specified gas types at recommended operating pressures.
- Use only HPLC-grade water in the humidity generators.
- Use care to avoid splashing the RH sensor with any salt solution. The RH sensors can be irreparably damaged by direct contact with salt solutions.
- Handle the RH probe carefully. The sensor housed in the probe is easily damaged.
- Do not expose the RH probe to an environment with RH greater than 90% RH.

Maintenance and Service Precautions

WARNING! HAZARDOUS VOLTAGES ARE PRESENT INSIDE THIS INSTRUMENT. SERVICE SHOULD BE PERFORMED BY QUALIFIED PERSONNEL ONLY.

AVERTISSMENT: CET INSTRUMENT PRESENTE DES NIVEAUX DANGEREUX DE TENSION. L'ENTRETIEN DOIT ETRE EFFECTUE PAR UN PERSONNEL QUALIFIE UNIQUEMENT.

WARNING! Protection may be impaired if this device is not used in the manner specified.

- Maintenance and service should only be performed by qualified personnel.
- Make sure the instrument is powered OFF and unplugged from the power source before removing the covers to perform any internal maintenance or service. Failure to do so can result in electrical shock, which can cause injury or death.
- Failure to use proper safety equipment when mixing salt solution can result in frostbite or burn injuries. Salt solutions should be prepared only by qualified people with proper safety equipment.

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Chapter 1: Introduction

This chapter provides a brief overview of the OX-TRAN Model 2/12 R Oxygen Transmission Rate System.

Read this chapter to get an overview of:

- The features of the OX-TRAN Model 2/12 R system
- A summary of basic steps in a permeation test
- A summary of how a Oxygen Transmission Rate measurement is performed
- A summary of how Film and Package testing is performed

Figure 1-1: OX-TRAN Model 2/12 R System

Features

The following features of the OX-TRAN Model 2/12 R Oxygen Transmission Rate System make it very versatile and easy to use:

- Fully automatic (Hands Off) testing.
- Removable test cell for faster film mounting.
- Pneumatically clamped test cells.
- TruSeal™ test cells for increased performance.
- Automatic control of the Test Cell Temperature.
- Automatic control of Pressure, Flow and RH.
- Automatic Barometric Pressure compensation.
- Package Testing Adapter (Optional).
- Carrier Purge feature for package testing.
- Fast changeover from Wet to Dry testing.
- Advanced oxygen sensor over-range protection.
- Advanced Gas Saver function reduces gas consumption.
- Advanced automatic testing features simplify testing Barriers with unknown properties.
- Automatic Test Sequencing (perform a sequence of tests at different RH and temperatures).
- Automatically save and print Test Results.
- Internal storage of at least 100 Test Results.
- Integrated and intuitive touch screen operator interface.
- Remote Access and Control (requires optional Perm-Net Light software).
- Standard Ethernet port (100T).
- Dual USB 2.0 ports (for connection of keyboard, mouse or memory devices).

Permeation Test Overview

A "Permeation Test" consists of up to two phases that are performed using a Test Cell. The "Cell" may contain a flat film sample or be connected to a package fixture. The Test Phase (always present) is used to measure the transmission rate of the test sample. The Individual Zero Phase is optional and may occur at the beginning or end of a Permeation Test. Each phase in the test consists of a series of discrete states. A Permeation Test may utilize all or only a subset of the possible test states. During a test the steps (or states) within each phase are executed in a fixed order. This order is called the "Test Sequence". A brief description of the phases and states within a permeation test are given below:

Individual Zero Phase

An Individual Zero Phase is used to determine the amount of oxygen that is present in the carrier gas from factors other than actual transmission through the sample. This amount is subtracted from the transmission rate obtained for each sample during testing. For more information on when and how to use an Individual Zero Phase see "Individual Zero Processing" in Chapter 3.

Conditioning the Sample

Almost every material requires a period of time to acclimate to the environment and reach equilibrium. A time period can be specified to allow the barrier to "Condition" to the test environment. The Conditioning Period when used will occur at the beginning of each test phase.

ReZero State

Periodically the instrument baseline must be measured so that any changes in the baseline will not affect the accuracy of your transmission rate data. This is done during a "ReZero State" by measuring the apparent oxygen transmission rate of the ReZero Cell.

Cell Examination State

The Cell Examination State is used to measure the transmission rate of the barrier sample. The carrier gas leaving the Test Cell is sent to the oxygen sensor where the amount of oxygen contained in the gas is measured to determine a transmission rate.

Bypass State

When no gas is being routed to the oxygen sensor it is said to be in the Bypass State. The Bypass State is used to maximize the useful life of the sensor. The oxygen sensor is automatically placed in Bypass during conditioning, when tests are completed or when an excessively high level of oxygen is detected.

Test Completion

At some point sufficient measurements will have been made to accurately determine the transmission rate of the samples. A Permeation Test can be terminated manually by the user, after a fixed number of test cycles or using an automatic convergence process. When testing is complete, the cell is removed from the test sequence and no further transmission rate examination of that sample is performed. For more information on stopping a transmission rate test see "Determining When to Stop a Test" in Chapter 3.

Report Generation

You can request a report for one or both cells at any time until a new permeation test is started. See the instrument Help System for information on printing reports.

Measuring an Oxygen Transmission Rate

To make an accurate transmission rate measurement a known concentration Test Gas (usually 100% Oxygen) is applied to one side of the barrier material to be tested and the other side is swept with an oxygen free Carrier Gas (nitrogen). This process is illustrated in Figure 1-2 which depicts a Film sample mounted in a standard OX-TRAN Model 2/12 R Test Cell.

As shown in the illustration the film is mounted between the two parts of the test cell. The o-rings and sealing surfaces in the cell prevent outside air from affecting the measurement.

The Test Gas (oxygen) is continuously admitted to bottom half of the cell and allowed to exit through an exhaust port.

The Carrier Gas enters the top half of the cell. As Test Gas permeates the sample barrier it mixes with the Carrier Gas. The output side (exhaust) of the test cell is routed to an oxygen sensor. The amount of oxygen in the carrier gas is measured using the oxygen detector.

Seal leakage can be a significant source of error when measuring the transmission rate of a film sample. The TruSeal™ flush ring at the perimeter of the Test Cell minimizes the effect of ambient oxygen on the measurement. During a test the TruSeal™ flush ring is purged with carrier gas minimizing the possibility of leakage past (or permeation through) the seals.

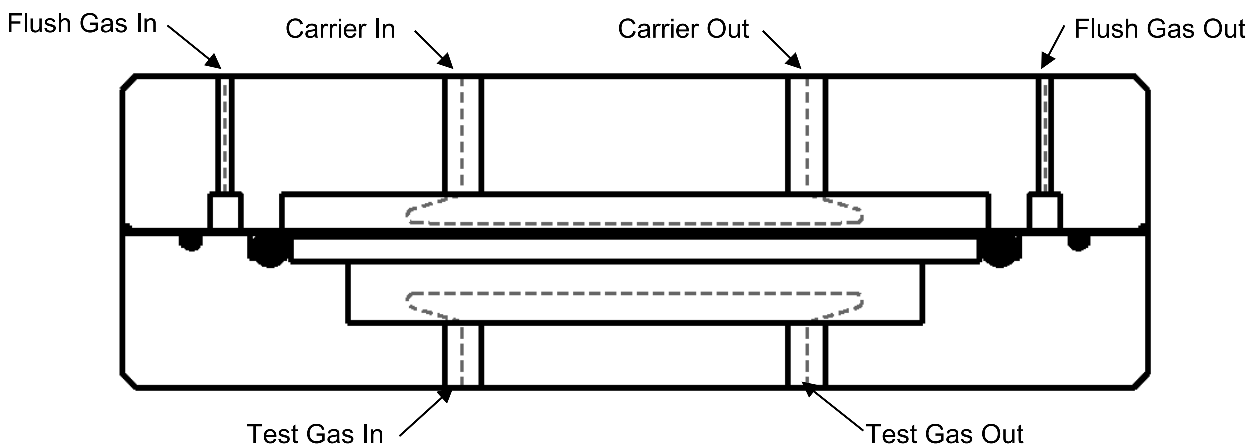


Figure 1-2: The OX-TRAN Model 2/12 R Test Cell

Testing Films and Packages

The OX-TRAN Model 2/12 R can measure the oxygen transmission rate of film samples or entire packages.

To test a film sample it is prepared and mounted in a Test Cell. The test cell is used to maintain the film sample at a specified temperature. The Test Gas and Carrier Gas supplied to the test cell can be Dry or at a specified RH. For more information on testing Flat Film samples see Chapter 6.

To test packages at ambient temperature; a package mounted in an appropriate "fixture" can be connected to the OX-TRAN Model 2/12 R using the optional Package Adapter. For more control over sample temperature an Environmental Chamber can be used. For more information on testing packages see Chapter 7.

Chapter 2: Setting Up

This chapter provides information on how to set up an OX-TRAN Model 2/12 R and prepare it for use.

Read this chapter to learn about:

- Unpacking the System
- The Oxygen Trap
- Preparing for System Installation
- Front Panel Parts and Controls
- Back Panel Parts and Controls
- Connecting oxygen and nitrogen gas lines to the instrument

Unpacking the System

Each OX-TRAN Model 2/12 R instrument is shipped in its own crate. Any optional kits or accessories may be shipped in the instrument crate or in separate cartons. A checklist will be included for the instrument and any of the optional kits you may have purchased.

If any components are missing or damaged please call MOCON in the USA at (763) 493-6370.

The Oxygen Trap

An Oxygen trap is required for each instrument to remove residual oxygen from the Carrier gas. The recommended oxygen trap will last approximately one year under normal conditions when the residual oxygen in the carrier gas is 10 ppm or less.

Preparing for Installation

The Site Preparation Instructions (Appendix A) contain important information about preparing a location for the instrument and the facilities required for your new instrument. Please read Appendix A before proceeding with the installation of the OX-TRAN Model 2/12.

The ambient environmental conditions in which the instrument will be used must meet those specified on page 10-1 in Chapter 10.

The OX-TRAN Model 2/12 R should be placed on a bench or table capable of supporting approximately 43 kg (95 lbs). The work surface should be flat, clean and free of excessive vibration.

If installing a printer that will be directly connected to the OX-TRAN Model 2/12, place it next to the instrument. Read the manual that came with the printer for installation procedures.

Do not plug the instrument or printer into a power source until all components have been set up and connected.

Before proceeding with the setup or operation of the instrument familiarize yourself with the locations and names of the parts and controls on the front and rear of the instrument.

Front Panel Parts and Controls

The names and locations of the parts and controls located on the front of the instrument are shown in Figure 2-1, Figure 2-2 and Table 2.1.

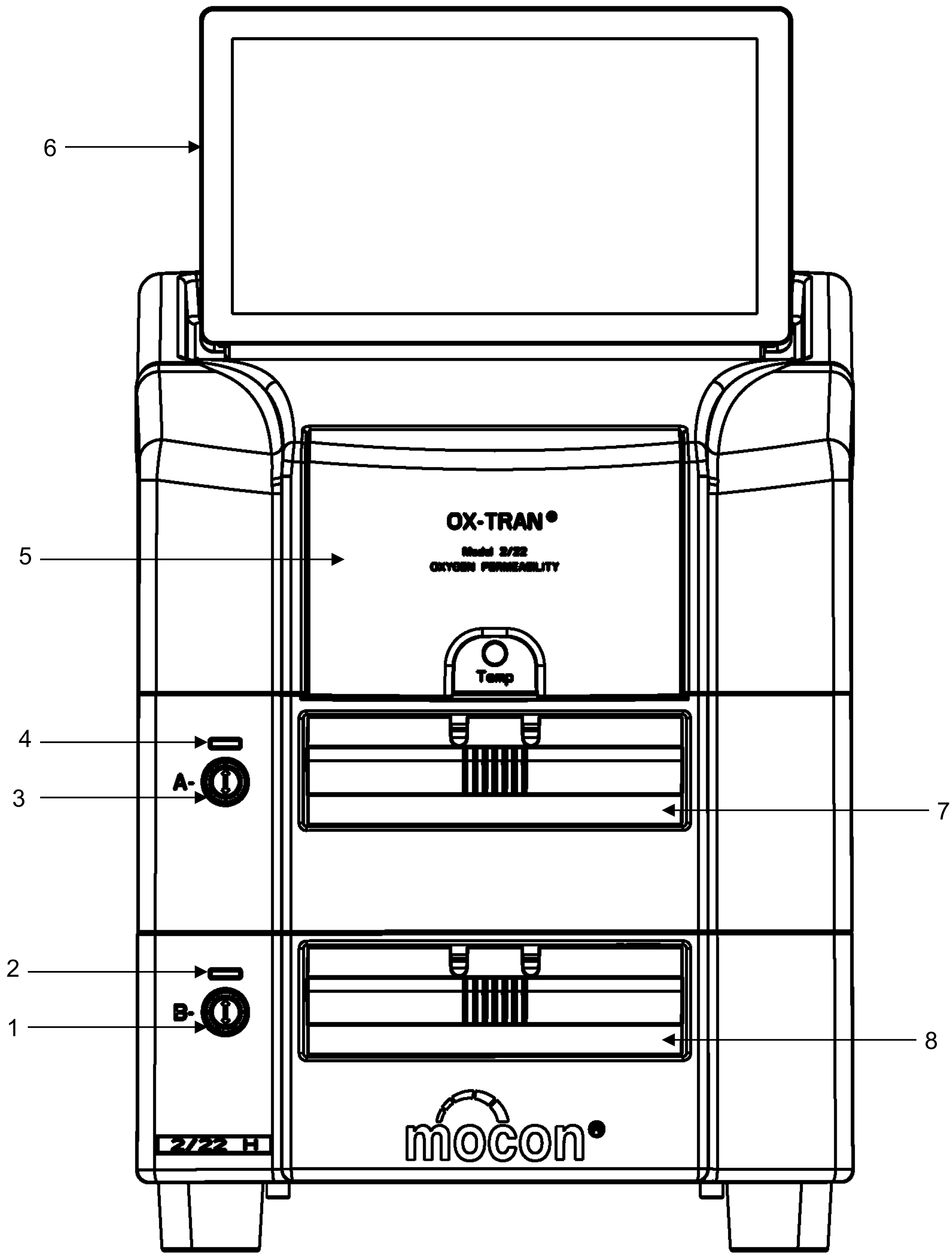


Figure 2-1: Front Panel Parts and Controls

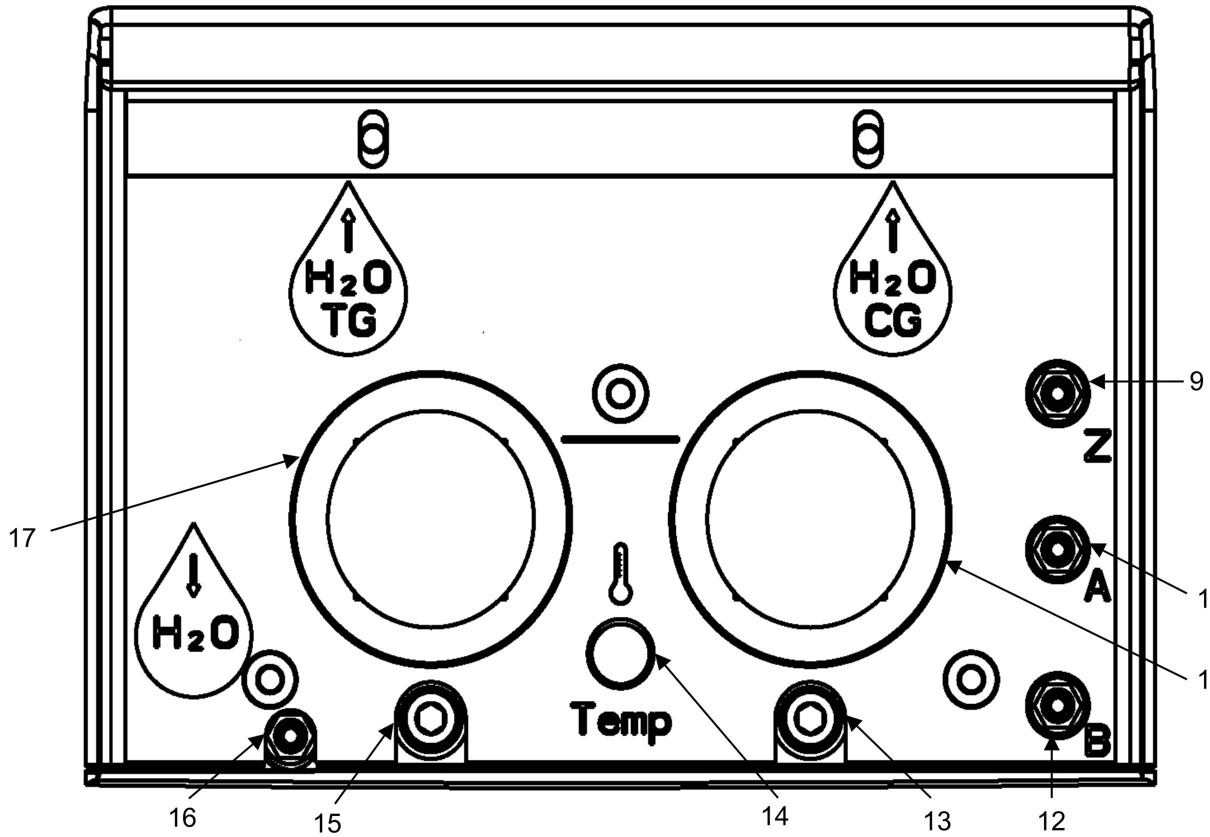


Figure 2-2: Front Panel Parts and Controls

Item	Name	Description
1	Cell B Load/Unload button	This button is used to Load and Unload the Test Cell
2	Cell B Status Indicator	This indicator is used to show the Status of Cell B
3	Cell A Load/Unload button	This button is used to Load and Unload the Test Cell
4	Cell A Status Indicator	This indicator is used to show the Status of Cell A
5	Cover	The cover that is used to access the Humidifiers and cell vents
6	Instrument Display	The color touch-screen display used for instrument control
7	Test Cell Drawer - Cell A	The drawer where the Test Cell for Cell A is contained
8	Test Cell Drawer - Cell B	The drawer where the Test Cell for Cell B is contained
9	ReZero Cell Vent	The carrier gas vent for the ReZero cell
10	Cell A Vent	The carrier gas vent for Test Cell A
11	Water Reservoir - Carrier Gas	Window showing the Carrier Gas Reservoir water level
12	Cell B Vent	The carrier gas vent for Test Cell B
13	Carrier Gas Reservoir Drain/Fill Valve	The screw used to open & close the reservoir Drain/Fill valve
14	Thermometer Well	A thermometer well for use with a external thermometer
15	Test Gas Reservoir Drain/Fill Valve	The screw used to open & close the reservoir Drain/Fill valve
16	Reservoir Drain/Fill Port	The Drain/Fill port for the Reservoirs
17	Water Reservoir - Test Gas	Window showing the Test Gas Reservoir water level

Table 2.1: Front Panel Parts and Controls

Back Panel Parts and Controls

The names and locations of the parts and controls located on the back of the instrument are shown in Figure 2-3 and Table 2.2.

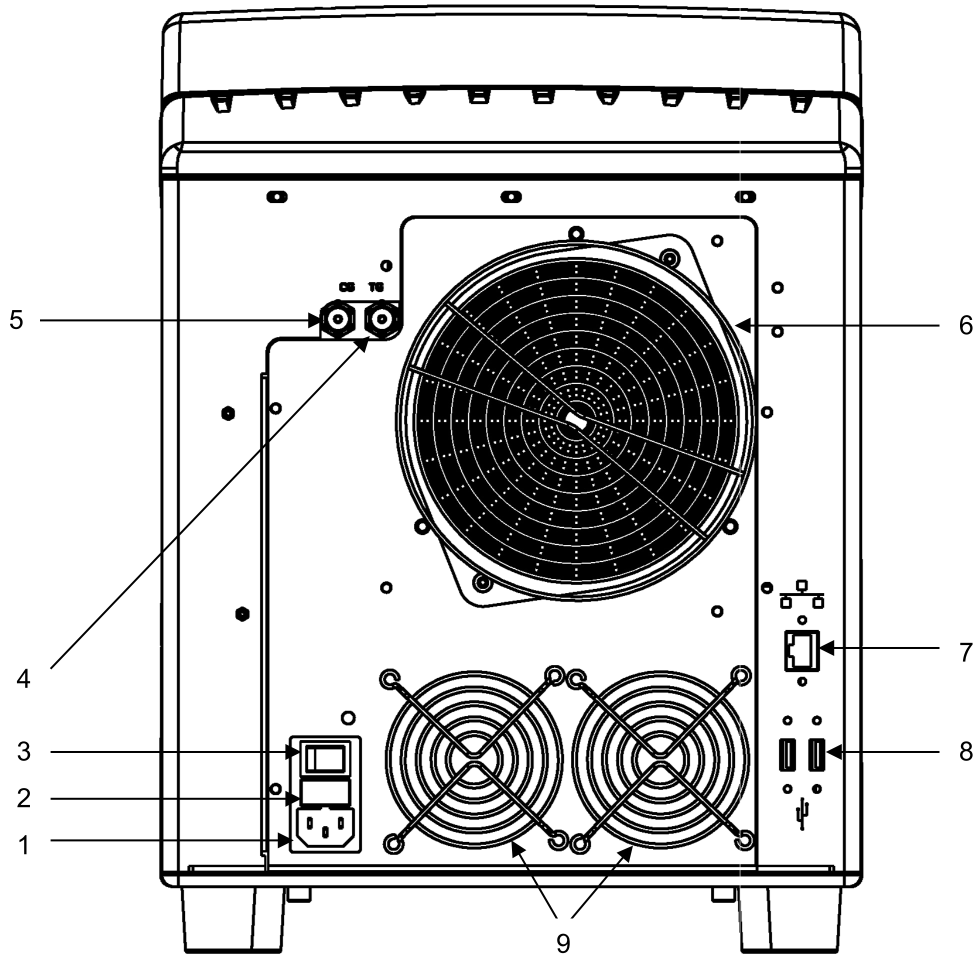


Figure 2-3: Back Panel Parts and Controls

Item	Name	Description
1	Power In	The connector the power cord attaches to.
2	Fuse Holder	The fuse holder contains the fuses used to protect the instrument.
3	Power Switch	The switch that is used to turn the instrument on and off. I is ON O is OFF
4	Test Gas Inlet Port	The fitting that connects the test gas supply to the instrument.
5	Carrier Gas Inlet Port	The fitting that connects the carrier gas supply to the instrument.
6	Cooling Fan	The fan that supplies cooling air to the test cell heating/cooling system.
7	Network Port	A 10/100T Ethernet port for connection to a network.
8	USB Ports	USB 2.0 Ports for connection of USB devices (keyboard, mouse).
9	Enclosure Fans	The fans that supply cooling air to the instrument enclosure.

