OX-TRAN®
Model 2/48
Operator's Manual

Revision E

mocon® / AMETEK®

Gas-Detection
LAUPER INSTRUMENTS

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About This Manual

This manual explains how to set up and use the OX-TRAN Model 2/48 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 2/48

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 5 "Testing Packages" on page 5-1 and Chapter 6 "Testing Flat Films" on page 6-1.

If You Have Problems Operating the System:

1. If an error message appears on instrument screen see Chapter 8 "Troubleshooting" beginning on page 8-1 in this manual.

2. If no error message appears but you have other problems, see Chapter 8 "Troubleshooting" beginning on page 8-1 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 four-person lift is recommended.
- The maximum pressure applied to the instrument from the Compressed Air supply must not exceed 100 psi (1.9 bar), or damage to the instrument will occur.
- The maximum pressure applied to the instrument from the Carrier Gas supply must not exceed 28 psi (6.9 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 Carrier Gas humidity generator.
- Use only distilled water in the Chamber RH water reservoir.
- 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.

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Figures

Tables

Chapter 1: Introduction

This chapter provides a brief overview of the OX-TRAN Model 2/48 Oxygen Transmission Rate System.

Read this chapter to get an overview of:

- The features of the OX-TRAN Model 2/48 system
- A summary of how an Oxygen Transmission Rate measurement is performed
- A summary of the basic steps in a permeation test
- A summary of how Package and Film testing is performed

Figure 1-1: OX-TRAN Model 2/48 System

Features

The following features of the OX-TRAN Model 2/48 Oxygen Transmission Rate System make it very versatile and easy to use:

- Fully automatic (Hands Off) testing.
- Four Test Cells to provide increased test capacity.
- Four Conditioning cells to speedup through-put.
- Removable Test Cartridges for faster sample mounting.
- TruSeal™ Test Cells for increased performance.
- Test Cartridges available for Cups, Bottles, Trays, Flexible Packages and Films.
- Ambient temperature only – no temp control.
- Automatic Barometric Pressure compensation.
- Automatic control of Pressure, Flow and RH on Carrier Gas side.
- Independent control of the Carrier Gas RH.
- Advanced Gas Saver function reduces gas consumption.
- Advanced sample Smart Conditioning Mode.
- Advanced Auto-Purge function to purge packages.
- Advanced Reference Check function to verify instrument performance.
- Advanced Automatic Test function to simplify testing of samples with unknown properties.
- Advanced oxygen sensor over-range recovery function.
- Advanced Quick Check function to detect potential over range conditions.
- Absolute coulometric, patented and low maintenance Coulox oxygen sensor.
- 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).
- Conforms to ASTM D3985, F1927, F1307 and F2622.

Measuring an Oxygen Transmission Rate

To make an accurate transmission rate measurement a Test Gas (20.9% 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 (usually a nitrogen/hydrogen mix). This process is illustrated in Figure 1-2 which depicts a package mounted in a Diffusion Cell designed for a Cup or Tray.

As shown in the illustration the package is mounted between the parts of the Diffusion Cell. The sealing surfaces and O-rings in the cell prevent outside air from affecting the measurement.

The Test Gas side of the sample is exposed to ambient air environment. Real time environmental temperature, relative humidity, and barometric pressure, are monitored and recorded by the OX-TRAN Model 2/48 .

The Carrier Gas passes through a catalyst to remove any residual oxygen and then enters the carrier side of the cell. As oxygen permeates the sample barrier it mixes with the Carrier Gas. The output side (exhaust) of the diffusion cell is routed to an oxygen sensor. The amount of oxygen in the carrier gas is measured using the patented Coulox oxygen detector.

Seal leakage in the diffusion cell can be a significant source of error when measuring the transmission rate of a sample. The TruSeal™ flush ring at the perimeter of the 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.