Table 2.2: Back Panel Parts and Controls

Test Gas (Oxygen)

The OX-TRAN Model 2/12 R equires an oxygen test gas with a purity of at least 99.9%. The regulator (on the compressed gas cylinder) must be approved for oxygen use. The optional Regulator Assembly contains an approved Oxygen Regulator. A standard T size cylinder should provide sufficient gas to operate a single instrument for several weeks.

Carrier Gas (Nitrogen)

The OX-TRAN Model 2/12 R equires UHP Nitrogen (Ultra High Purity) for the Carrier Gas. The Carrier Gas supply must contain less than 10 ppm residual oxygen. A standard T size cylinder will typically provide sufficient gas to operate a single instrument for several weeks.

Gas Distribution Systems

Each instrument ships with two local regulator/isolation devices (called Regulator Tees) that can be used to connect the instrument to a common Test Gas/Carrier Gas distribution system. Figure 2-4 illustrates how a gas distribution system for multiple instruments can be created using the provided Regulator Tees.

When using compressed gas cylinders, consideration should be given to the impact cylinder replacement will have on operational efficiency. Interruptions to the gas supply when a cylinder is changed (or goes empty) will have an adverse effect on any active tests. Cylinder manifolds that provide an uninterrupted gas supply during cylinder replacement are available from many gas suppliers.

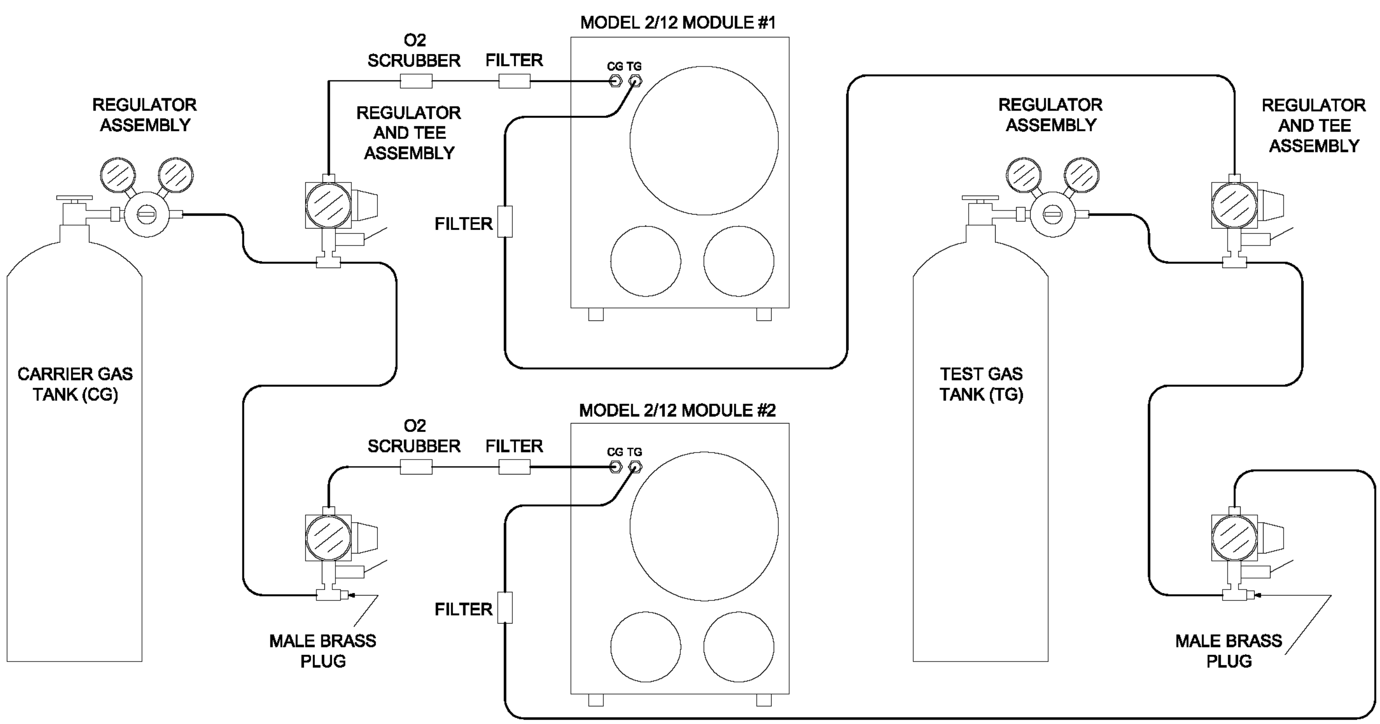


Figure 2-4: System Plumbing Connection Diagram

Connecting the Gas Lines

The OX-TRAN Model 2/12 R has two gas inlets, one for connecting the Test Gas (oxygen) supply and the other for connecting the Carrier Gas (nitrogen) supply. These compression fittings are intended for use with 1/8" copper tubing. Refer to Figure 2-3 and Figure 2-4 for the location of these fittings and an example of plumbing system diagram.

The optional Starter Kit (051-939) contains 50 feet (14 meters) of tubing in addition to extra compression nuts, ferrules and grease.

Follow these steps to connect the Carrier Gas supply lines:

1. Remove the brass plug from the Carrier Gas fitting on the instrument back panel. Save the plug it will be needed later.

2. Cut a piece of tubing approximately 3 inches in length (8 cm).
3. Cut a piece of tubing approximately 6 inches in length (15 cm)
4. Cut a piece of tubing approximately 10 inches in length (25 cm).
5. Remove the nuts and ferrules that came with the Brass Filter and a Regulator Tee.
6. Apply a thin coating of Apiezon grease to four of the brass compression ferrules.
7. Apply a thin coating of Apiezon grease to the ferrules that came with the oxygen scrubber.

8. Connect the Carrier Gas fitting on the instrument back panel to the Brass Filter (051-791) using the 3 inch length of tubing and two nuts and ferrules. The arrow on the Filter must point towards the tube connected to the instrument back panel.
9. Connect the 10 inch length of tubing to the input of the Brass Filter using a nut and ferrule.

10. Connect the end of the 10 inch tube to the output fitting on the oxygen scrubber using one of the nuts and ferrules that came with the scrubber. The arrow on the oxygen scrubber must point towards the Brass Filter.
11. Connect the 6 inch length of tubing to the input fitting on the oxygen scrubber using the nuts and ferrules that came with the scrubber.
12. Connect the other end of the 6 inch length of tube to the output fitting of a regulator tee using a nut and ferrule.

13. Apply a thin coating of Apiezon grease to two compression ferrules.
14. Cut a piece of tubing to connect the regulator tee to the Carrier Gas cylinder regulator.
15. Connect the Carrier Gas regulator tee to the Carrier Gas (Nitrogen) supply regulator using two nuts and ferrules.

16. If there are additional instruments to be connected, repeat steps 2 - 12 and 17 - 19 for each instrument.

17. Apply a thin coating of Apiezon grease to two compression ferrules.
18. Cut a piece of tubing to connect the regulator tee on the previous instrument to the regulator tee on the next instrument.
19. Connect the previous Carrier Gas regulator tee to the next Carrier Gas regulator tee using two nuts and ferrules.
20. Using the plug removed in step one, cap the open port on the last regulator tee assembly.

Caution: Before proceeding verify that the Carrier Gas and Test Gas inlets on each instrument are connected to the appropriate gas supply. If the Carrier Gas inlet is connected to the oxygen supply, the oxygen sensor will be damaged and replacement will be required.

Follow these steps to connect the Test Gas supply lines:

1. Remove the brass plug from the Test Gas fitting on the instrument back panel. Save the plug as it will be needed later.

2. Cut a piece of tubing approximately 3 inches in length (8 cm).

3. Cut a piece of tubing approximately 13 inches in length (41 cm).

4. Connect the Test Gas fitting on the instrument back panel to the Stainless Steel Filter (052-084) using the 3 inch length of tubing and two nuts and ferrules. The arrow on the Filter must point towards the tube connected to the instrument back panel.

5. Connect the input of the Filter to the output fitting on a regulator tee using the 13 inch length of tubing and two nuts and ferrules.

6. Cut a piece of tubing to connect the regulator tee to the Test Gas cylinder regulator.

7. Connect the Test Gas regulator tee to the Test Gas (Oxygen) supply regulator using two nuts and ferrules.

8. If there are additional instruments to be connected, repeat steps 2 - 5 and 9 - 10 for each instrument.

9. Cut a piece of tubing to connect the regulator tees on the previous instrument to the appropriate regulator tees on the next instrument.

10. Connect the previous Test Gas regulator tee to the next Test Gas regulator tee using two nuts and ferrules.

11. Using the plug removed in step one, cap the open port on the last regulator tee assembly.

Caution: Before proceeding verify that the Carrier Gas and Test Gas inlets on each instrument are connected to the appropriate gas supply. If the Carrier Gas inlet is connected to the oxygen supply the Oxygen sensor will be damaged and replacement will be required.

Setting the Gas Supply Pressures

Set the Gas Supply Pressures as follows:

1. Set the Carrier Gas cylinder or main line regulator pressure to 35 psi.
2. Set the Test Gas cylinder or main line regulator pressure to 35 psi.
3. Set the pressure on the Carrier Gas regulator-tee so that the gauge reads 29 psi.
4. Set the pressure on the Test Gas regulator-tee so that the gauge reads 29 psi.

Caution:	**The maximum Carrier Gas pressure to the instrument must not exceed 32 psi. Input pressures greater than 32 psi (2.2 bar) will damage the system.**

Caution:	**The maximum Test Gas pressure to the instrument must not exceed 32 psi. Input pressures greater than 32 psi (2.2 bar) will damage the system.**

Note: When using compressed gas cylinders the tank must be replaced when the pressure falls below 300 psi (on the first stage of the regulator).

System Outgassing

Before the system can be used any air trapped in the gas lines and instrument must be purged out. After purging the carrier gas supply system, the instrument must be out-gassed. After the initial purge, residual oxygen may still be present in the seals and void spaces within in the instrument. Out-gassing removes this residual oxygen from the system.

To out-gas the system follow these steps:

1. Verify the Gas Supply Pressures are set correctly; see setting the Gas Supply Pressures on page 2-8.
2. Turn the instrument on.
3. Mount a film in the Test Cells, for more information see "Mounting a Sample in the Test Cell" on page 6-5.
4. Load and Clamp the Test Cells, for more information refer to "Loading and Unloading the Test Cell" on page 6-6.
5. Let the system out-gas for at least one hour before starting a test.

Chapter 3: Preparing for a Test

This chapter provides information on how to prepare for a permeation test.

Read this chapter to learn about:

- Testing Basics
- How Barrier Properties Affect Testing
- Developing Test Methods for Films and Packages
- Developing a Temperature Profile

Testing Basics

A permeation test is comprised of a series of discrete actions or events. Some of these steps require human thought, action or intervention. Some of the steps are performed by the instrument and will be discussed elsewhere. The most important part of the process is the planning and preparation that occurs before the actual testing begins. Inadequate planning or preparation may result in an inaccurate measurement. This chapter contains information on the factors that should be considered when planning for a permeation test.

How Barrier Properties Affect Testing

A good understanding of the barrier material properties for the samples to be tested is very helpful when preparing for a permeation test. The transmission rate of the sample and the conditions at which it will be tested may require changes to the test methodology.

Any sample with a transmission rate within the range of the instrument (as specified in Chapter 10) can be tested. Additional consideration is advised when setting up tests for samples that have a transmission rate within 25% of the upper or lower end of the instruments test range. A Good Barrier is generally considered any material with a transmission rate less than 10 cc / (m^2 • day) or 0.05 cc / (pkg • day). A Poor Barrier is generally considered any material with a transmission rate greater than 100 cc / (m^2 • day) or 0.5 cc / (pkg • day) when using a 100% oxygen test gas.

Testing Good Barriers

When testing Good Barrier film samples use as large a sample as possible, masking is not normally advised. Longer Cell Examination and ReZero Examination times may be required. An Individual Zero test phase may improve measurement accuracy when testing Good Barriers.

Testing Poor Barriers

Use caution when testing Poor Barriers an excessively high transmission rate may over-range the oxygen sensor. Persistent or repeated over-range conditions will shorten the lifespan of the Oxygen sensor. Common poor barrier materials include polyethylene, polycarbonate and acrylic.

The possibility of an over-range condition can be reduced by; lowering the oxygen concentration of the Test Gas, using a mask to reduce the sample area when testing film samples or increasing the Carrier Gas flow rate. Using any or all of these methods to reduce the amount of oxygen the Oxygen Sensor is exposed to will also increase the life of the sensor.

Testing Mixed Barriers

Simultaneously testing barriers with widely divergent transmission rates is not recommended. The data for both samples may not be accurate when there is a large difference in the two transmission rates. If during a test there is a large difference in the transmission rates, set one cell to Idle and continue testing the other one. You may want to determine which sample will condition more rapidly and test that sample first.

Testing Moisture Sensitive Barriers

With some materials such as nylon, cellophane and ethyl vinyl alcohol, variations in the amount of water vapor absorbed from the carrier and test gases will significantly affect the oxygen transmission rate.

NOTE: Use an Individual Zero phase (see "Individual Zero Processing" on page 3-3 in this chapter) when testing low transmission rate samples under high relative humidity conditions.

Some hydroscopic materials expand or swell when water is absorbed into the polymer or fiber structure. The extent of this swelling depends largely on the solubility factors of the polymer or fiber. If swelling is severe enough, the film may droop or dome, causing the gas ports (ingress or egress) to be covered. This will result in erroneous data.

To prevent this blockage, always precondition hygroscopic films in a hydrator or container over either distilled water (100% RH) or a salt solution (see Appendix F) that will give the desired RH. If several RH levels will be used during testing, always precondition at the highest RH anticipated before mounting the sample in the cell.

Developing Test Methods for your Films and Packages

Choosing the appropriate test conditions and methodology is one of the most important preparatory tasks. Inaccurate test results and "Failed" tests are commonly caused by inappropriate methodology. A good understanding of the characteristics of the barrier sample will be very helpful in choosing an appropriate methodology. For specific information on how to set or adjust the Test Method parameters discussed in this section please refer to the Instrument Help System.

The Examination Time

The Exam Time specifies how long (in minutes) the Test Cell (containing the sample) will be examined to determine the oxygen transmission rate. During this examination time the carrier gas (along with any oxygen that has permeated the sample) is routed to the sensor. For some barriers you may need to increase the examination time. This is because the sensor approaches its final value at an exponential rate. For some barriers the sensor may not properly stabilize within the default examination time. For most barriers the small increase in oxygen transmission rate caused by increasing the examination time is insignificant.

The ReZero Frequency

The baseline of the instrument can shift slightly during testing due to such changes as ambient temperature. The ReZero process adjusts for these small shifts in the instrument baseline.

The ReZero function can be turned on and off. The default is on with a new zero taken every two cell examination periods (equivalent) to one pass for each cell. The default values were chosen to provide optimum conditions when testing very good barriers. This means that a new baseline (the ReZero value) will be established after every cell examination.

The Sample Conditioning Time

When you condition a sample in the test cell, carrier gas and test gases are routed to the test cell as they are during testing. However, the carrier gas is not routed to the Permeant sensor. This conditioning period allows a sample barrier to acclimate to the conditions within the test cell.

During individual zero processing nitrogen is used as the test gas. When you use individual zero processing the sample will actually be conditioned twice, once in nitrogen before individual zero testing and once in oxygen before oxygen transmission rate testing.

Some barrier materials may take a long time to reach equilibrium, a conditioning period offers two advantages when performing a test:

- It prevents unnecessary exposure of the Permeant sensor to oxygen, thus extending the life of the sensor.
- It limits the number of transmission rate values that appear on a printed report.

The amount of time in hours that the sample is conditioned can be specified. After the specified conditioning period the system will automatically begin testing or individual zero processing.

Individual Zero Processing

Adjusting the ReZero frequency will compensate for small shifts in the baseline zero. It may also be necessary to compensate for individual variations such as edge leakage or edge effect in the test cells. This is done with Individual Zero Processing.

During individual zero processing nitrogen is routed through both halves of the test cell. Any oxygen that is picked up on the carrier gas side is thus due to factors other than permeation.

The instrument automatically subtracts this Individual Zero value from the oxygen transmission rate value to produce a very accurate result.

Whenever you test a Very Good barrier you should perform individual zero processing. The settings for the Individual Zero mode field are explained below.

None	When Individual Zero mode is set to "None" an Individual Zero phase will not be performed. The default Individual Zero mode is "None".
Beginning/End	When using these options, the individual zero value for the cell is measured. This value is subtracted from the measured transmission rate to give a corrected transmission rate value. The "Beginning" and "End" settings indicate when the Individual Zero phase will be performed at the Beginning or at the End of the test.
Use Last	In this mode the latest individual zero value measured is used. This value is subtracted from the measured transmission rate to give a corrected transmission rate value. The mode is useful if making many tests on the same type of material and the user is confident that edge leakage is not a problem and every sample barrier is mounted the same.

Determining When to Stop a Test

The setting used for the "Test Mode" parameter determines how and when a transmission rate test is stopped (Test Completion). Four different methods of stopping a transmission rate test are provided. The four methods are: "Continuous", "Standard", "Convergence By Cycles" and "Convergence By Hours".

The **Continuous** mode executes until manually stopped by an operator. The **Standard** mode executes for the number of cell examination cycles specified by the "Number of Cycles" parameter. The **Convergence** modes execute until equilibrium is achieved as defined by the convergence parameters.

Unless the characteristics of the test sample are well understood, the continuous mode should be used. If the test is stopped prematurely the transmission rate reported will not reflect the true transmission rate for the material. For more detailed information on the "Test Mode" parameter see the Instrument Help system.

Choosing a Test Method

There are three different ways to specify how a permeation test is to be performed. These "Test Methods" are described briefly in the following section. For more detailed information see the Instrument Help system.

The Auto Test Method

The Auto-Test Method removes most of the requirements for the user to make decisions regarding test methodology. The Auto-Test Method utilizes an internal rule-set to dynamically optimize test parameters and an advanced dynamic convergence algorithm. To perform a test the user just needs to enter the sample identification information and the standard test conditions (Test Temperature and RH). For more information see "How the Auto-Test Method Works" in Appendix D.

A test performed using the Auto-Test Method may take longer to complete due to stricter requirements for Test Completion (when a test is stopped). The Auto Test Method does not allow the flexibility of specifying exactly how the test will be performed.

The Advanced Test Method

The Advanced Test Method allows the user to specify all of the parameters and conditions used to perform a permeation test. An Advanced Test Method allows the most flexibility in determining how a permeation test will be executed. The Advanced Test method also allows Test Sequencing.

Saved Test Methods

Saved Test Methods are Advanced Test Methods that have been saved and can be recalled for later use. Saved test methods are accessed using the "Methods" control displayed at the bottom of any Advanced Test Method screen.

Using Test Sequencing

The Sequential Testing function allows a series of tests to be performed on the same samples at different test conditions (Temperature and RH). Once started a sequential test series will execute all of the tests in the Sequential Test Parameters table without requiring user intervention.

The series of test to be executed is defined by enabling the Sequential Test function in an Advanced Test method and defining the individual test conditions using the Sequential Test Parameters Table. For more information see "How Sequential Testing Works" in Appendix D.

Chapter 4: Using the Instrument Software

This chapter provides an overview of the software system used to operate the OX-TRAN Model 2/12. Detailed information on how to use the instrument software can be found in the Instrument Help System.

Read this chapter to learn about:

- The Features and Capabilities of the Instrument Software
- The Structure and Organization of the Instrument Software
- Accessing the Screens and Functions in the Instrument Software

The instrument software is used to control and monitor all instrument functions and test activity. The only activities that require operator intervention are loading/unloading the test cells, filling the humidifier reservoirs, setting the initial test conditions and starting tests.

Many of the test conditions can be set automatically when the "Auto Test" function is used to start a test. The operator has full control of all test parameters when the "Advanced Test" function is used. As the test progresses data is collected and logged.

The resulting data is made available in tables and charts. The information (displays and reports) is available in both tabular and graphical formats. A Diagnostic interface is included for instrument maintenance and calibration.

Software Features

- Stored Test Methods
- Multiple Test Strategies
- Independent Cell Level Test Parameters
- Automatic or Manual Test Parameter Selection
- Automatic Sequential Execution of up to ten Tests
- Real Time Graphical Display of Test Status
- Real Time Tabular Display of Test Status
- Automatic Reporting and Archival of Test Results
- Manual Reporting and Archival of Test Results
- Optional FDA CFR 21 Part 11 Compliant Operation

Instrument Software Structure and Organization

All of the User Interface and Instrument Control functions of your permeation system are accessed through the Instrument Software. The User Interface consists of a Title bar, an Icon bar, and the Workspace

The "Title" bar is a fixed region at the top of the screen that shows the users login status, the name of the current screen displayed in the workspace, an icon for printing a screen image, an icon for accessing the Help System and a "close" button. The "Icon" bar is the fixed region below the Title bar containing seven icons. The "Workspace" occupies the remaining space below the Icon bar.

The various functions and screens that appear within the workspace are accessed using the icons in the Icon bar. Selecting one of these icons displays a screen in the workspace or a menu from which additional choices can be made.

When the instrument is started the Home screen is automatically displayed in the workspace. The application contains eighteen additional screens, which are organized according to their primary function or task. These functions can be described as belonging to one of the following six categories:

- Test Setup
- Starting and Running Tests
- Monitoring Test Activity
- Reporting Test Results
- Maintenance and Diagnostics
- Help

The functions in the first four categories listed above are organized into nine different screens. Each of these screens when "opened" replaces the one previously displayed in the workspace. Seven of the remaining screens are accessed using "Tools" icon.

The two remaining screens are accessed using the "Help" icon. The first Help menu item is used to display the Instrument Help System. The help system is displayed in the workspace below the Icon bar and contains two panes. There is a navigation\search pane on the left and a topic pane on the right. The help system contains detailed information on all of the features, functions and fields in the instrument software.

The "About" menu item is used to display information about the instrument that may be needed when requesting service or support.

Chapter 5: Permeant Sensor Calibration

The Permeant Sensor in the OX-TRAN Model 2/12 R equires periodic calibration to ensure accuracy when measuring the oxygen transmission rate.

NOTE: MOCON is not responsible for problems resulting from improper use of the Permeant Sensor Calibration function or use of an inadequate transmission rate reference material.

Permeant Sensor Performance Check

The instrument should be calibrated on a regular basis. MOCON recommends a Calibration Check be performed at least monthly. The instrument should be checked more frequently when testing low barrier materials or performing a high volume of tests.

The accuracy of the oxygen sensor can only be checked by using a film to generate a reference transmission rate. The transmission rate of this film must be known to a high degree of accuracy. In addition, it is highly desirable that the film have a traceable certificate of accuracy. MOCON strongly discourages using any material that does not meet these conditions.

Mocon strongly advises using only our Certified Films to check the accuracy of the Permeant Sensor

NOTE: Mocon has available certified NIST traceable films that cover the usual testing range. Call MOCON in the USA at (763) 493-6370 for more information.

Performing a Permeant Sensor Calibration

Calibration of the Permeant (Oxygen) Sensor is a two step process. First, a film sample with a known transmission rate must be tested. Refer to the "Permeant Sensor Calibration Test Setup" in this chapter for information on setting up a film test. The data from the test can then be used to adjust the permeant sensor.

After suitable data is available the "OTR Calibration" screens can be used to create and assign a Permeant Sensor calibration record. Refer to the Instrument Help System for more information on creating a Permeant Sensor calibration record.

After a Permeant Sensor calibration record has been created and saved it can be viewed, assigned, inactivated or deleted using the "OTR Calibration" screen. Refer to the Instrument Help System for more information on using the OTR Calibration screen.

Permeant Sensor Calibration Test Setup

To calibrate the instrument to a standard reference film or a certified film use the following procedure:

NOTE: Mocon has available Certified Films that cover the usual testing range. Call MOCON in the USA at (763) 493-6370 for more information.

NOTE: Mocon Certified NIST Films, if not damaged, should last for a year. Do not use the film if it is wrinkled, punctured or contaminated with grease or fingerprints.

NOTE: Certified films should be stored in a manner that will keep them clean and free from wrinkles. MOCON Certified NIST traceable films should be stored in the provided case.

NOTE: MOCON is not responsible for problems resulting from improper calibration or use of an inadequate transmission rate reference material.

1. Select a Certified Film that most closely approximates the transmission rate of the film samples you will be testing.

2. Unclamp and remove the Test Cell from the instrument.

3. Mount the Certified Film (or other reference material) in the Test Cell. For information on mounting films see "Mounting a Sample in the Test Cell" on page 6-5.

4. Replace the test cell and clamp it in place. For information on installing and clamping the Test Cell see "Loading and Unloading the Test Cell" on page 6-6.

5. The Calibration Film Test Procedure should be performed using an "Advanced" Test Method. For information on how to set up an Advanced Test see the instrument Help System.

6. Verify the following Instrument Level parameters have been correctly assigned:

Cell Temperature: When using MOCON provided Certified Films, the test temperature must be set to the value given on the label. If calibrating with another known film, use the temperature at which the transmission rate for the film was measured.

Instrument ReZero:	Instrument ReZero	Enabled
	ReZero Frequency	2
	ReZero Exam Minutes	45

NOTE: Use of the "Test ID", "Sample ID" and "Material ID" fields is advised to document the all of the relevant information on the specific material used to perform the test.

7. Verify the following Cell Level parameters have been correctly assigned:

Package/Film selection: Verify that Package mode is selected if using a masked MOCON Certified Film. If using another film, set the Package/Film control to the appropriate setting for the method used to establish the reference transmission rate.

Area/Cell: Verify the area is set correctly when not using Package mode.

8. Verify the following Test Level parameters have been correctly assigned:

Test Mode: Verify the Test Mode parameter is set to continuous mode.

Exam Minutes: Set the examination time appropriately for the sample being tested. At least 45 minutes is recommended.

Individual Zero Mode: Use of an "Individual Zero" test phase is not advised when using the OX-TRAN 2/12 to test MOCON Certified Films. If an "Individual Zero" test phase is used, setting the Individual Zero control to "Beginning" is advised.

9. After the film has been mounted and test parameters correctly assigned, start testing the reference sample.

10. Monitor the progress of the test using the "Cell Status" and "Instrument Status" screens. When the reference sample has reached equilibrium, advance the cell to the "Test Complete" state. The sample is usually considered to be at equilibrium when there is no discernable trend in the data.

NOTE: Do not advance the test to the Test Complete state unless the film is at equilibrium.

11. Adjust the output of the Permeant Sensor using the "OTR Calibration" screen. Refer to the Instrument Help System for more information on performing an adjustment.

NOTE: Calibration films should be stored in a manner that will keep them clean and free from wrinkles. MOCON Certified NIST Films should be stored in the provided case. You will need to use these films again whenever the instrument needs re-calibration.

Chapter 6: Testing Flat Film Samples

This chapter contains information on how to test flat film samples. Suggestions on how to maximize the accuracy of your results and procedures describing how to perform the test are discussed.

Read this chapter to learn about:

- Testing Suggestions
- Preparing for a Film Test
- Sample Size
- Using Masks
- Sample Orientation
- Preparing the Samples for Testing
- Filling the Humidifiers
- Filling the Humidifiers during a Test
- Conducting a Film Test

Testing Suggestions

The following information will assist you in the day to day operation of your instrument.

- Test duplicate samples whenever possible.
- Use good samples. Pinholes and creases can contribute to false readings.
- Use caution when recording data for a new or unknown specimen. Some materials approach equilibrium slowly. When in doubt repeat the test.
- If the test is to be run under precise RH conditions, make sure that the humidifiers have sufficient water in them.
- If no testing will be performed for a significant period of time (overnight or weekend) no special precautions are needed. The Gas Saver function will automatically be activated (when enabled) whenever both test cells are in the "Idle" state.

  Turning off the power and gas supplies to instrument is not recommended. If the instrument is shutdown you will need to wait for it to outgas before testing can resume.

Preparing for a Film Test

Before a test can be conducted there are a number of tasks that must be performed: The samples to be tested must be prepared. The samples must be mounted in a Test Cell and Loaded into the instrument. Finally, if the test requires a Generated RH the Humidifiers must be checked and filled if necessary.

For information on preparing the film samples refer to the sections on “Sample Size”, “Using Masks” and “Orienting the Sample” in this chapter.

For information on mounting samples and loading the test cell refer to “Mounting a Sample in the Test Cell” and “Loading and Unloading the Test Cell” in this chapter

For information on fill the Humidifiers refer to “Filling the Humidifiers” in this chapter

Sample Size

The film sample should be approximately 4" x 4" (10.16 x 10.16 cm), with a thickness not exceeding 3 mm (0.12 inches). Smaller samples can be masked to allow them to be mounted in the Test Cell, see the following section on “Using Masks”.

The film must be cut to a specific size and shape so it will fit in the Test Cell. Mocon provides a film template (available as part of optional Starter Kit 051-939) as an aid to cutting your film samples.

Using Masks

A foil mask should be used if any of these conditions exist:

- You are testing a material with a transmission rate near or exceeding 28800 cc / (m^2 • day) for full size samples. If such materials are tested as full size samples, the sensor will over range.

  Using a 5 cm^2 mask will reduce the amount of oxygen sent to the sensor by a factor of 10. A 5 cm^2 mask will allow a sample with an un-masked (50 cm^2 area) transmission rate of up to 288000 cc / (m^2 • day) to be tested safely.

- The test material is not available in pieces large enough to mount in the cell.

- The test material is too fragile to support itself across the full cell area.

NOTE: Some materials may fail to adhere fully to the masks, and thus give erroneous and/or highly variable sample-to-sample transmission rates. Always check the compatibility and seal of your sample to the mask adhesive to determine if these problems exist.

When using a mask, specify the mask open area be before starting the test. The mask reduces the area of the test sample (from the standard unmasked 50 cm^2 area). To correctly calculate transmission rate, the instrument must compensate for the difference between the masked and unmasked areas.

If your sample is thin (less than 5 mils), you need only mask one side. Mount the sample in the test cell with the film side facing up.

If your sample is thicker than 5 mils, mask both sides. Be sure the mask apertures are accurately aligned and the edges around the foil aperture are tight against the film.

Orienting the Sample

When mounting test samples, orientation can be important. Edge leakage or oxidation on some materials can affect the test result. It is important to place the "barrier side towards the carrier". Follow the guidelines below to minimize edge leakage and oxidation effects.

Homogeneous Materials

If you are testing a homogeneous, one-layer sample, the orientation of the sample in the cell is not critical.

Multi-Layered and Laminated Materials

Install a multilayered film or laminate with the barrier coating or laminate up, toward the top of the cell. For example, a one-sided, PVDC-coated paper should be mounted with the PVDC side up, placing the PVDC towards the carrier gas.

Metalized Materials

Insert the film into the test cell with the metalized side towards the carrier gas to prevent oxidation.

Humidified Testing

The OX-TRAN Model 2/12 R has the capability of generating a controlled RH from 0 to 90% for both the carrier gas and the test gas. Humidified Carrier and Test Gases are created by moving pressurized gas through a humidifier filled with HPLC-grade water and mixing the wet gas with a dry gas in the appropriate ratios.

Caution:	**To prevent damage to the system, the water level must not exceed the Fill Line.**

Filling the Humidifiers

Before starting a test requiring RH generation the level in the humidifiers should be checked and filled if necessary. Follow these steps to fill the humidifiers:

Note: Refer to Figure 6-1 for the location of the referenced controls.

1. Open the door on the instrument to access the Humidifiers.
2. Check the water levels to determine if there is sufficient water to perform the test.
3. Fill a syringe with HLPC-grade water and attach a short piece of tubing to the luer fitting.
4. Push the end of the tubing onto the Fill/Drain Port fitting.
5. Open the appropriate Drain/Fill Valve by turning it 2-3 turns counterclockwise.
6. Slowly push in the plunger on the syringe to force the water into the reservoir.
7. Close the Drain/Fill Valve and remove the syringe.

Filling the Humidifiers during a Test

During a long test requiring RH generation the level in the humidifiers should be checked periodically and filled if necessary. Follow these steps to fill the humidifiers during a test:

Note: Refer to Figure 6-1 for the location of the reference controls.

1. Open the door on the instrument to access the Humidifiers.
2. Check the water levels to determine if there is sufficient water to perform the test.
3. Put the instrument in ByPass using the GoTo control.
4. Fill a syringe with HLPC-grade water and attach a short piece of tubing to the luer fitting.
5. Push the end of the tubing onto the Fill/Drain Port fitting.
6. Open the appropriate Drain/Fill Valve by turning it 2-3 turns counterclockwise.
7. Slowly push in the plunger on the syringe to force the water into the reservoir.
8. Close the Drain/Fill Valve and remove the syringe.
9. Start a ReZero examination using the GoTo control.

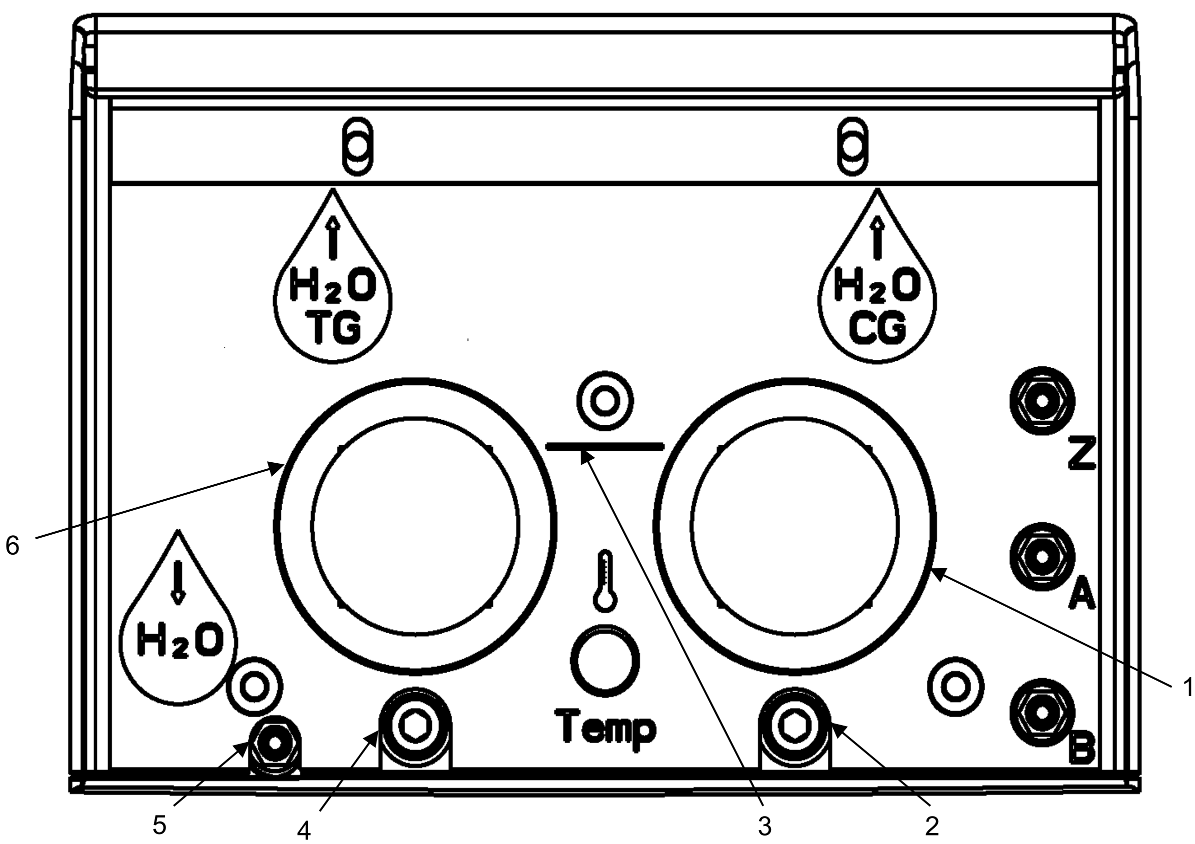


Figure 6-1: Humidifier Fill Port and Controls

Item	Name	Description
1	Water Reservoir - Carrier Gas	Window showing the Carrier Gas Reservoir water level
2	Drain/Fill Valve - Carrier Gas	The screw used to open & close the Carrier Gas Drain/Fill Valve
3	Reservoir Fill Line	The maximum level to which the reservoir should be filled.
4	Drain/Fill Valve - Test Gas	The screw used to open & close the Test Gas Drain/Fill Valve
5	Water Fill/Drain Port	The port used to drain and fill the Humidifiers
6	Water Reservoir - Test Gas	Window showing the Test Gas Reservoir water level

Table 6.1: Humidifier Fill Port and Controls

Mounting a Sample in the Test Cell

Follow the instructions below to mount a film sample in the Test Cell:

Note: For information on cutting and preparing the film samples refer to the sections on "Sample Size", "Using Masks" and "Orienting the Sample" in this chapter.

Note: For an illustration of how a film mounts on the cell surface refer to Figure 6-2.

1. Remove the Test Cell from the instrument (see Loading and Unloading the Test Cell).

2. Separate the top part from bottom part of the cell and remove the old film sample.

3. Clean the film sealing surfaces of the cell to remove the old grease.

4. Apply new Apiezon grease to the sealing surfaces.

5. Inspect the TrueSeal flushing ring and ports, remove any excess grease.

6. Place the top of the cell on a flat surface with the cavity up.

7. Place the film on the greased sealing surface, remove any wrinkles as necessary.

8. Assemble the two parts of the Test Cell.

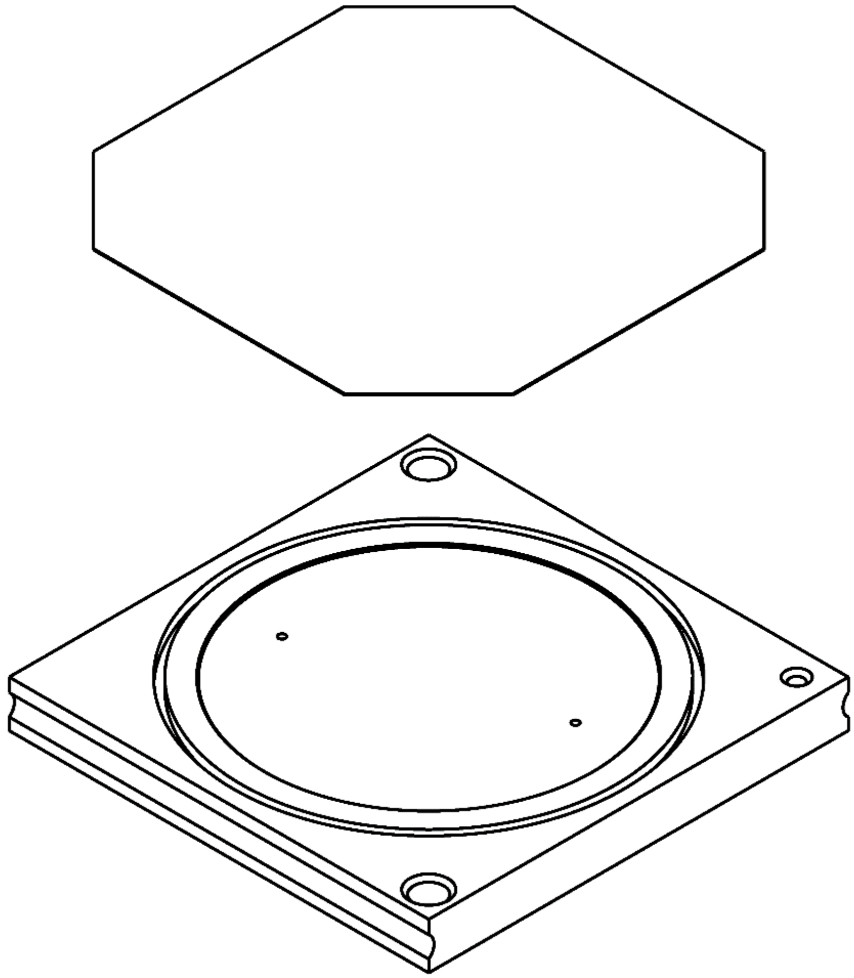


Figure 6-2: Mounting a Film Sample

Loading and Unloading the Test Cell

The OX-TRAN Model 2/12 R uses a pneumatic system to clamp, unclamp and eject the Test Cell. The Test cell must be manually loaded and unloaded from the instrument.