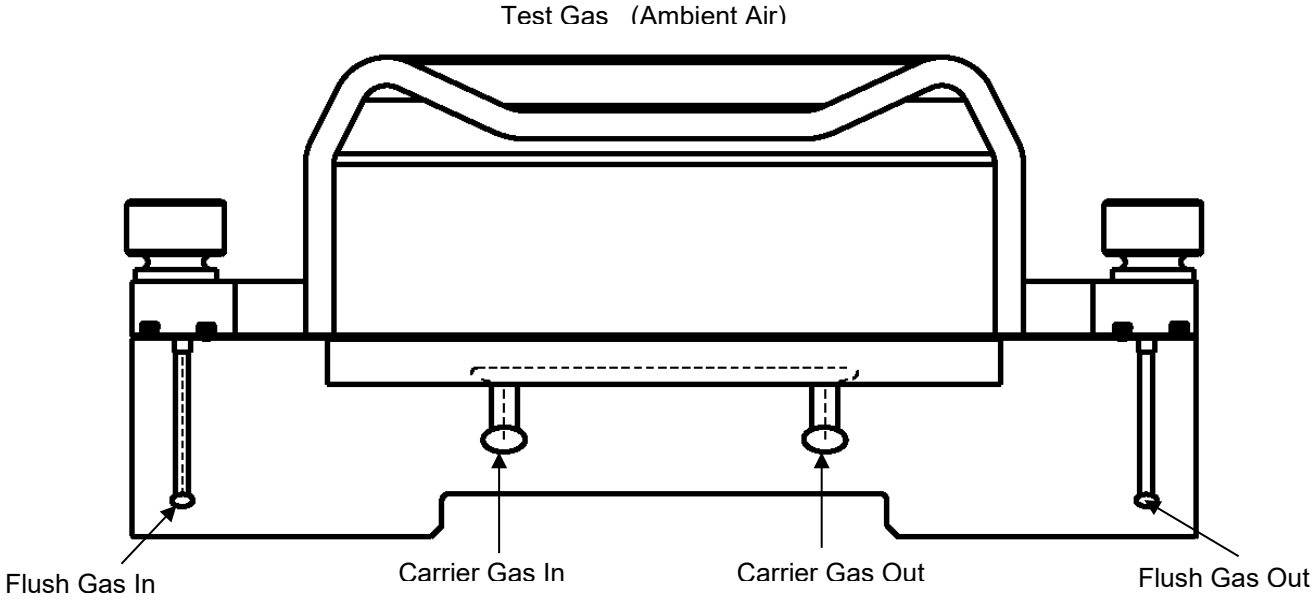

Figure 1-2: An OX-TRAN Model 2/48 Permeation Cell

Testing Packages and Films

To test packages (or films) the sample must be mounted in a Diffusion Cell. A Diffusion Cell exposes one side of the sample barrier to a Test Gas (ambient air in OX-TRAN Model 2/48) and the other side to a Carrier Gas. The carrier gas supplied to the cell can be dry or at a specified RH.

The Diffusion Cells used in the OX-TRAN Model 2/48 expose the Test Gas side of the sample barrier to the environmental ambient air. Real time environmental temperature, RH and barometric pressure are monitored and recorded by the OX-TRAN Model 2/48 instrument.

The design of an effective Diffusion Cell must accommodate the physical characteristics of the sample to be tested. A Diffusion Cell design optimized for testing small cups may not be suitable for testing large trays. The OX-TRAN Model 2/48 contains an upper deck for testing, and a lower deck for conditioning. Each deck has positions for four removable Diffusion Cells. These removable Diffusion Cells are referred to as Test Cartridges. To accommodate most testing requirements MOCON offers a selection of Test Cartridges. The design of these Test Cartridges is optimized for different types of samples (bottles, trays, pouches, bags, cups and films).

To test packages the sample must be mounted in an appropriate Test Cartridge. After the sample is mounted in a Test Cartridge, it is installed and clamped into one of the four positions on the testing deck for testing, or on the conditioning deck for conditioning. The four positions on the testing deck are referred to as Test Cells. The method used to mount the sample in the Test Cartridge is dependent on the design of the cartridge and the sample. For more information on mounting packages see the information supplied with your Test Cartridges. See Figure 1-3, Figure 1-4 and Figure 1-5 for examples of some of the Test Cartridges that are available. For more information on testing packages see Chapter 5.

To test a film sample, it is prepared and mounted in a Film Test Cartridge. After the sample is mounted, it is installed and clamped into one of the positions on the testing deck. See Figure 1-6 for an illustration of the Film Test Cartridge. For more information on mounting and testing Film Samples see Chapter 6.

Figure 1-3: Large Tray Cartridge

Figure 1-4: Package Adapter Cartridge

Figure 1-5: Bottle & Cup Cartridge

Figure 1-6: Film Cartridge

Permeation Test Overview

A "Permeation Test" consists of up to two phases that are performed using a Test Cell. The "Cell" may contain a package cartridge or a film cartridge. 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. The Individual Zero value is used to correct the transmission rate values obtained from 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 test environment and reach equilibrium. A conditioning state can be specified to allow the barrier to "Condition" to the test environment. When used, the Conditioning State will occur at the beginning of each test phase. For more information on how to use Conditioning see "Conditioning the Sample" in Chapter 3.