To Unload the Test Cell from the Cell Tray follow the instructions below (refer to Figure 6-3):

1. Press the Cell Load/Unload button on the front of the instrument (see Figure 2-1).
2. Open the Cell Tray completely by gently pulling straight back from the front panel.
3. Grasp the Test Cell by the front and back edges and lift straight up.

To Load the Test Cell into the Cell tray follow the instructions below (refer to Figure 6-3):

1. Grasp the Test Cell by the front and back edges and lower it straight down.
2. Close the Cell Tray completely by gently pushing straight towards the front panel.

3. Gently hold the Cell Tray Shut with a finger.

4. Press the Cell Load/Unload button to clamp the cell (see Figure 2-1).

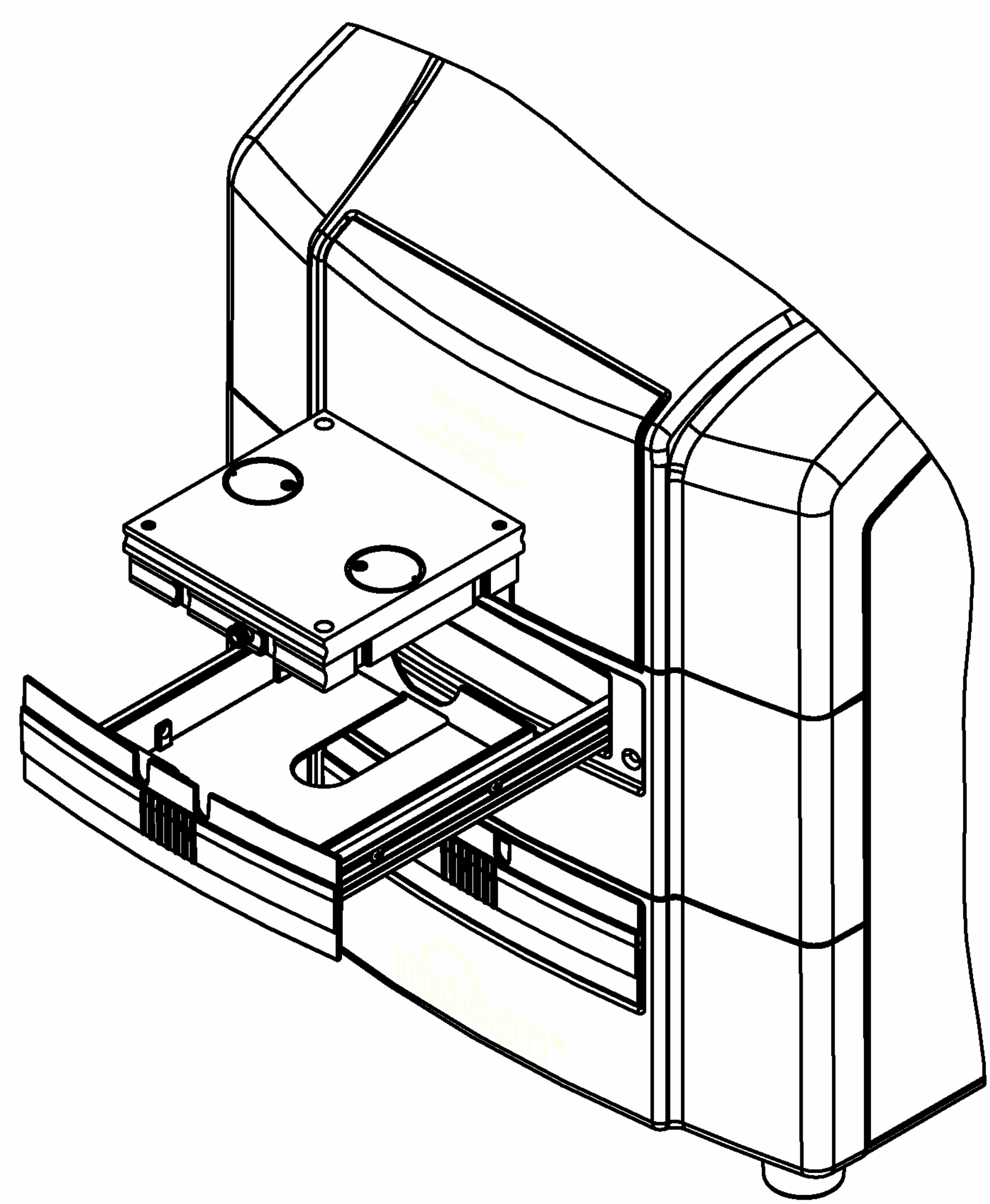


Figure 6-3: Loading the Test Cell

Setting Up and Starting a Film Test

After the samples are loaded and the instrument is ready there are a number of test parameters that must be set. There are two types of test parameters, cell parameters and instrument parameters. Cell Parameters are specific to each cell (Sample ID, Sample Thickness). Instrument parameters are common for all cells (Cell Temperature and Test Gas RH, Carrier Gas RH). The "Test" icon is used to access the screens and controls required to set up the test conditions and start a test.

There are two basic types of test methods that can be used to start a test; an "Auto Test" method or an "Advanced Test" method. The "Auto Test" method attempts to automatically optimize some of the test parameters while the test is executing. An "Auto Test" method can be used to determine the optimum test methodology when the properties of the barrier material are not known. An "Auto Test" is started by selecting the "Test" icon and filling out the fields displayed on the "Cell" and "Instrument" screens.

An "Advanced Test" method allows the operator total control of all test parameters. An Advanced Test method is setup and started by selecting the Test icon and "paging" to the "Advanced Test" screen using the "arrow" control located at the right edge of the screen. The "Cell", Instrument" and "Test" screens are used to specify the entire set of test conditions prior to starting a test on the desired Test Cell. The entire sets of parameters (called the Test Method) can be saved, recalled or exported using the "Method" and "Save Method" controls.

For more information on setting up and starting a test see the Instrument Help system.

Monitoring and Controlling a Film Test

The status of an active test can be monitored and controlled using the "Home", "Cell Status" and "Instrument Status" screens. These screens are accessed by selecting the "Home" and "Status" icons.

As each phase or state in a test is completed the test will automatically be advanced to the next step as specified by the currently executing test method. The operator can control (override) the execution of the test using the Abort, Advance and GoTo controls.

Test data can be viewed and reports created (in graphical or tabular form) using the controls on the Cell and Instrument status screens.

For more information on setting up, starting tests and generating reports see the Instrument Help system.

Chapter 7: Testing Packages

This chapter contains information on how to test packages. Suggestions on how to maximize the accuracy of your results and procedures describing how prepare for and perform a package test are discussed.

Read this chapter to learn about:

- Testing Suggestions
- Preparing for a Package Test
- Preparing the instrument for a Package Test
- Package Testing Methods
- Supplying a Test Gas
- Package Mounting Methods

Testing Suggestions

The following information will assist you in testing packages with your instrument.

- Test duplicate samples whenever possible.
- Use good samples. Poor sealing of packages to the test fixture and pin holes can contribute to false readings.
- Use caution when recording data for a new or unknown specimen. Some materials approach equilibrium slowly. When in doubt repeat the test.
- Testing packages using Generated RH is not advised. The RH at the package cannot be measured.
- If no testing will be performed for a significant period of time (overnight or weekend) no special precautions are needed. The Gas Saver function will automatically be activated (when enabled) whenever both test cells are in the "Idle" state.

  Turning off the power and gas supplies to instrument is not recommended. If the instrument is shutdown you will need to wait for it to outgas before testing can resume.

Preparing the Instrument for a Package Test

To accommodate package testing the film Test Cell must be replaced with the optional Package Adapter. The tubing to the package fixture should be connected to the Package adapter before placing it into the Test Cell tray. Refer to Figure 7-1 for an illustration on how the Package Adapter fits into the Test Cell Tray.

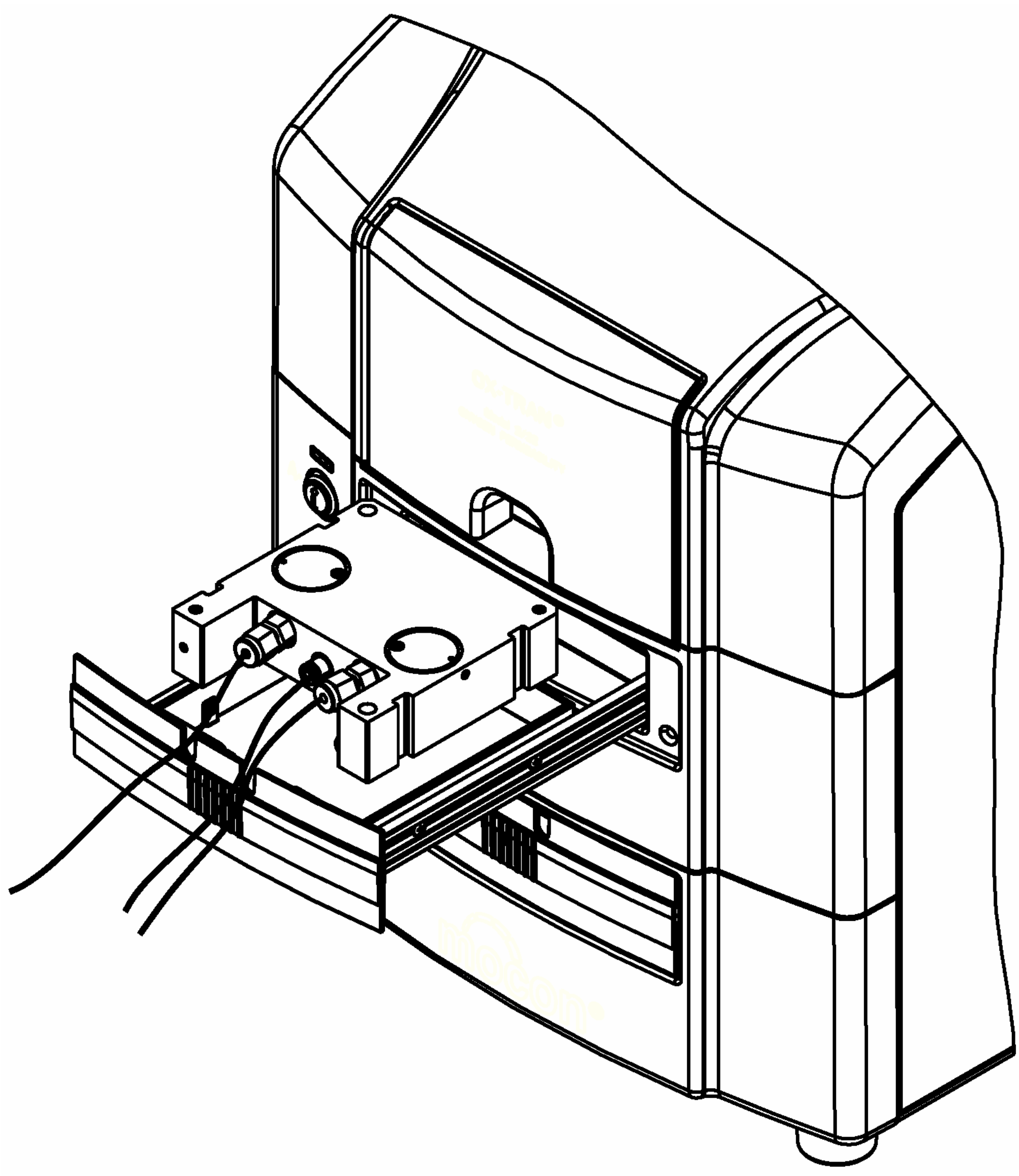


Figure 7-1: Installing the Package Adapter Cell

Package Testing Methods

There are many different types of packages and most of them can be tested on the OX-TRAN Model 2/12. Most packages can be classified as belonging to one of two categories, rigid packages or flexible packages.

To test a package, a fixture must be created that allows a Test Gas to be supplied to one side of the package (usually the outside) and the Carrier Gas to the other. The process of creating this package "fixture" is often referred to as "Mounting the Package". See Package Mounting Methods in this chapter for more information.

Testing using Ambient Conditions

If you require transmission rate data only at room temperature, you can test packages without an Environmental Chamber. However, be aware that your transmission data may be scattered or flawed by fluctuations in ambient temperature and RH.

To test at ambient conditions the mounted package can often be attached directly to the Package Adapter. If the mounted package is unusually large or heavy the tubing may need to be extended.

Package Conditioning

The barrier materials used in packages are generally thicker than films samples. Thicker materials often require a longer time to condition to the test environment. A safe guideline is a conditioning period of 8 to 24 hours. You may determine that a shorter or longer conditioning period is necessary. If the outer bag has tightly expanded (when using a poly bag), puncture a small hole in it. This will not affect test data and will allow test gas to fill the bag at a consistent pressure.

Testing using an Environmental Chamber

An environmental chamber will be required if any of the following conditions apply:

- Tighter control of sample temperature is needed than ambient conditions allow.
- A sample temperature above or below room temperature is required.

CAUTION:	**Damage to the system may occur if you attempt RH testing in an Environmental Chamber at certain temperatures.**

CAUTION:	**When connecting the instrument to an external device such as an environmental chamber the plumbing must be isolated so that it does not come in contact with the electrical ground (i.e. Insulate the copper tubing so that it does not come in contact with any metallic or conductive surfaces in the environmental chamber).**

Package Mounting Methods

The type of fixture required is usually dependent on the type of package, rigid or flexible. Rigid packages and semi-rigid packages (bottles, trays or cups) can often be mounted on a Package Plate. A "fixture" for Flexible packages is created by sealing all unnecessary openings and then sealing (usually with epoxy) two tubes into the package envelope to allow the Carrier Gas to "sweep" the interior.

Mounting Bottles, Cups and Trays using a Package Plate

To mount a rigid or semi-rigid package the package is inverted and the open side is sealed to the plate using an appropriate adhesive. The type of adhesive (epoxy or hot-melt are commonly used) required depends on the properties of the package and expected transmission rate. Epoxy is usually preferred for Good barriers.

An example of a bottle mounted on a Package Plate is shown in Figure 7-2. MOCON has available two Package Mounting Fixtures (see Appendix B) that can be used to mount packages.

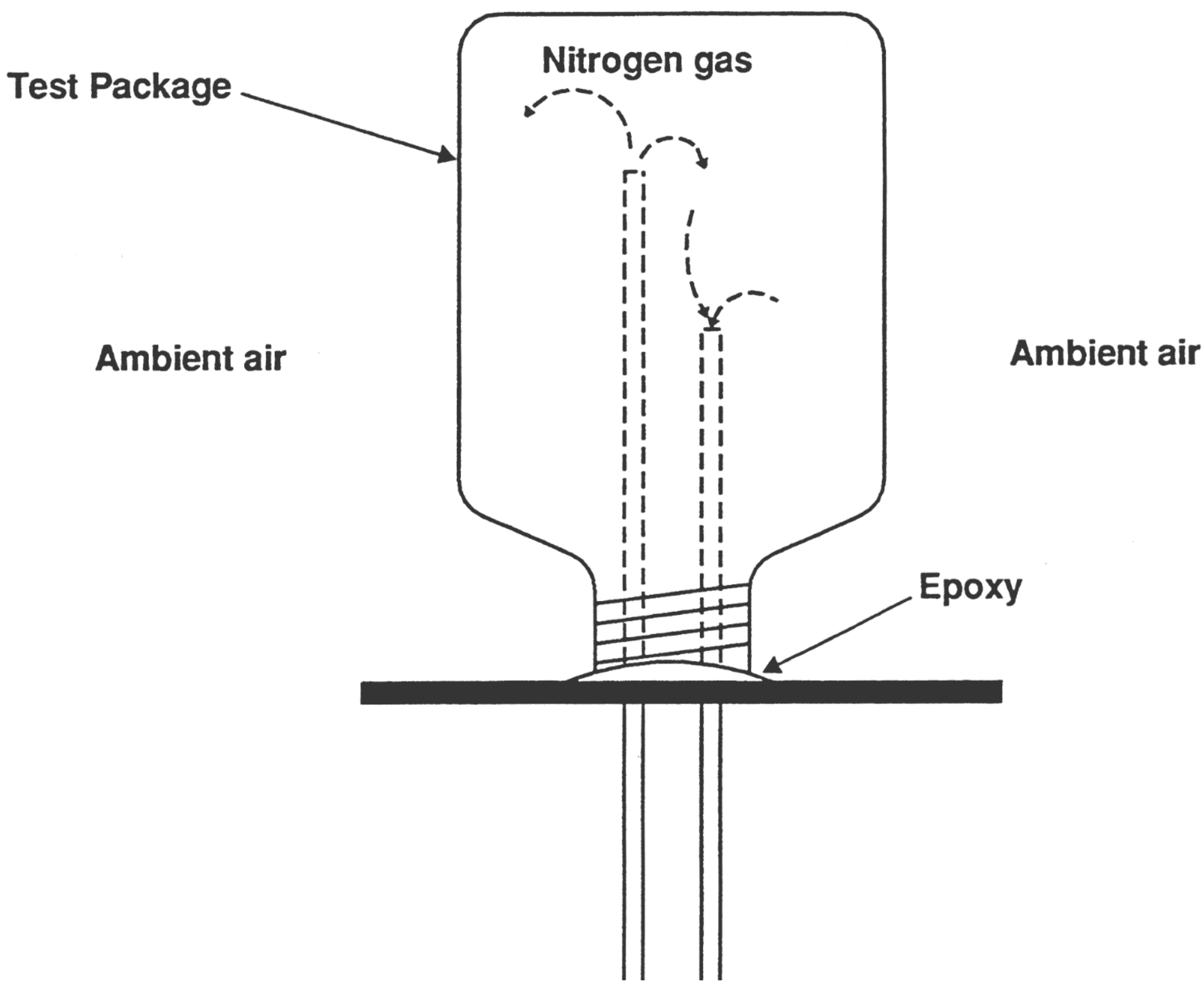


Figure 7-2: Using a Package Mounting Plate

Mounting Pouches and Bags

Flexible packages require a different mounting method than rigid packages. Flexible packages can be mounted with the carrier gas tubes entering the top or bottom of the package.

The following instructions, along with Figure 7-3 and Figure 7-4 will assist you in mounting the package.

1. Make two cuts in the package just large enough for the ends of the tubing to slip through.

2. Liberally apply epoxy to the tubing at the points where the tubing enters the package. Be careful not to seal off the ends of the tubing. Five Minute Epoxy works well for this (see Figure 7-3).

3. Move the package slightly so the ends of the tubing slide a short distance into the package. This will allow the tubing to be sealed to the inside surface of the package instead of just the outside surface (see Figure 7-4). This is especially important if you are testing package made of paper, which are coated with a barrier on one side (usually the inside).

4. Allow the adhesive to harden completely before continuing.

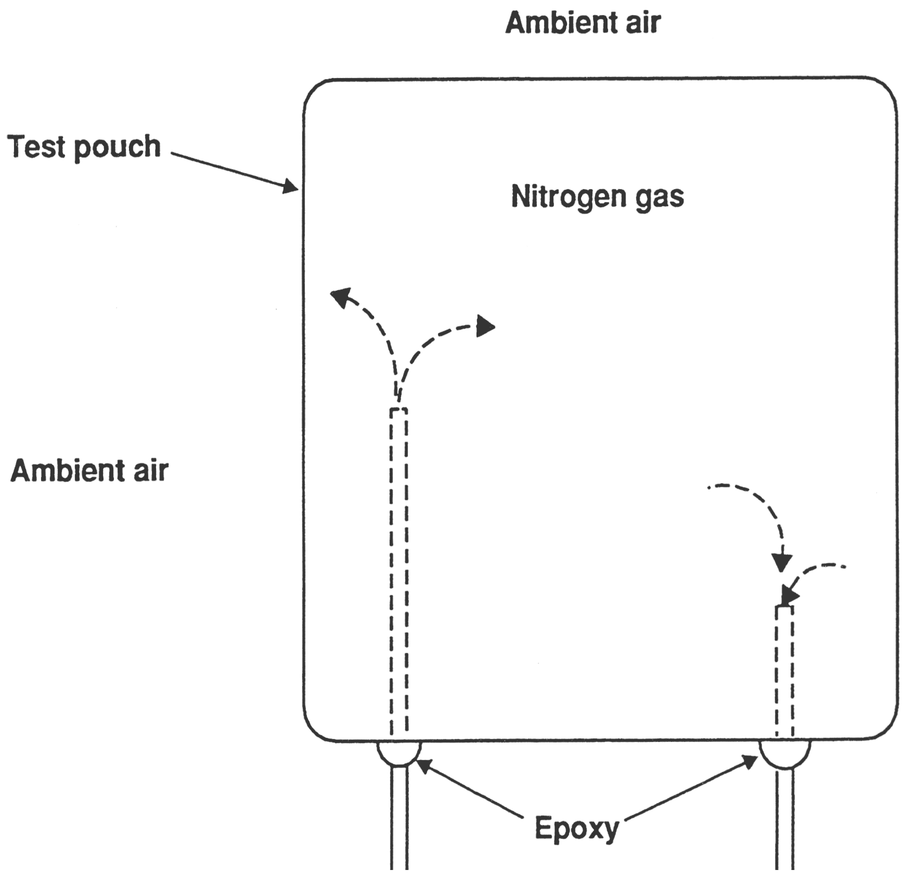


Figure 7-3: Pouches and Bags - Bottom Mount

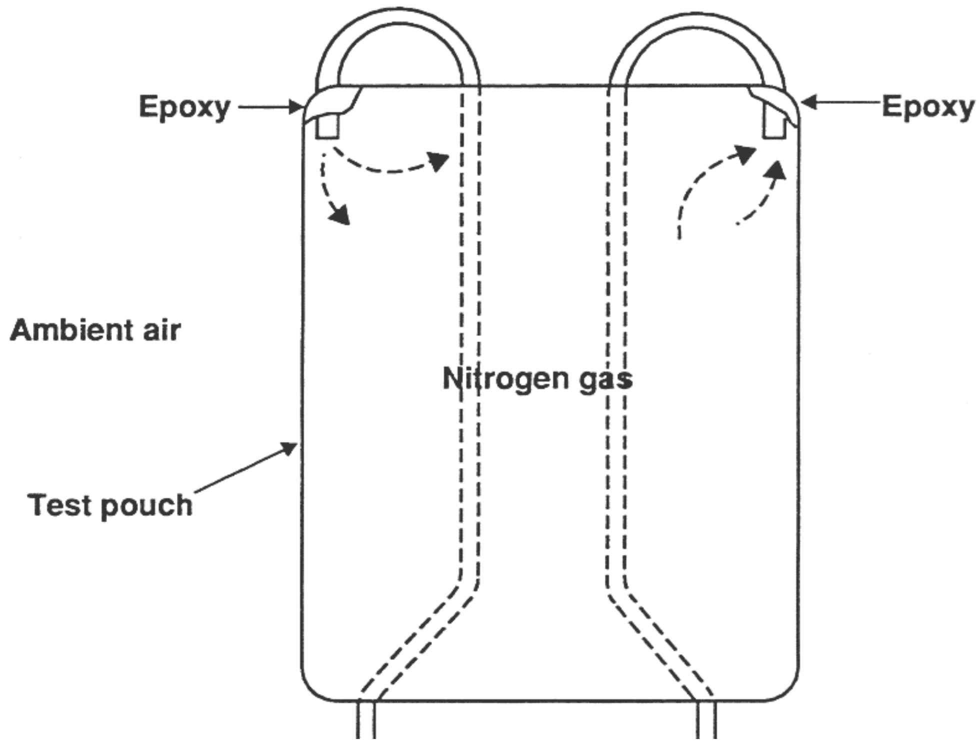


Figure 7-4: Pouches and Bags - Top Mount

Supplying a Test Gas

To perform a transmission rate measurement a Test Gas must be applied to one side of the barrier material. When testing packages the Test Gas is usually applied to the outside of the package fixture. How the Test Gas is applied to the package fixture is usually dependent on the concentration of the gas that will be used.

The simplest way to apply a Test Gas to a package is to use ambient air. After the package fixture is connected to the instrument no additional steps are required.

Using an oxygen concentration for the Test Gas that is higher or lower than ambient air requires additional steps when creating the package fixture. The package fixture must be modified to allow a test gas to be applied to the outside of the barrier material. This is usually done by sealing the package fixture into a bag containing tubing that allows a Test Gas to purge the bag (see Figure 7-5).

Using Ambient Air for the Test Gas

Using ambient air is the simplest way to supply a test gas. The transmission data however, will be affected by changes in the ambient temperature and RH. Placing the packages in an environmental chamber will minimize the effects of ambient temperature variation. Using an environmental chamber may not result in a similar reduction in the effects of ambient RH variation on the transmission rate.

Using a Compressed Gas for the Test Gas

Using a compressed gas for the Test Gas has a number of advantages. The effect that ambient RH has on the package is minimized (compressed gases are by nature dry (0% RH). The compressed test gas supply displaces any ambient water vapor.

The properties of the barrier material usually determine what oxygen concentration will be required for the Test Gas. Good barriers will require a higher concentration (usually 100%). Poor barriers will require lower concentrations (21% or even 5%). Compressed gas cylinders in these and other oxygen concentrations are readily available.

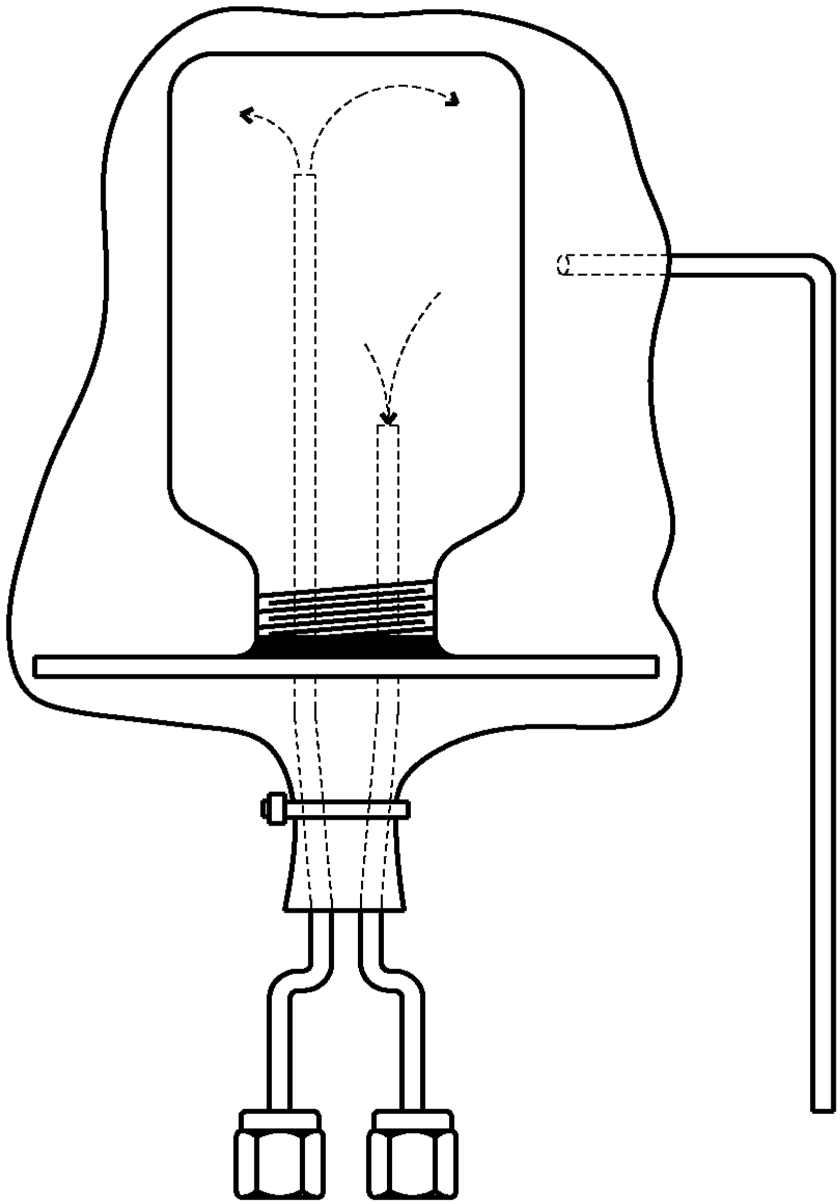


Figure 7-5: Supplying a Test Gas

Setting Up and Starting a Package Test

After the samples are loaded and the instrument is ready there are a number of test parameters that must be set. There are two types of test parameters, cell parameters and instrument parameters. Cell Parameters are specific to each cell (Sample ID, Sample Thickness). Instrument parameters are common for all cells (Cell Temperature and Test Gas RH, Carrier Gas RH). The "Test" icon is used to access the screens and controls required to set up the test conditions and start a test.

There are two basic types of test methods that can be used to start a test; an "Auto Test" method or an "Advanced Test" method. The "Auto Test" method attempts to automatically optimize some of the test parameters while the test is executing. An "Auto Test" method can be used to determine the optimum test methodology when the properties of the barrier material are not known. An "Auto Test" is started by selecting the "Test" icon and filling out the fields displayed on the "Cell" and "Instrument" screens.

An "Advanced Test" method allows the operator total control of all test parameters. An Advanced Test method is setup and started by selecting the Test icon and "paging" to the "Advanced Test" screen using the "arrow" control located at the right edge of the screen. The "Cell", Instrument" and "Test" screens are used to specify the entire set of test conditions prior to starting a test on the desired Test Cell. The entire sets of parameters (called the Test Method) can be saved, recalled or exported using the "Method" and "Save Method" controls.

For more information on setting up and starting a test see the Instrument Help system.

Monitoring and Controlling a Package Test

The status of an active test can be monitored and controlled using the "Home", "Cell Status" and "Instrument Status" screens. These screens are accessed by selecting the "Home" and "Status" icons..

As each phase or state in a test is completed the test will automatically be advanced to the next step as specified by the currently executing test method. The operator can control (override) the execution of the test using the Abort, Advance and GoTo controls.

Test data can be view and reports created (in graphical or tabular form) using the controls on the Cell and Instrument status screens.

For more information on setting up, starting tests and generating reports see the Instrument Help system.

Chapter 8: Maintenance

This contains information on how to clean and maintain the OX-TRAN Model 2/12.

Read this chapter to learn about:

- Cleaning the Instrument
- Cleaning the Test Cell
- Cleaning the Air Filter
- Maintaining the Test Cells
- Maintaining the Oxygen Sensor
- System Standby
- System Shutdown, Relocation and Storage

The following information will assist in the daily operation and maintenance of the OX-TRAN Model 2/12 R system. Included are answers to the questions most commonly asked of the MOCON Technical Services Group.

Cleaning the Instrument

The OX-TRAN Model 2/12 R is housed in a painted metal and plastic case that is easy to clean and maintain. Periodically wipe the case with a damp cloth and mild detergent solution.

> **Warning!**
>
> **Turn OFF the instrument and unplug it from its power source before beginning these procedures. Failure to do so can result in electrical shock, which can cause injury or death.**

Some important precautions to follow:

- Leave the instrument covers on while cleaning; do not get liquids in the instrument.
- Never use alcohols or solvents on the instrument case. These chemicals could damage the instruments as well as the case.

NOTE: There are no user serviceable parts inside the OX-TRAN Model 2/12. A MOCON service representative should perform all other internal maintenance and adjustments.

Cleaning the Air Filter

Periodically the air filter on the back of the instrument should be removed and cleaned. The recommended interval is twice a year (or whenever there is a significant buildup of dust).

If the filter is not cleaned on a regular basis air will not circulate properly through the cooling system. The performance of the temperature control system for the Test Cells may be affected and the instrument safety systems may prevent the system from being used.

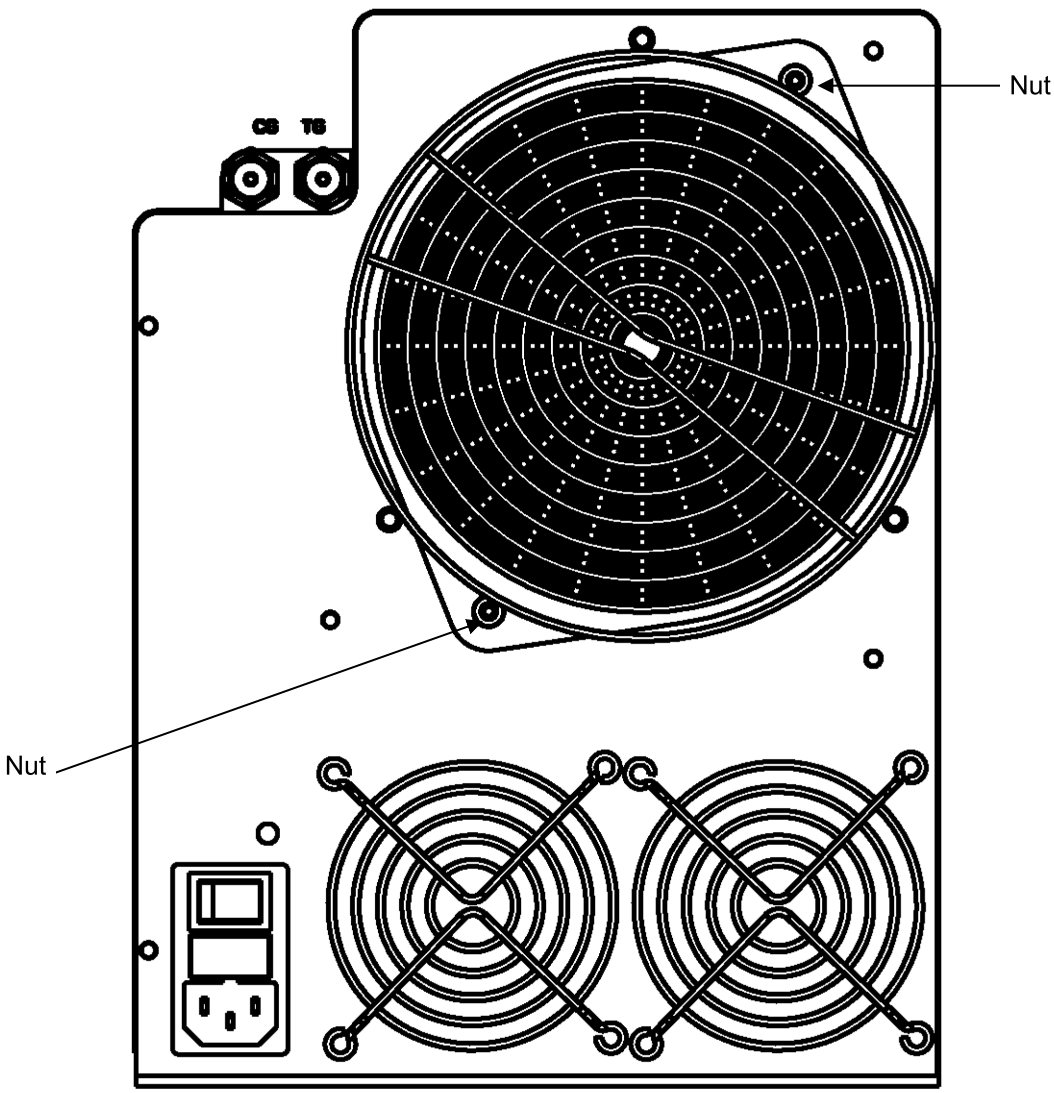


Figure 8-1: The Air Filter

The filter can be removed without removing the fan guard from the enclosure. To remove the cooling system air filter remove the two nuts shown in Figure 8-1 above.

Cleaning the Test Cells

Periodically the test cells should be cleaned to remove any excess buildup of grease. Alcohol can be used to remove any residue from the Apiezon grease.

Inspect the gas ports and TrueSeal flush ring and remove any grease that could obstruct the flow of gas.

Maintaining the Test Cells

Periodically the test cells should be examined and any damaged, deformed, cracked or brittle o-rings replaced. The parts of the test cell and their associated part numbers are illustrated in Figure 8-2 and Table 8.1.

Inspect the film sealing surface of the top half of the test cell for nicks and scratches. Dragging a finger nail across a nick or scratch is a simple way to estimate the depth of the flaw. Nicks and scratches deep enough to feel may cause errors in the transmission rate due to leakage.

Drying Out the Humidifiers

Before shutting down the instrument for long term storage or repair the Humidifiers must be drained and the chambers dried out to prevent any corrosion from occurring during storage or transport.

To prepare the Humidifiers for storage or transport follow the procedure below:

1. Advance all active tests to the Idle state.

2. Open the cover on the front of the instrument to access the Drain Port and Drain Screws. For more information see Figure 6-1and Table 6.1 for the location of the drain port and screws.

3. While holding a container under the drain port, open the drain screws for both humidifiers.

4. The pressure of the Carrier and Test gases will force all of the water out of the humidifiers.

5. After the humidifiers have been drained allow gas to vent out the drain port until all residual water that is visible has been removed.

6. Tighten the drain screws.

Test Cell Components and Part Numbers

The parts of the test cell are shown in Figure 8-2 below. Refer to Table 8.1 for the associated part numbers and the quantity used. To order replacement parts contact MOCON in the USA at (763) 493-6370.

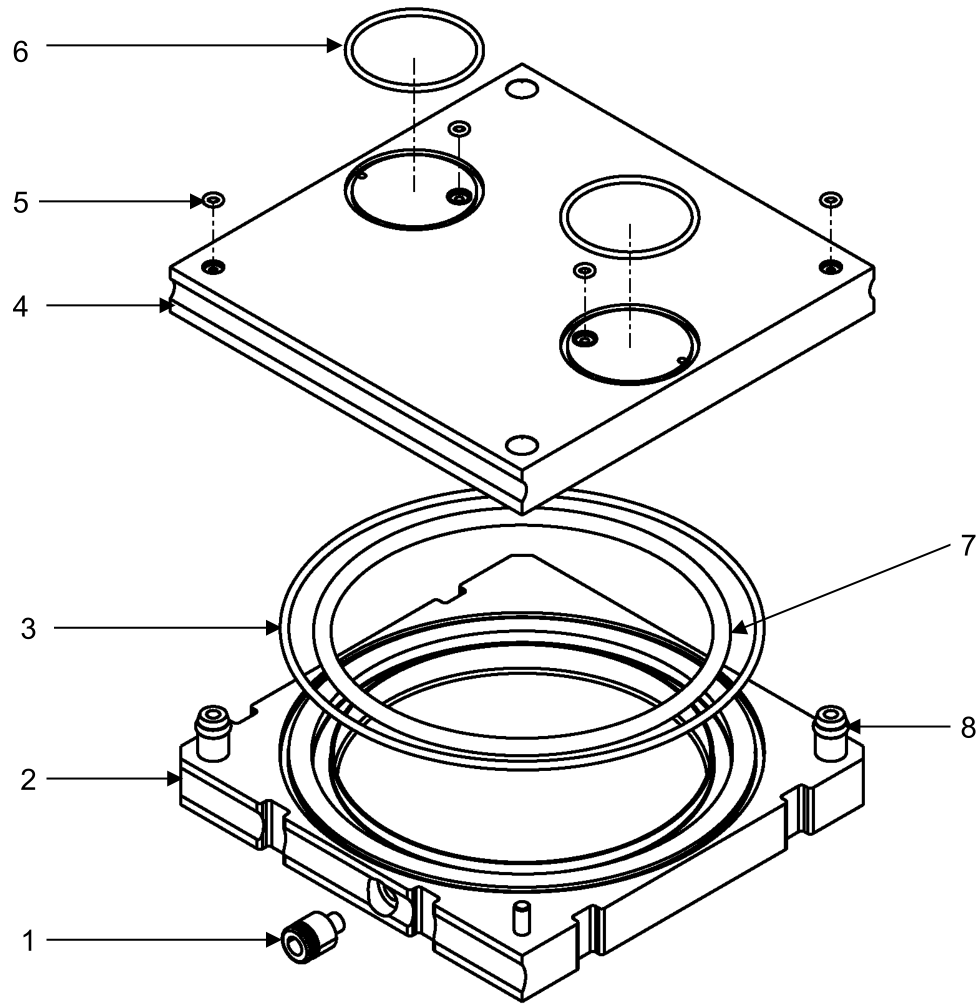


Figure 8-2: Test Cell Components

Item	Quantity	Part Number	Description
1	1	051-917	Fitting, Adapter, Push-to-Connect, 5/32 OD Tube
2	1	051-719	Cell, Diffusion, Bottom, OX 2/12
3	1	051-68	O-Ring, 3.739 ID X 0.070 CS, Buna, 70 Durometer
4	1	051-720	Cell, Top, OX 2/12
5	4	033-613	O-Ring, 0.087 ID X 0.040 CS, Buna N, 70 Durometer
6	2	051-684	O-Ring, 1.000 ID X 0.055 CS, Buna, 70 Durometer
7	1	380-008	O-Ring, 3.00 ID X 0.140 CS, Buna
8	2	050-112	O-Ring, 0.145 ID X .070 CS, Viton

Table 8.1: Test Cell Components

Maintaining the Oxygen Sensor

The only periodic maintenance the Oxygen sensor requires is regular Calibration Accuracy checks. The life of the Oxygen sensor supplied with your OX-TRAN Model 2/12 R is dependent on the amount of oxygen it is exposed to. The sensor can be damaged by accidents or by misuse such as continual exposure to extremely high concentrations of oxygen.

Verifying Oxygen Sensor Performance

Periodic calibration of the Permeant Sensor is recommended. Certified Films are available for this purpose. The "Permeant Sensor Performance Check" described in Chapter 5 should be performed using an appropriate Certified Film.

Maximizing Oxygen Sensor Life

The useful life of the Oxygen sensor is determined primarily by the amount of oxygen the sensor is exposed to. For example frequent testing at 500 cc/(m^2 • day) will deplete the oxygen sensor much quicker than frequent testing at 5 cc/(m^2 • day). The amount of oxygen the sensor is exposed to can be reduced by the following means:

- Use a lower oxygen concentration Test Gas to supply the driving force. If 21% O_2 is used for the Test Gas, instead of 100% O_2, the oxygen input rate to the sensor will be reduced by approximately a factor of five.

- Use a foil mask to reduce the test area. A 5 cm^2 foil mask will reduce the oxygen input rate to the sensor by a factor of ten.

- Using a Conditioning period. When conditioning time is used the sensor is taken off line for a period of time. This can prolong its useful life of the sensor.

Replacing the Oxygen Sensor

The symptoms of a depleted oxygen sensor are large rapid declines in transmission rate and extremely 'noisy' or non-repeatable test results. When the Oxygen sensor needs to be replaced please contact MOCON in the USA at (763) 493-6370.

Caution:	**Do not attempt to replace the Oxygen sensor. This should only be done by an authorized MOCON Technical Services Representative.**

System Standby

When a test series is complete, the instrument sets the sensor to the Bypass state. In this position the sensor is isolated and protected from inadvertent exposure to large amounts of oxygen.

If no testing will be performed for an extended period of time (overnight or weekend) leave a film mounted and clamped in the test cells. Turning off the power and gas supplies to the instrument is not recommended. If the instrument is shutdown you will need to wait for it to outgas before testing can resume.

When all cells are in the "Idle" state, the instrument will activate the "Gas Saver" function which automatically reduces the gas consumption by 25 to 50%.

System Shutdown for Storage or Repair

When shutting down the instrument for relocation, long-term storage, or if the instrument is to be sent for factory repairs, follow these instructions:

1. End all active tests and verify that the sensor is set to Bypass.

2. Set the Temperature Set Point to the approximate ambient temperature and allow the instrument to come to ambient temperature.

> **CAUTION: The instrument's testing temperature must be at ambient temperature with the gases flowing before turning the instrument off for a long period of time. If the temperature is not at ambient, condensation may form and damage to the instrument is likely.**

3. Remove the water from the Humidifiers see "Drying Out the Humidifiers" in this chapter.

4. Turn off power to the instrument.

5. Disconnect the gas lines at the rear of the module and use the brass fitting plugs (025-382) to seal the gas connections fittings on the rear of the instrument.

Chapter 9: Troubleshooting

This chapter contains information to assist you in solving problems that may occur during the operation of the instrument.

Read this chapter to learn about:

- Error Messages and Warnings
- Solving Operational Problems
- Sensor Over-Range Recovery
- Power Fail Recovery

Error Messages and Warnings

The instrument software is continually checking for errors. When an error is detected, an Error Message dialog will be displayed. Select the "Dismiss" button to close the dialog. If a condition that could cause damage is detected, any active tests will automatically be "Failed" and the sensor will be placed in the By-Pass state.

For additional information on any error messages that may occur, their cause and possible solutions please consult the Instrument Help System.

NOTE: If you encounter an error message and are unable to resolve the problem, write down both the error code and the message. This will help MOCON service representatives diagnose the problem. Contact MOCON in the USA at (763) 493-6370.

Troubleshooting Testing Problems

The following may assist in identifying and correcting problems that occur during instrument operation.

Symptom: Abnormally low results when testing Certified Films.

Comment: Perform a test using a Certified Film to verify the symptom. Certified Films must be tested at the conditions stated on the label. Abnormally low results under these conditions are generally due to sensor exhaustion.

Solution: Call MOCON in the USA for instructions at (763) 493-6370.

NOTE: For information on checking the performance of the oxygen sensor refer to the section titled "**Error! Reference source not found.**" in Chapter 5.

Symptom: Abrupt changes in display readings or long-term cyclic oscillations.

Comment: Unwanted data fluctuations observed during a test cycle may be caused by abrupt changes in the carrier gas flow rate. Such a transient symptom can be produced by a temporary restriction in any gas line, or gas usage by another system.

Regular, cyclic data fluctuations may also be observed in connection with ambient package tests where the test packages are exposed to ambient temperature fluctuations caused by frequent on/off heater and air conditioner cycles.

Solution: An Environmental Chamber (MOCON P/N 001-001) can be used when testing packages to reduce or eliminate this problem.

When testing packages, this effect can also be minimized by placing a loose-fitting plastic bag over the specimen, or by placing the specimen in an insulated box.

Recovering from a Sensor Over-Range Condition

A severe over range condition will terminate the test sequence on both cells.

If you see a red Cell Status indicator (on the front of the instrument), the test has failed due to a gas sensor over-range condition. In addition to the red Cell Status indicator, an error indicator may be displayed on the Home screen.

Examine the data on the Cell Status screen to determine the cause of the over-range condition. The Cell (or Cells) that caused the over-range will be "Failed". If the ReZero Cell failed due to an over-range condition all active tests will be failed.

Possible causes may be:

- The sample has a high transmission rate. To correct the problem testing can be done using a lower oxygen concentration test gas or a foil mask.
- The sample has pinholes, cracks or a poor-sealing surface.
- The cell is installed and clamped but no barrier is present.
- The o-ring seals on the top of the Test Cell are missing or damaged.

After correcting the cause of the malfunction restart the test on the failed cell (or cells).

Recovering from a Power Failure

The instrument software records data at periodic intervals. This data is used to assist in recovering from power failures and instrument restarts.

If testing is interrupted after the instrument has restarted testing will resume from the point at which it was interrupted.

Chapter 10 Specifications

This chapter contains the specifications of the OX-TRAN Model 2/12.

Read this chapter for details about:

- Physical specifications
- Environmental requirements
- Electrical requirements
- Gas Supply requirements
- Operational capabilities

Physical Specifications

	Height	Width	Depth	Weight
Uncrated	15.5 inches (39.4 cm)	12 inches (30.4 cm)	23 inches (58.0 cm)	95 pounds (43.1 kg)
Crated	25 inches (63.5 cm)	19 inches (48.3 cm)	37 inches (94 cm)	115 pounds (52.2 kg)

Table 10.1: Physical Specifications

Environmental Requirements

Temperature	Operation	22 °C ± 2 °C
	Storage	10 °C to 30 °C
Humidity	Operation	20% to 80% RH (non-condensing)
	Storage	5% to 85% RH (non-condensing)
Barometric Pressure	Operation	400 to 850 mmHg (522 to 1133 millibar)
Elevation (Maximum)	Operation*	2500 Meters (8202 Feet) above sea level

Table 10.2: Environmental Requirements

* The instrument may not comply with all agency ratings when operated above the maximum specified elevation.

Electrical Requirements

Voltage	100 - 240 VAC 50/60 Hz
Maximum Power Draw	700 VA

Current Draw at 100 VAC 50 Hz	1.80 A nominal
Current Draw at 120 VAC 60 Hz	1.50 A nominal
Current Draw at 220 VAC 50 Hz	0.82 A nominal
Current Draw at 240 VAC 50 Hz	0.75 A nominal

Table 10.3: Electrical Specifications

Gas Supply Requirements

Carrier Gas	Gas Composition	100% Nitrogen (< 10 ppm Oxygen)
	Supply Pressure, Nominal	29 PSI, (2.0 Bar), (200 kPa)
	Supply Pressure, Maximum	32 PSI, (2.2 Bar), (221 kPa)
	Supply Pressure, Minimum	26 PSI, (1.5 Bar), (1792 kPa)
	Flow Rate, Nominal, Test Active, Maximum	600 cc/minute
	Flow Rate, Nominal, Test Active, Minimum	60 cc/minute
Test Gas	Gas Composition	100% Oxygen (purity 99.9%)
	Supply Pressure, Nominal	29 PSI, (2.0 Bar), (200 kPa)
	Supply Pressure, Maximum	32 PSI, (2.2 Bar), (221 kPa)
	Supply Pressure, Minimum	21 PSI, (1.38 Bar), (145 kPa)
	Flow Rate, Nominal, Test Active	40 cc/minute

Table 10.4: Gas Supply Specifications

Operational Capabilities

Temperature Control Range	10 °C to 40 °C ± 0.2 °C
Time to Reach a Heated Temp (from ambient)	Approximately 45 minutes to reach 99% of a 40 °C setting
Time to Reach a Cooled Temp (from ambient)	Approximately 2 hours to reach 99% of a 10 °C setting
Humidity Control, Film Cell, Carrier Gas	0% to 90% RH ± 3 RH
Humidity Control, Film Cell, Test Gas	0% to 90% RH ± 3 RH
RH Film Cell-to-Cell Uniformity	± 3 RH
Time to Reach Humidity Setting	Approximately 3 hours to reach 99% of RH setting

Test Range, Film, 50 cm^2, 100% O_2	0.05 to 28,800 cc/(m^2 • day) 0.00323 to 1858 cc/(100in^2 • day) Lower Limit at 10 sccm Carrier Flow
Test Range, Package, 100% O_2	0.00025 to 144 cc/(pkg • day) Lower Limit at 10 sccm Carrier Flow
Resolution	0.05 cc/(m^2 • day) 0.0032 cc/(100in^2 • day) 0.0003 cc/(pkg • day)
Repeatability	± 0.05 cc/(m^2 • day) ± 00032 cc/(100in^2 • day) ± 0.0003 cc/(pkg • day) or 1.5% of value, whichever is greater

Table 10.5: Operational Capabilities - Ox-Tran 2/12 R

Film Area, Test Gas Concentration, Carrier Flow and Test Range

Area	Test Gas %	Flow	Test Range
50 cm^2	100%	10 sccm	0.05 to 2,880 cc/(m^2 • day)
			0.0032 to 186 cc/(100in^2 • day)
50 cm^2	100%	100 sccm	0.5 to 28,800 cc/(m^2 • day)
			0.0323 to1,860 cc/(100in^2 • day)
50 cm^2	21%	10 sccm	0.239 to 14,400 cc/(m^2 • day)
			0.0154 to 930 cc/(100in^2 • day)
50 cm^2	21%	100 sccm	2.39 to 144,000 cc/(m^2 • day)
			0.154 to 9,300 cc/(100in^2 • day)
5 cm^2	100%	10 sccm	0.5 to 28,800 cc/(m^2 • day)
			0.0323 to 1,860 cc/(100in^2 • day)
5 cm^2	100%	100 sccm	5.0 to 288,000 cc/(m^2 • day)
			0.3225 to 18,600 cc/(100in^2 • day)
5 cm^2	21%	10 sccm	2.39 to 144,000 cc/(m^2 • day)
			0.154 to 9,300 cc/(100in^2 • day)

Table 10.6: Test Range

Environmental Chamber Specifications

Temperature Range	5 °C to 50 °C ± 0.5 °C
Humidity Control	None

Table 10.7: Environmental Chamber Specifications

Appendix A: Site Preparation Instructions

(See Next Pages)

mocon® / AMETEK®

Part Number 140-218
Revision D

7500 Mendelssohn Avenue North
Minneapolis, MN 55428 U.S.A.
Telephone 763-493-6370
Web Site: www.ametekmocon.com

SITE PREPARATION INSTRUCTIONS
IMPORTANT!
REQUIREMENTS FOR THE START-UP OF THE OX-TRAN® Model 2/12 SYSTEM

The following must be furnished by the customer before a new OX-TRAN Model 2/12 R can be set up. If a MOCON technical representative will be setting up your system these items must be on site before we can arrange to visit your plant.

1. **SPACE REQUIREMENTS** - Each OX-TRAN Model 2/12 R instrument requires 18 to 24 inches (46 to 62 cm) of bench space. The instrument is 23 inches (58 cm) deep. The bench should provide additional space to allow for the required electrical and plumbing connections. The instrument weighs 95 pounds (43.1 kilograms) the bench should provide adequate support for the instrument.

   A printer requires approximately 24 inches (62 cm) of bench space. Benches should be sufficiently large and strong to accommodate the instrument and printer in close proximity.

2. **ENVIRONMENTAL REQUIREMENTS -** The OX-TRAN Model 2/12 R should be operated in an environment with a stable room RH between 20% and 80% non-condensing, and at an ambient temperature of
   22 °C ± 2 °C. It is important to locate the instrument in a relatively stable environment free from drafts and temperature fluctuations.

3. **POWER REQUIREMENTS** - The OX-TRAN Model 2/12 R equires 100 - 240 VAC ± 10% at 50/ 60 Hz. Maximum power consumption for each instrument is 700 VA (maximum surge). The instrument must be provided with a quiet computer grade electrical circuit with an isolated ground and an appropriate grounded receptacle. In the USA a duplex NEMA 5-15R receptacle must be provided for each instrument.

   NOTE: MOCON only provides power cords with instruments configured for 120V.

   See the last page of these instructions for details and cautions on

   "RECOMMENDED ELECTRICAL INSTALLATION"

4. **OXYGEN -** A cylinder of 99.9% oxygen with a MOCON-approved, stainless steel 2 stage oxygen regulator is required. A standard "T" size cylinder will provide several weeks of operation.

5. **NITROGEN** - The required carrier gas is UHP (Ultra High Purity) Nitrogen (Oxygen <10PPM). A standard "T" size cylinder may provide several weeks of operation.

6. **REGULATOR ASSEMBLY** - If the customer chooses to purchase the optional regulator assembly, then the two gas cylinders are the only items that must be supplied by the customer. The regulator assembly contains everything else that is needed.

7. **Oxygen Trap** - To ensure the carrier gas supplied to the OX-TRAN Model 2/12 R is free of residual oxygen an Oxygen Trap is required for each instrument. An Oxygen Trap is included with a purchased instrument and can be purchased directly as a standalone item (P/N 051-595) from MOCON. If the customer would rather purchase directly from the supplier, a suitable device (P/N 202295-B) is available from:

   Chromatography Research Supplies Inc.

   2601 Technology Drive

   Louisville, KY 40299 USA

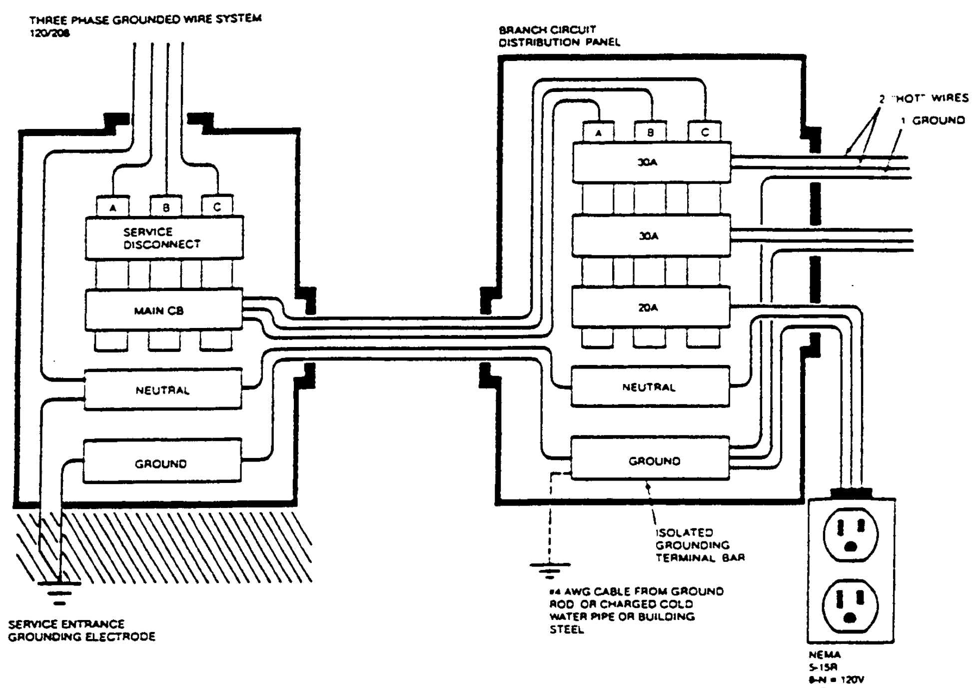
   Telephone 800 327 3800

   www.chromres.com

8. **COPPER TUBING -** Metallic tubing is required for connecting the oxygen and nitrogen supplies to the rear panel of the instrument. Desiccated and sealed (D&S), refrigeration-grade copper tubing (1/8 OD x 0.030 Wall / 3.175 mm OD x 0.762 mm) is required. This tubing can be purchased through MOCON by calling MOCON in the USA at (763) 493-6370, or through your local tubing supplier.

9. **DISTILLED WATER** - You should use HPLC grade water for relative humidity generation. Obtain this water through a local supplier.

RECOMMENDED ELECTRICAL INSTALLATION



NOTES

1. The impedance of the equipment ground path from receptacle being utilized back to main service entrance where equipment ground and neutral are connected together must be one ohm or less.

2. Machinery and air conditioners can generate a large amount of electrical interference on the AC power lines. These disturbances can interfere with the operation of the system unless steps are taken to isolate the power disturbances from the power lines serving the instrument. Electrical noise can sometimes be eliminated by repair, replacement, relocation or electrical filtering of the originating device. If not, a suitable power line conditioner may have to be installed in the AC line to the system by a qualified electrician. A noisy circuit or improper grounding will cause adverse performance and possible damage to the system.

WARNING!	The installation of the appropriate electrical circuit and receptacle requires the skill and knowledge of a qualified electrician. Do not attempt to test the electrical current in your facility or to wire or fabricate the electrical power circuit without the services of a qualified electrician.

The MOCON OX-TRAN Model 2/12 R system will provide years of useful life provided these requirements are observed. Please contact MOCON in the USA at (763) 493-6370 with any questions regarding these Site Preparation Instructions.

Appendix B: Spare Parts

The following is a list of the spare parts that are available for the OX-TRAN Model 2/12. To order, contact the MOCON in the USA at (763) 493-6370.

Part Number	Description	Quantity	Unit Of Measure
021-548	Grease, Apiezon T, Brown, 25 Gram Tube	1	EA
024-180	Thermometer, 4 inch Long, 0 °C to 50 °C	1	EA
024-383	Tubing, Tygon, 1/4 OD X 1/8 ID, Clear	1	EA
025-382	Plug, Fitting, 1/8 Tube, Brass, 7/16 Hex	1	EA
027-240	Tubing, Copper, 1/8 OD X 0.030 Wall, Desiccated and Sealed	50	FT
027-326	Kit, Knife With Cutting Mat	1	EA
027-343	Regulator Tee, Tested	1	EA
030-802	Flask, Erlenmeyer, 250 ml, Narrow Mouth, Heavy Duty Rim	1	EA
030-803	Stopper, RH Calibrator	1	EA
030-804	Stopper, EPDM, Red, Tapered, 70 Durometer	1	EA
034-285	Assy, Package Mounting Fixture, 5 X 5	1	EA
033-613	O-Ring, 0.087 ID X 0.040 CS, Buna N, 70 Durometer	10	EA
050-112	O-Ring, 0.145 ID X 0.070 CS, Viton	10	EA
051-683	O-Ring, 3.739 ID X 0.070 CS, Buna, 70 Durometer	10	EA
051-684	O-Ring, 1.000 ID X 0.055 CS, Buna, 70 Durometer	10	EA
051-810	Assy, Test Cell, OX-TRAN 2/22	1	EA
051-914	Assy, Package Adapter Cell, OX-TRAN, 2/22	1	EA
051-918	Fuse, 8A, 250V, 5 X 20 mm, T-LAG Glass	10	EA
051-924	Assy, Template, Trimming, Film , OX-TRAN, 2/22	1	EA
051-929	Certified Film, #1, 2/22, 30 cm Sq, 23.0 °C, 0% RH, Black/White	1	EA
051-930	Certified Film, #2, 2/22, 30 cm Sq, 23.0 °C, 0% RH, White/Black	1	EA

Part Number	Description	Quantity	Unit Of Measure
051-931	Certified Film, #3, 2/22, 1 sq cm, 23.0 °C, 0% RH, Red/White	1	EA
052-423	Certified Film, 2/12, 20 sq cm, 23.0° C, 0% RH, 10 SCCM	1	EA
105-259	Mask, Aluminum Foil, 4X4, Blank	10	EA
110-559	Assy, Package Mounting Fixture, 4 X 4	1	EA
110-671	Set, Certified Film, 2/22, Set of 3	1	EA
130-015	Mask, Aluminum Foil, 5 CM^2, 4 X 4, No Mounting Holes	10	EA
143-204	Manuscript, OX-Tran, 2/12, On Flash Drive	1	EA
210-017	Cord, Power, 125V, 18/3, SVT, IEC, Unshielded, 7 1/2 FT	1	EA
310-027	Nut, 1/8 Tube, Brass	10	EA
310-051	Ferrule, 1/8 Tube, Brass	10	EA
380-008	O-Ring, 3.00 ID X 0.140 CS, Buna	10	EA
052-720	Syringe, Disposable, 60mL, Luer Tip	1	EA

Appendix C: Warranty and Service Policies

(See Next Pages)

Part Number 032-846
Revision H

7500 Mendelssohn Avenue North
Minneapolis, MN 55428 USA
Telephone 763-493-6370
Web Site: www.ametekmocon.com

WARRANTY POLICY
STATEMENT OF LIMITED WARRANTY

MOCON, Inc. warrants that any part of any MOCON instrument or accessory ("Instrument") which proves to be defective in material or workmanship during the warranty period will be repaired by MOCON "certified" service personnel only, or at MOCON's option replaced, free of charge: FCA designated MOCON location.
Please consult the MOCON technical services department to determine which warranty statement applies to your instrument. This warranty applies to the original purchaser only, and is subject to the following terms and conditions:

1. Units or systems with MOCON offered field training, either purchased as an option or included in the purchase price.
   - If field training is performed by MOCON personnel or "certified" representatives the warranty period is:
     - One year from date of shipment from MOCON's factory for the Instrument.
     - Coulox® and IR Sensors in the following Instruments have an extended warranty as defined below:
       - OX-TRAN 2/22, 2/28, 2/40, 2/48,
       - PERMATRAN-W 3/34
       - PERMATRAN-C 4/30
       - AQUATRAN 3/38, 3/40 (together, the 'Extended Warranty Instruments")

     The extended warranty is defined as a Four-Year Pro Rata Warranty for the Coulox® and IR Sensors (the "Sensor(s)") installed by the factory in the Extended Warrant Instruments. If a Sensor is determined to be defective during the applicable warranty period, the sole and exclusive remedy shall be a discount, based on the table below, towards the purchase of a replacement Sensor or replacement of a Sensor at MOCON designated facility, FCA.

Time after Shipment	Sensor Replacement Cost Discount
Less than one year	100% off replacement cost at time of replacement
Greater than 1 year but less than 2 years	75% off replacement cost at time of replacement
Greater than 2 years but less than 3 years	50 % off replacement cost at time of replacement
Greater than 3 years but less than 4 years	25% off replacement cost at time of replacement
Greater than 4 years	No Discount

   - If field training is not purchased, the warranty period is Ninety days from date of shipment from MOCON's factory.

2. Units or systems without MOCON offered field training.
   - One year from date of shipment from MOCON's factory.

3. Spare parts, repairs and accessories when purchased separately and not a part of a new instrument order.
   - Ninety days from date of shipment from MOCON's factory.

4. This warranty covers normal use only. It does not cover damage that results from alteration, accident, misuse, abuse, neglect, or failure to follow assembly, installation, operational, or other MOCON instruction.

5. All warranty repair items are to be shipped at purchaser's expense, to and from MOCON

6. MOCON software is provided "as is" and MOCON makes no warranty as to the software, including up time. In no event shall MOCON be liable for any damages in excess of the price paid for software including, but not limited to, direct, consequential (including, without limitation, lost profits), special, exemplary, incidental and indirect damages, arising out of or in connection with the use, the results or the inability to use the software, and imposed under any cause of action whatsoever, including contract, warranty, strict liability, or negligence, even if MOCON has been notified of the possibility of such damages.

MOCON will also not be liable under any circumstances for Product replacement or associated labor, loss of use, loss of profits, or for any other indirect, incidental, collateral, exemplary, punitive, consequential or special damages, or losses arising out of the purchase of the Product and/or out of this limited warranty, even if MOCON or its' designated representative have been advised of the possibility of such damages or claims. To the extent such claims are not excludable as adjudged by a court of competent jurisdiction, you agree to accept as sole and exclusive remedy, a payment equal to the original purchase price for the product adjudged to be defective. This warranty gives you specific legal rights and you might also have other rights that vary from country/region to country/region, state to state, or province to province.

SOME COUNTRIES, REGIONS, STATES OR PROVINCES DO NOT ALLOW THE EXCLUSION OR LIMITATION OF REMEDIES OR OF INCIDENTAL, PUNITIVE, OR CONSEQUENTIAL DAMAGES, OR THE APPLICABLE TIME PERIODS, SO THE ABOVE LIMITATIONS OR EXCLUSIONS MAY NOT APPLY TO YOU. EXCEPT TO THE EXTENT LAWFULLY PERMITTED, THIS LIMITED WARRANTY DOES NOT EXCLUDE, RESTRICT OR MODIFY, AND IS IN ADDITION TO THE STATUTORY RIGHTS APPLICABLE TO THE SALE OF THIS PRODUCT TO YOU.

EXCEPT FOR THIS LIMITED WARRANTY, AND TO THE FULLEST EXTENT ALLOWED BY LAW, NEITHER MOCON NOR ANY AUTHORIZED DISTRIBUTOR MAKES ANY OTHER WARRANTY OF ANY KIND, EXPRESS OR IMPLIED, INCLUDING ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. MOCON DOES NOT OFFER, ASSUME OR AUTHORIZE THE OFFER OR ASSUMPTION OF LIABILITY FOR IT OR FOR ANY OTHER WARRANTY, EITHER EXPRESS OR IMPLIED BY ANY AUTHORIZED DISTRIBUTOR OR OTHER INDEPENDENT THIRD PARTY.

Part Number 032-847
Revision D

7500 Mendelssohn Avenue North
Minneapolis, MN 55428 USA
Telephone 763-493-6370
Web Site: www.ametekmocon.com

INTERNATIONAL SERVICE POLICY

MOCON offers a complete range of service options to purchasers of MOCON instrumentation and systems.

♦♦♦SERVICE PERFORMED WITHIN THE WARRANTY PERIOD♦♦♦

LOCAL SERVICE (IF AVAILABLE)

A request may be made for your local representative to visit your facility. If a special trip to your location is required, you will be billed for time, travel expenses, and parts. Once the representative arrives at your plant, parts (if covered by warranty) are free of charge. Contact your representative for labor rates. If you are unsure of whether you have a local representative, please contact MOCON and we will direct you to the location nearest you.

RETURN UNIT TO MOCON U.S.A.

If replacing the part appears to be beyond the local representative's capability or if no local representative exists, the customer may elect to ship the instrument back to the factory in Minneapolis, Minnesota, U.S.A., for repairs. In this case, the Customer is responsible for round trip freight, insurance, and duties, with MOCON providing all labor and materials free of charge, subject to warranty restrictions. Our Service Department will keep turnaround time to a minimum.

U.S.A. SERVICE PERSONNEL

When the malfunction is considered by MOCON to be an emergency, MOCON service personnel can be dispatched from the U.S.A. to visit your facility and to correct the problem you are experiencing. The charges for this service include travel expenses incurred and portal-to-portal travel time at prevailing labor rates. Labor and parts expended while on your premises are free of charge, subject to warranty restrictions.

PART REPLACEMENT

If a local service representative is not available in country and if a defective part can be determined by the Customer's maintenance personnel, a free replacement part can be shipped collect to the customer for installation by the Customers maintenance personnel.

♦♦♦SERVICE PERFORMED AFTER THE WARRANTY PERIOD♦♦♦

LOCAL SERVICE (IF AVAILABLE)

A request may be made for your local representative to visit your facility. If a special trip to your location is required, you will be billed for time, travel expenses, and parts. If you are unsure if you have a local representative, please contact MOCON and we will direct you to the location nearest you.

RETURN UNIT TO MOCON U.S.A.

If replacing the part appears to be beyond the local representative's capability or if no local representative exists, the Customer may elect to ship the instrument back to the factory in Minneapolis, Minnesota, U.S.A., for repairs. The Customer is responsible for round trip freight, insurance and duties, and will be billed for parts and labor required to accomplish the repair. If the required parts are in stock, turnaround time is minimal.

U.S.A. SERVICE PERSONNEL

When the malfunction is considered by MOCON to be an emergency, MOCON service personnel can be dispatched from the U.S.A. to visit your facility and to correct the problem you are experiencing. The charges for this service include travel expenses incurred, portal-to-portal travel time at prevailing labor rates, and parts expended.

PART REPLACEMENT

If a local service representative is not available in country and if a defective part can be determined by the customer's maintenance personnel, a replacement part can be shipped collect to the customer for installation by in-house maintenance personnel. Charges will include the cost of the parts plus shipping.

Part Number 032-848
REVISION E

7500 Mendelssohn Avenue North
Minneapolis, MN 55428 USA
Telephone 763-493-6370
Web Site: www.ametekmocon.com

DOMESTIC SERVICE POLICY

MOCON offers a complete range of service options to purchasers of MOCON instrumentation and systems.

♦♦♦SERVICE PERFORMED WITHIN THE WARRANTY PERIOD♦♦♦

RETURN UNIT TO MOCON

The Customer may elect to ship the instrument back to the factory in Minneapolis, Minnesota, for repairs. In this case, the Customer will pay the charge for round trip freight and insurance, with MOCON providing all labor and materials free of charge subject to warranty restrictions.

SERVICE REPRESENTATIVE VISIT

If malfunction is considered by MOCON to be an emergency, a MOCON service representative will be dispatched from MOCON to visit the Customer's facility to correct the problem. The charges for this service include all travel expenses and the service technician's portal-to-portal travel time at the prevailing labor rates. Labor and parts expended while on the Customer's premises are free of charge, subject to warranty restrictions.

♦♦♦SERVICE PERFORMED AFTER WARRANTY PERIOD♦♦♦

In the event that repairs are required after the warranty period, the Purchaser again has several alternatives.

PREVENTIVE MAINTENANCE CONTRACT

Preventive maintenance contracts are available. MOCON recommends the instruments sold by MOCON have preventative maintenance performed yearly to facilitate calibration and reduce the likeliness of unexpected failures and downtime. If it is found during the PM visit that repairs are needed, repairs may be able to be performed during the PM visit if time in the schedule permits. Additional labor charges may apply for repairs conducted during the PM visit.

RETURN UNIT TO MOCON

The Customer may elect to ship the instrument back to the factory in Minneapolis, Minnesota, for repairs. The Customer is responsible for the cost of round-trip freight and insurance. The Customer will be billed for parts and labor required accomplishing the repair.

SERVICE REPRESENTATIVE VISIT

If malfunction is considered by MOCON to be an emergency, a MOCON service representative will be dispatched from MOCON to visit the Customer's facility to correct the problem. The charges for this service include all travel expenses, the service technician's portal-to-portal travel time at prevailing labor rates, parts used, and on-stie labor at the prevailing labor rates to repair the equipment.

♦♦♦GENERAL TERMS AND CONDITIONS♦♦♦

- Invoices are due NET 30 days (with approved credit) and are billed and payable in U.S. dollars.

- All parts are shipped EXW MOCON factory Minneapolis, Minnesota; freight and Insurance will be billed separately.
- MOCON insures all shipments unless advised otherwise.
- All repairs after the original instrument warranty period are warranted for 90 days on parts and labor, EXW. MOCON factory.

Please refer to the latest version of MOCON's Warranty Policy sheet for warranty information.

Appendix D: Theory of Operation

How the Oxygen Sensor Works

The oxygen sensor is a fuel cell that performs in accordance with Faraday's Law. When exposed to oxygen, the sensor generates an electrical current that is proportional to the amount of oxygen entering the sensor.

The oxygen sensor contains two electrodes, a flat PTFE tape coated with an active catalyst, the cathode and a lead anode. The sensor enclosure is airtight except for a small capillary with allows oxygen access to the working electrode. The cathodic and anodic reactions are respectively:

$$O_2 + 2H_2O + 4e^- \rightarrow 4OH^-$$

$$2Pb + 4OH^- \rightarrow 2PbO + 2H_2O + 4e^-$$

The electrons create a current which can be used to calculate the amount of oxygen entering the Oxygen sensor.

How the Transmission Rate is measured

The OX-TRAN Model 2/12 R measures transmission rate by directly measuring the current produced by the sensor. The vertical axis on the Permeant Sensor (Raw Counts) graph is current (1 count = ~ 10 pA).

The measured current is then corrected and scaled using the gain, barometric pressure, area and flow as is appropriate for the Test Method and Permeant Sensor calibration specified for the measurement.

Factors that Affect the Transmission Rate of a Barrier Material

The oxygen transmission rate of barrier materials is affected by several factors:

- Barrier test temperature
- Test gas (oxygen) concentration effect on driving force
- Barometric pressure effect on driving force
- Relative humidity

Barrier Temperature

The temperature at which the barrier is tested has a great effect (usually logarithmic) on transmission rate. This makes temperature one of the most important test conditions for most barrier materials. Many barriers exhibit a 6% to 15% rise in oxygen transmission rate for each degree C rise in temperature.

Test Gas Driving Force

The driving force of the test gas has a direct effect on the oxygen transmission rate. The driving force of the test gas is affected by the oxygen concentration of the test gas and the ambient Barometric pressure.

Barometric Pressure

Barometric pressure has a proportional effect on the oxygen transmission rate of a specimen due to the increase/decrease in the density of the test gas.

The instrument automatically compensates all transmission rate data to sea-level pressure (760 mmHg).

Due to the wide potential variation in altitudes, reproducibility between laboratories may not be possible unless the transmission rate data is compensated to sea-level pressure. The instrument compensates all transmission rate data to sea-level pressure using the following ratio:

$$\frac{Standard\ barometric\ pressure\ (760mmHg)}{Ambient\ barometric\ pressure}$$

Relative Humidity

The amount of water vapor some materials (such as nylon, cellophane and ethyl vinyl alcohol) are exposed to significantly affects the oxygen transmission rate of the barrier. The barrier properties of some of these materials can be permanently affected by prolonged exposures to significant amounts of water vapor.

The OX-TRAN Model 2/12 R provides the capability to test these types of materials in a controlled "wet" test environment. A Relative Humidity for the Test and Carrier gases between 0% and 90% RH can be specified.

How a Humidified Test Gas is Generated

Humidified Carrier and Test Gases are created by moving pressurized gas through a humidifier filled with HPLC-grade water and mixing the wet gas with a dry gas in the appropriate ratios.

A separate humidifier is provided for each of the gases (Test and Carrier). A mixing valve is used to "mix" the saturated gas (~100% RH) with the dry gas. A mix-ratio of 50% yields a gas with an RH of approximately 50%.

A RH sensor is used to measure the actual RH delivered to the Test Cell. The instrument uses the measured RH value to adjust the mixture ratio to maintain the RH of the gas delivered at the specified value.

The RH that the sample will be tested at can be changed from wet-to-dry or dry-to-wet by simply changing the RH set points. The "Sequential Test" feature can be used to automatically perform a sequence of tests at different RH levels.

How the ReZero Cell Works

The transmission rate measured for samples mounted in the Test Cells is the sum of the transmission rate due to permeation through the barrier material and all other sources of oxygen ingress. This includes the system baseline. If the system baseline can be measured, subtracting it from the apparent transmission rate of the Test Cells will give a more accurate representation for the transmission rate of the barrier material.

During a ReZero State the instrument routes carrier gas (which is at the same temperature and RH as used in the Test Cells) to the oxygen sensor. The instrument components used to perform this function are referred to as the ReZero Cell. The ReZero Cell is different from the Test Cells in that it does not contain a barrier material that is exposed to a Test Gas. This means that any residual oxygen in the carrier gas is not due to permeation through the barrier materials mounted in the Test Cells. The residual oxygen measured in the ReZero State is therefore considered to be a good representation of the system baseline.

Periodically the instrument baseline is measured using the ReZero Cell. The ReZero Interval and Examination Time is determined the by currently active Test Method. The resulting data is used to correct the transmission rate data for any active tests. This ensures that changes in the baseline do not affect the accuracy of the transmission rate data.

How the Auto-Test Method Works

The Auto-Test Method utilizes an internal rule-set to dynamically optimize how a permeation test is performed. The Auto-Test Method also utilizes an advanced dynamic convergence algorithm to determine when the sample has reached equilibrium. The Equilibrium Determination is used to advance the test to the next phase or terminate the test as required by the criteria in the rule-set.

The measured transmission rate and internal rule-set are used to dynamically optimize the Cell Examination time, the ReZero Frequency, the ReZero Examination time and the Individual Zero State.

The Convergence algorithm makes an Equilibrium Determination based on the absolute-magnitude-of or the magnitude-of-change-in the transmission rate. If the absolute magnitude of the transmission rate is less than the noise floor of the instrument, the sample is declared to be at equilibrium. Above the noise floor the acquired Cell Examination data is used to calculate two variables. These variables are calculated using data sets representing different time frames. These variables represent the "Current" transmission rate and the "Historical" transmission rate. When the difference in the value of these variables is less than 1%, the sample is declared to be at equilibrium.

The absolute magnitude of the measured transmission rate is used to determine if an Individual Zero Phase will be performed during the test. The performance of the Individual Zero Phase is optimized in the same manner as used for the Test Phase. When included, the Individual Zero Phase will always be performed after the Test Phase.

Completed Auto-Test Methods will contain a log showing the changes in the dynamically assigned test parameters in addition to the normal Cell Examination data.

How Sequential Testing Works

The Sequential Test function allows a sequence of tests to be performed on the same sample (at different test conditions) without user intervention. The specific tests performed, are determined by the contents of the Sequential Test Parameters table. The Sequential Test function is an Advanced Test Method property.

The Sequential Test Parameters table is used to specify the Test Temperature, Test Gas RH and Carrier Gas RH for each test to be performed. Tests are executed in the order they are placed in the Sequential Test table. A maximum of ten sequences can be added to the table.

The criteria for the completion of all the tests in the table, is determined by setting of the "Test Mode" parameter. If the "Test Mode" parameter is set to "Continuous" manual user intervention will be required to Advance each test to the "Complete" state.

The Advance and Abort controls can be used to control the execution of each test and the overall sequence. Aborting a test in the sequence terminates the remainder of the sequence. A fatal error in any test in the sequence terminates the remainder of the sequence.

The "Auto Print", "Auto Save" and "Auto Export" functions can be used to create reports and save the results for each test as it is completed.

Note: It may be possible to reduce the total time required to execute the entire sequence by specifying the variable test conditions in numerical order. For example the lowest temperature first and the highest temperature last.

Appendix E: Electrical and Plumbing Diagrams

Title	Part Number
Plumbing Diagram, OX-TRAN Model 2/12	052-377
Electrical Diagram, OX-TRAN Model 2/12	052-378

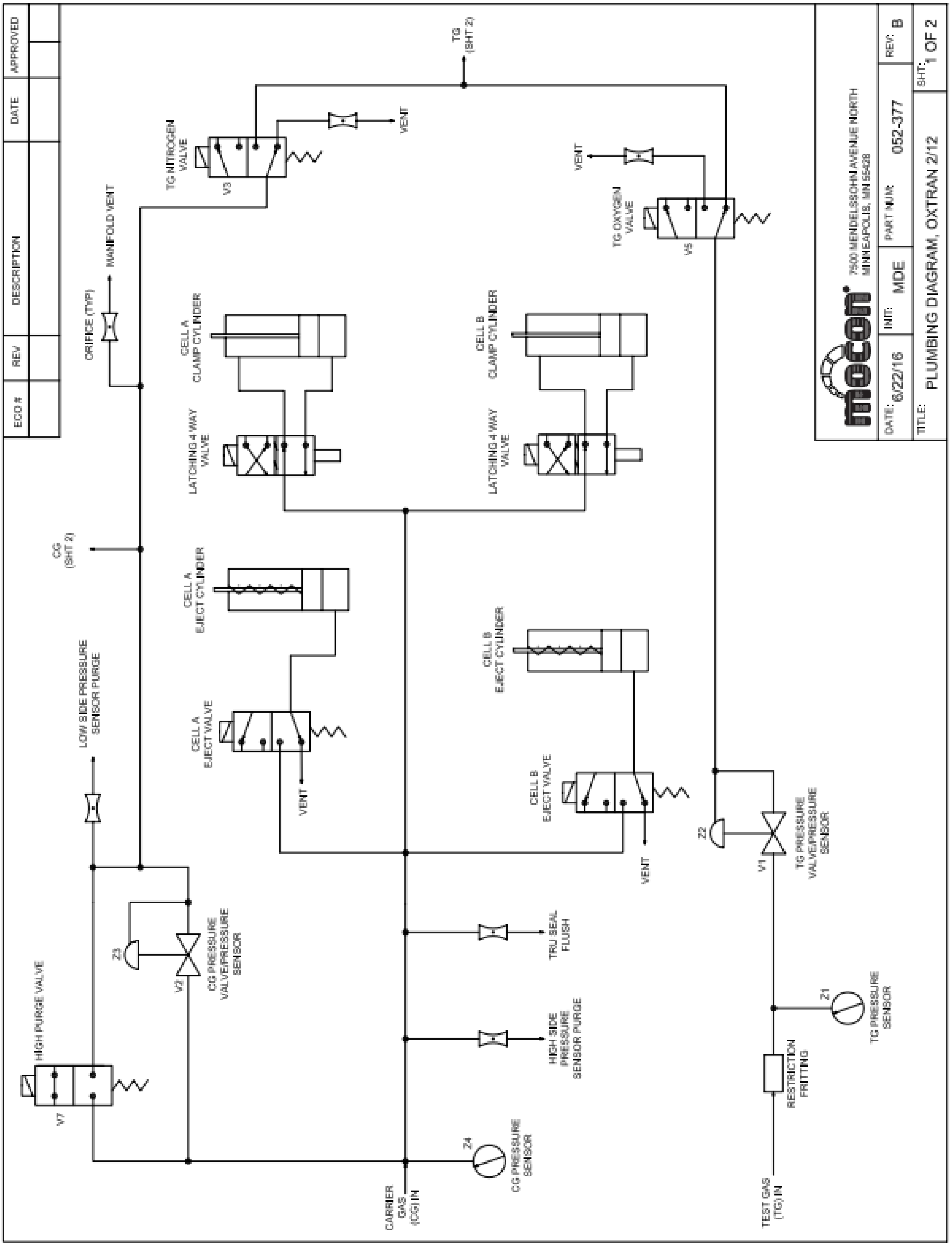


Figure E-1: Plumbing Diagram Page 1

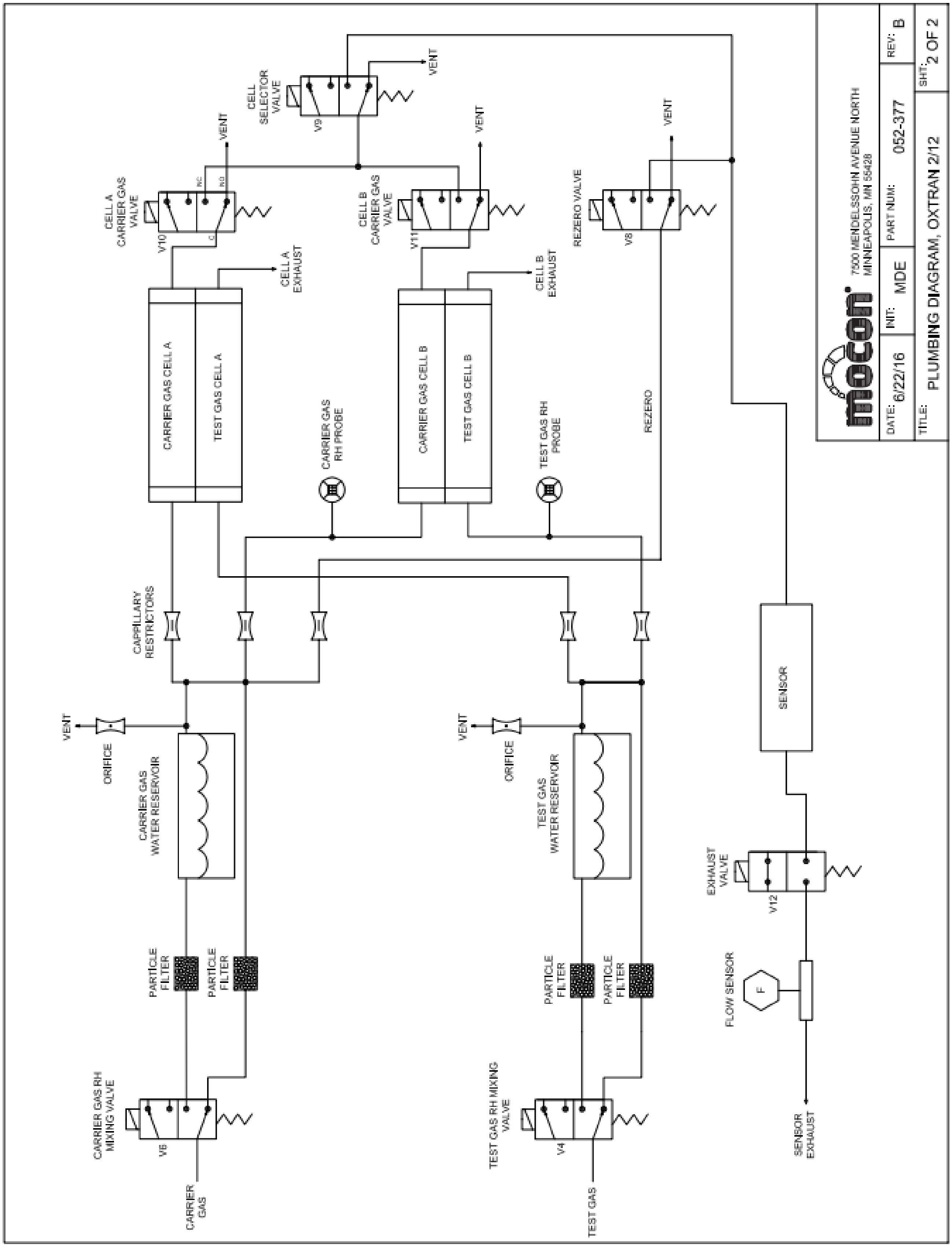


Figure E-2: Plumbing Diagram Page 2

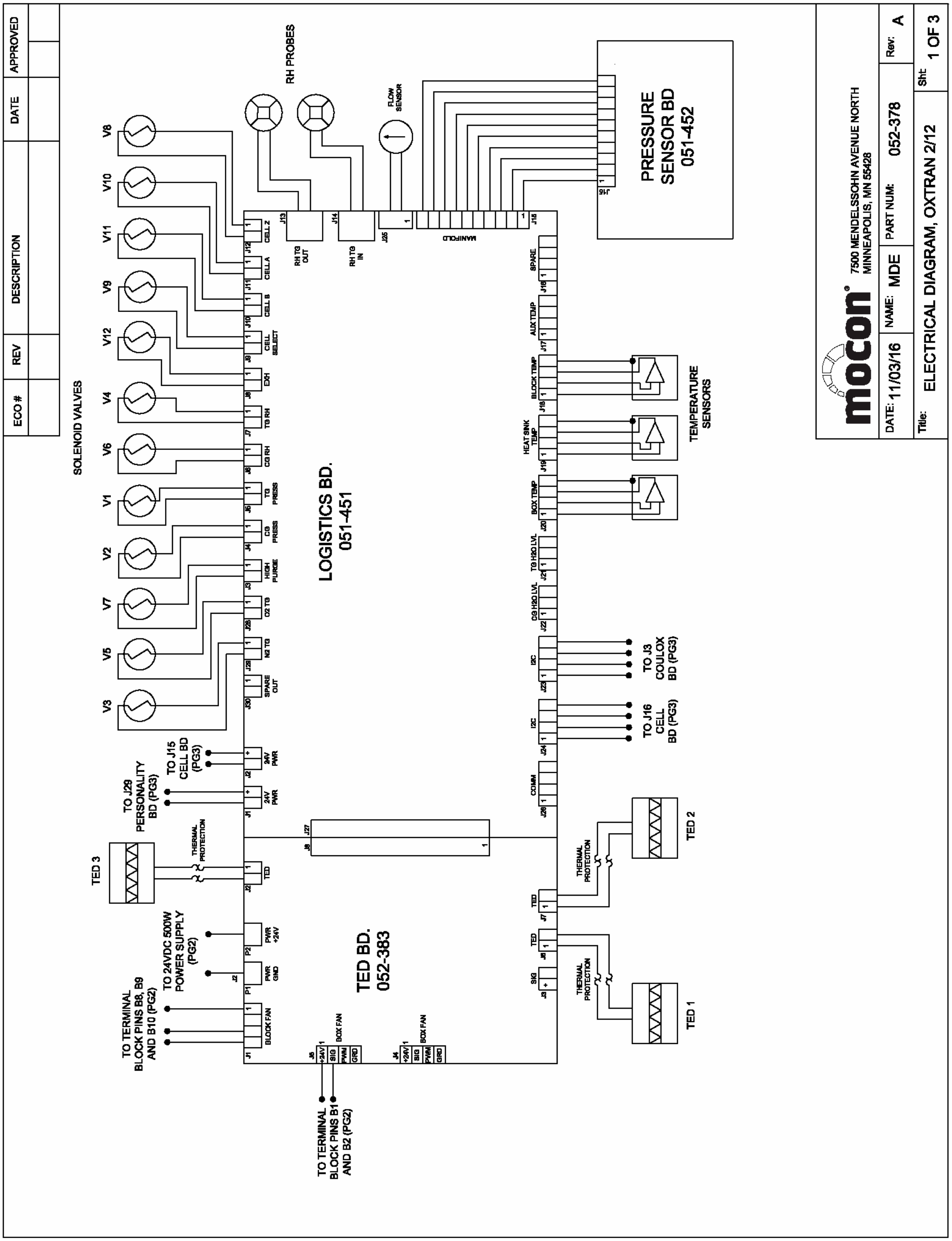


Figure E-3: Electrical Diagram Page 1

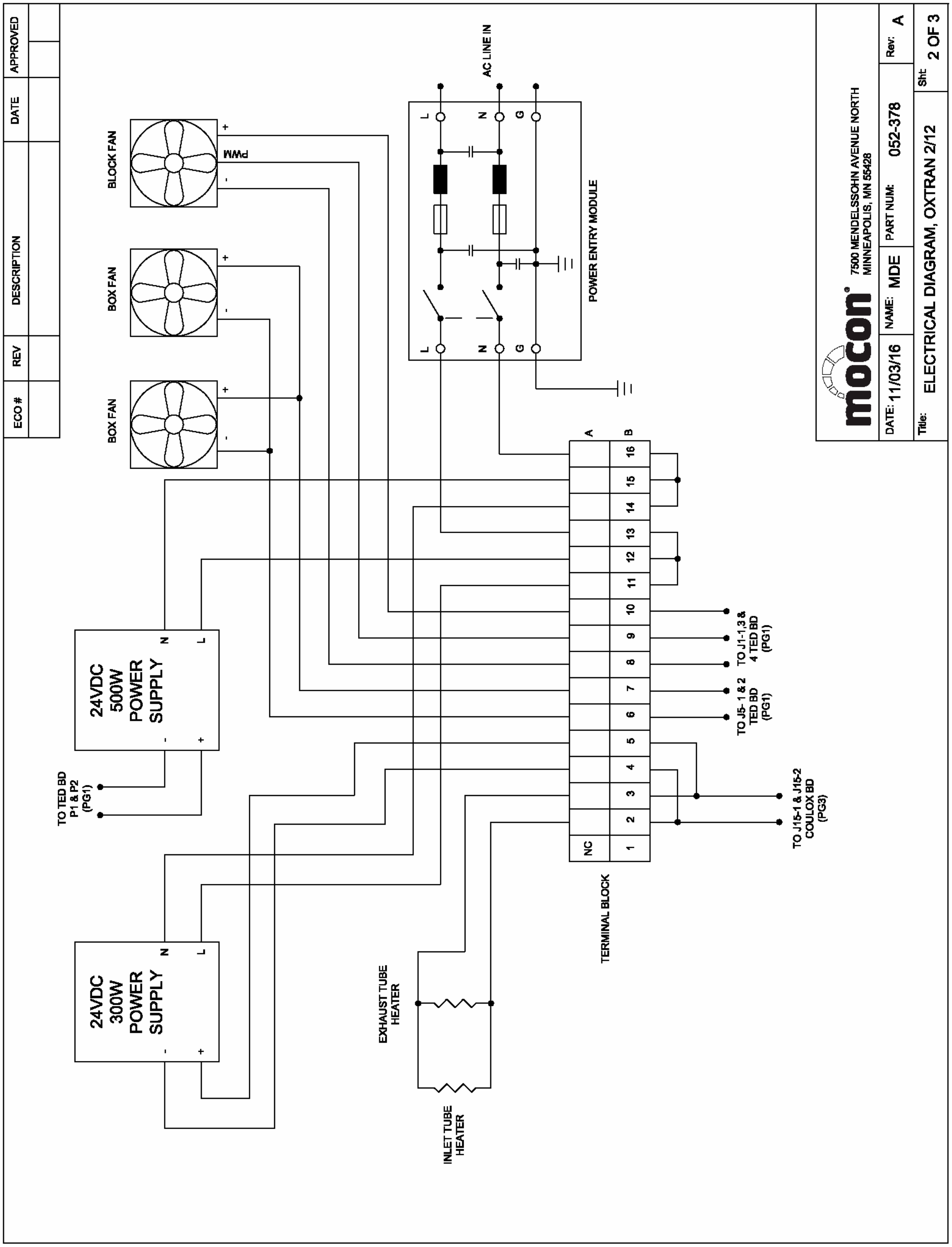


Figure E-4: Electrical Diagram Page 2

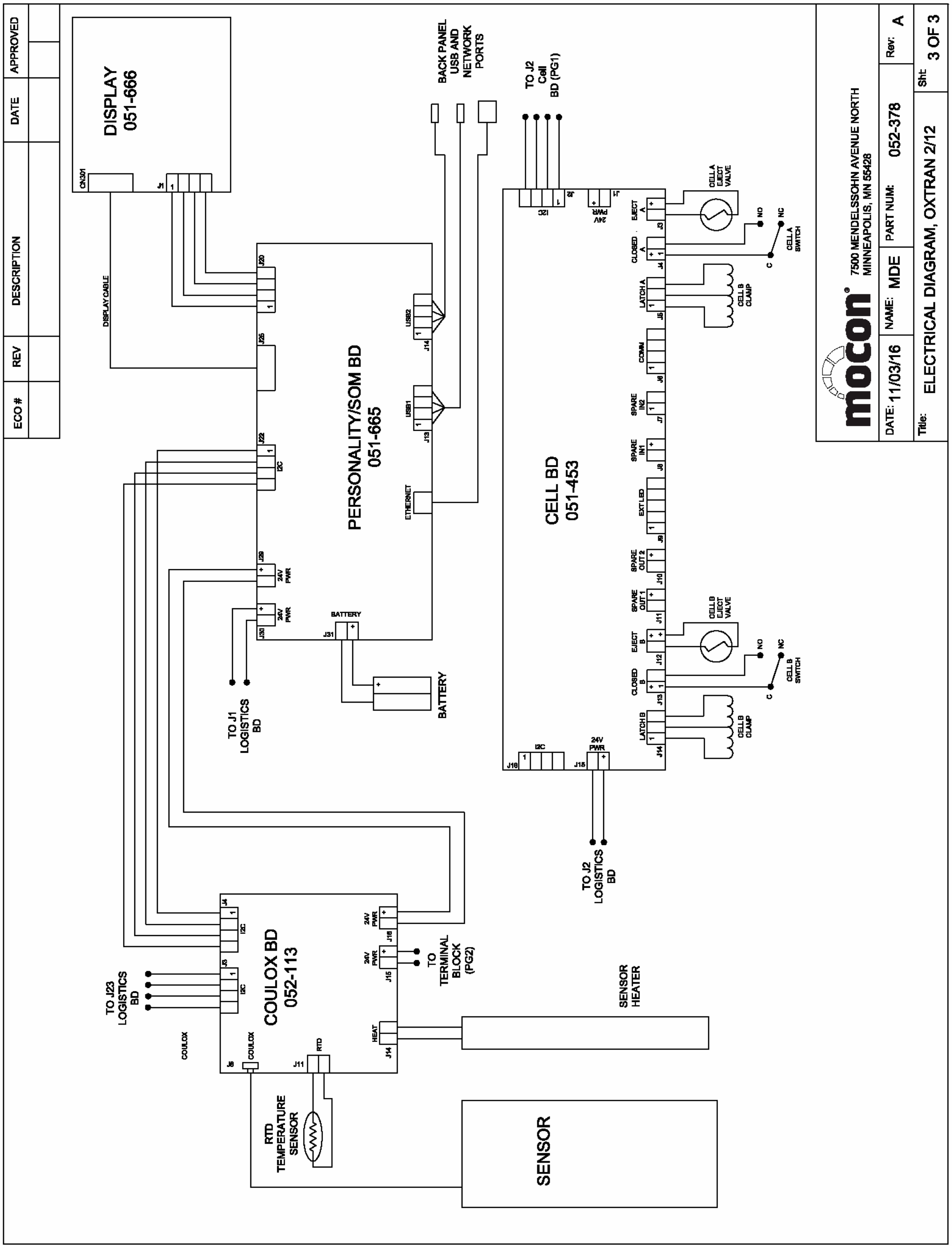


Figure E-5: Electrical Diagram Page 3

Appendix F: Preparing RH Calibration Standards

To calibrate or check the RH probes used in the OX-TRAN Model 2/12, requires RH reference values (or standards). A RH Calibration Standard consists of a saturated salt solution or molecular sieve in a "Calibration Flask". Calibration Standards should be kept tightly sealed using the "Flask Stopper" when not in use. The molecular sieve should be regularly replaced.

RH Calibration Equipment

MOCON has available the following materials to facilitate the preparation of RH reference standards suitable for the calibration of the RH Probes in the OX-TRAN Model 2/12.

- Calibration Flask MOCON Part Number 030-802
- RH Probe Stopper MOCON Part Number 030-803
- Flask Stopper MOCON Part Number 030-804

Choosing a Salt Solution

⚠ **Warning!** Some salts will produce exothermic or endothermic reactions when mixed with water. Failure to use proper safety equipment when mixing salt solution can result in frostbite or burn injuries. Salt solutions should be prepared only by qualified people with proper safety equipment.

RH sensor calibration will be performed at a specific temperature. A salt must be chosen that will produce the desired RH at that temperature.

For most salt solutions the RH produced by the solution is dependent on temperature. To choose the correct salt solution for your application, consult one of the following resources:

- Table F.1, Salt Solution Humidity Standards in Percent RH shown below.
- Handbook of Chemistry and Physics.
- The National Bureau of Standards.

Salts	15 °C	20 °C	25 °C	30 °C	35 °C
Lithium Bromide	6.86	6.61	6.37	6.16	5.97
Lithium Chloride	11.30	11.31	11.30	11.28	11.25
Potassium Acetate	23.40	23.11	22.51	21.61	21.61
Magnesium Chloride	33.30	33.07	32.78	32.44	32.05
Potassium Carbonate	43.15	43.16	43.16	43.17	43.17
Potassium Iodine	70.98	69.90	68.86	67.89	66.96
Sodium Chloride	75.61	75.47	75.29	75.09	74.87
Ammonium Sulfate	81.70	81.34	80.99	80.63	80.27
Potassium Chloride	85.92	85.11	84.34	83.62	82.95
Ammonium Monophosphate	93.85	93.32	92.65	92.00	91.42
Potassium Nitrate	95.41	94.62	93.58	92.31	90.79

Table F.1: Salt Solution Humidity Standards in Percent RH

Preparing a High Level Calibration Standard

A High Level RH Calibration standard can be prepared using a salt solution as follows:

1. Chose the appropriate salt for the calibration standard. See "Choosing a Salt for a Calibration Standard" in this appendix.

2. Prepare a saturated salt solution. See "Preparing a Saturated Salt Solution" in this appendix.

3. Thoroughly clean a calibration flask and flask stopper. Rinse the calibration flask and flask stopper using distilled water.

4. Thoroughly dry the calibration flask and flask stopper before proceeding to the next step.

5. Fill the flask ¼ to ½ full using the salt solution.

6. Add several grains of the salt used in the solution to the filled flask. This will provide a nucleation point to prevent super-saturation.

7. Tightly seal the flask using the Flask Stopper.

8. Wait four to six hours to allow the solution to come to equilibrium at the desired temperature before use.

Preparing a Low Level Calibration Standard

A Low Level RH Calibration standard can be prepared using a molecular sieve as follows:

1. Thoroughly clean a calibration flask and flask stopper. Rinse the calibration flask and flask stopper using distilled water. They must be completely dry before use.

2. Fill the flask ¼ to ½ full with the molecular sieve. Molecular sieve (part number 930-009) is available from MOCON.

3. Tightly seal the flask using the Flask Stopper.

4. Wait 2 to 3 hours before use.

Preparing a Saturated Salt Solution

1. Fill a clean glass beaker with distilled water. Leave enough room in the beaker so the water will not overflow when the salt is added to the beaker.

2. Place the beaker on a hot plate. The hot plate should be held at a temperature of 5 °C (10 °F) above the temperature at which it will be used.

3. Slowly add small amounts of the appropriate salt to the water.

4. Stir gently until no more salt will dissolve in the water when stirred. At that point, the water is saturated. There should always be some un-dissolved salt in the solution.

5. Remove the salt solution from the heat.

Appendix G: Compliance

Declaration of Conformity

Manufacturer: AMETEK MOCON.
7500 Mendelssohn Avenue North
Minneapolis, MN 55428 USA
(763) 493-6370
www.ametekmocon.com

Type of Equipment: Electrical Equipment for measurement, Control and Laboratory Use

Model: OX-TRAN Models 2/12 T and 2/12 R

Application of Council Directive(s):

2014/35/EU Low Voltage Directive
2014/30/EU EMC Directive
2011/65/EU RoHS Directive

Standard(s) to which conformity is declared:

IEC 61010-1:2010 Third Edition
EN 61326-1:2013

Class A Radiated & Conducted
Basic Immunity Test Requirements

EN 61000-3-2:2014 (Rev 4)
EN 61000-3-3:2013 (Ed 3)

This declaration is based on an understanding of the materials used and information provided by third-party suppliers. AMETEK MOCON proactively manages the supply chain to ensure information pertaining to composition of the materials used is accurate. AMETEK MOCON has not and does not conduct destructive testing or chemical analysis to verify material composition.

Place of Issue: Minneapolis, MN USA

Date of Issue April 7th, 2022

Hasan Akhtar
Global Director, Quality and Safety