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 Coulox sensor it is said to be in the Bypass State. The Bypass State is used to maximize the useful life of the sensor. The Coulox 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 all cells at any time until a new permeation test is started. See the instrument Help System for information on printing reports.

Chapter 2: Setting Up

This chapter provides information on how to set up an OX-TRAN Model 2/48 and prepare it for use.

Read this chapter to learn about:

- Unpacking the System
- Preparing for System Installation
- Front Panel Parts and Controls
- Back Panel Parts and Controls
- Testing Deck and Conditioning Deck Parts and Controls
- Connecting nitrogen line to the instrument

Unpacking the System

Each OX-TRAN Model 2/48 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.

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 2/48.

The ambient environmental conditions in which the instrument will be used must meet those specified on page 9-1 in Chapter 9.

The OX-TRAN Model 2/48 should be placed on a bench or table capable of supporting approximately 102 kg (225 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 2/48, 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, and **Error! Reference source not found.**.

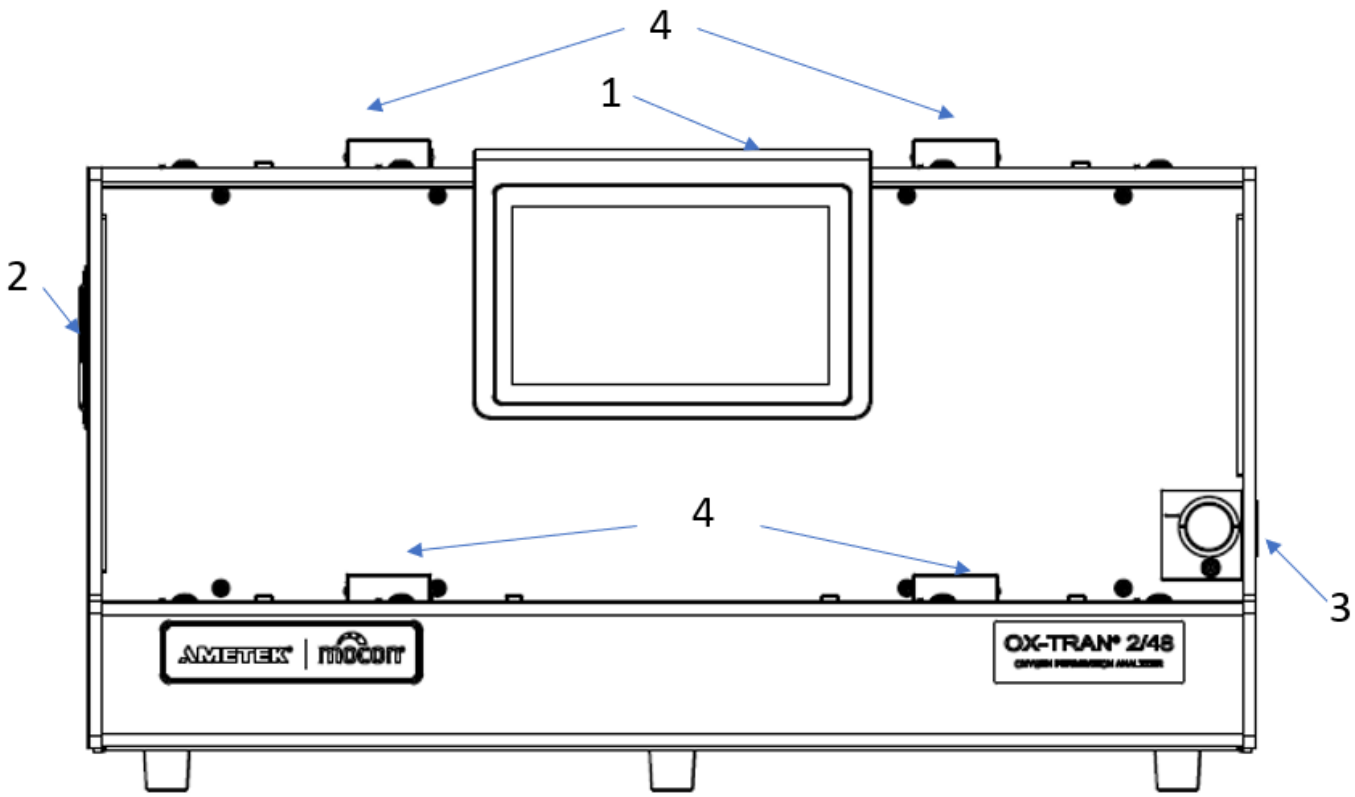

Figure 2-1: Front Panel Parts and Controls

Item	Name	Description
1	Instrument Display	The color touch screen display used for instrument control
2	Cooling Fans	The fans that supply air for heating and cooling the Test Chamber.
3	Carrier Gas Inlet Port	The fitting that connects the Carrier Gas supply to the instrument.
4	Test Cell Clamping Manifold	The carrier gas block to connect test cartridges

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 2-2 and Table 2.2.

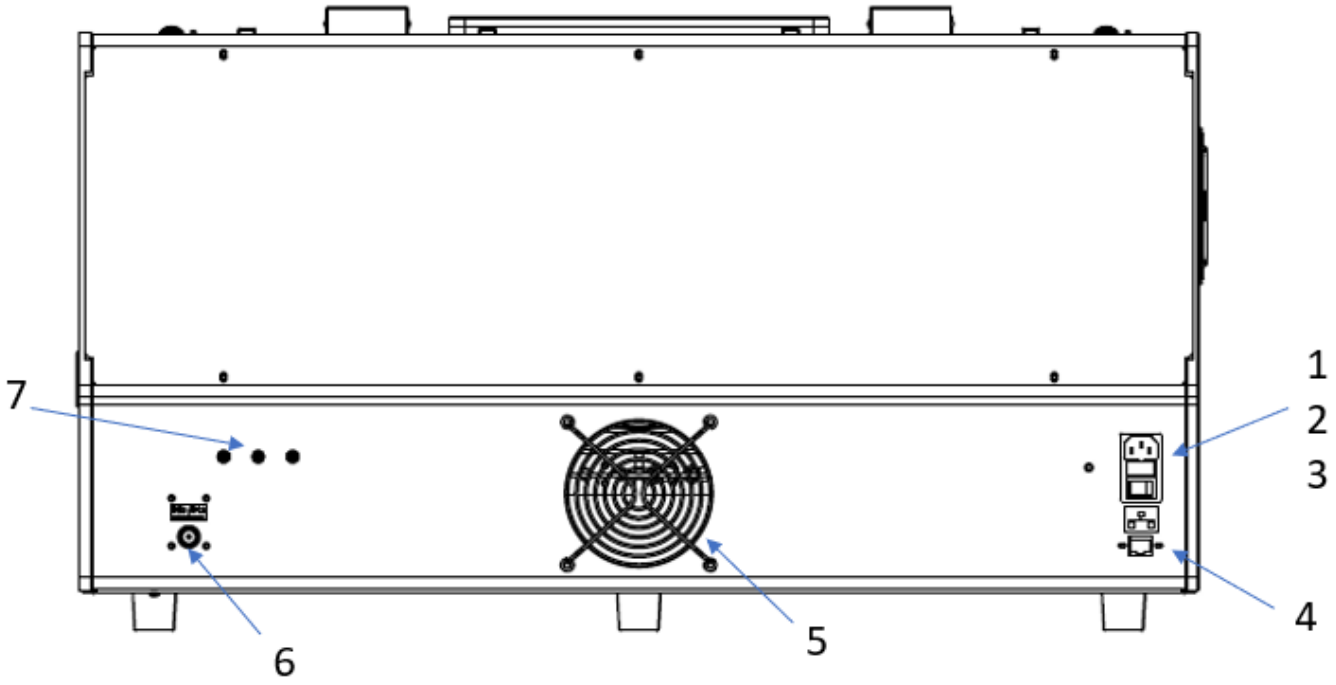

Figure 2-2: Back Panel Parts and Controls

Item	Name	Description
1	Power Inlet	The connector for the power cord.
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	Network Port	A 10/100T Ethernet port for connection to a network.
5	Enclosure Fan Exhausts	The exhaust vents for electronics enclosure cooling fans.
6	Carrier Gas Inlet Port	The fitting that connects the Carrier Gas supply to the instrument.
7	System Vents	The vents for the ReZero cell, Cell Select valve and Sensor exhaust.

Table 2-2: Back Panel Controls and Connections

Top View Onboard 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 2.3.

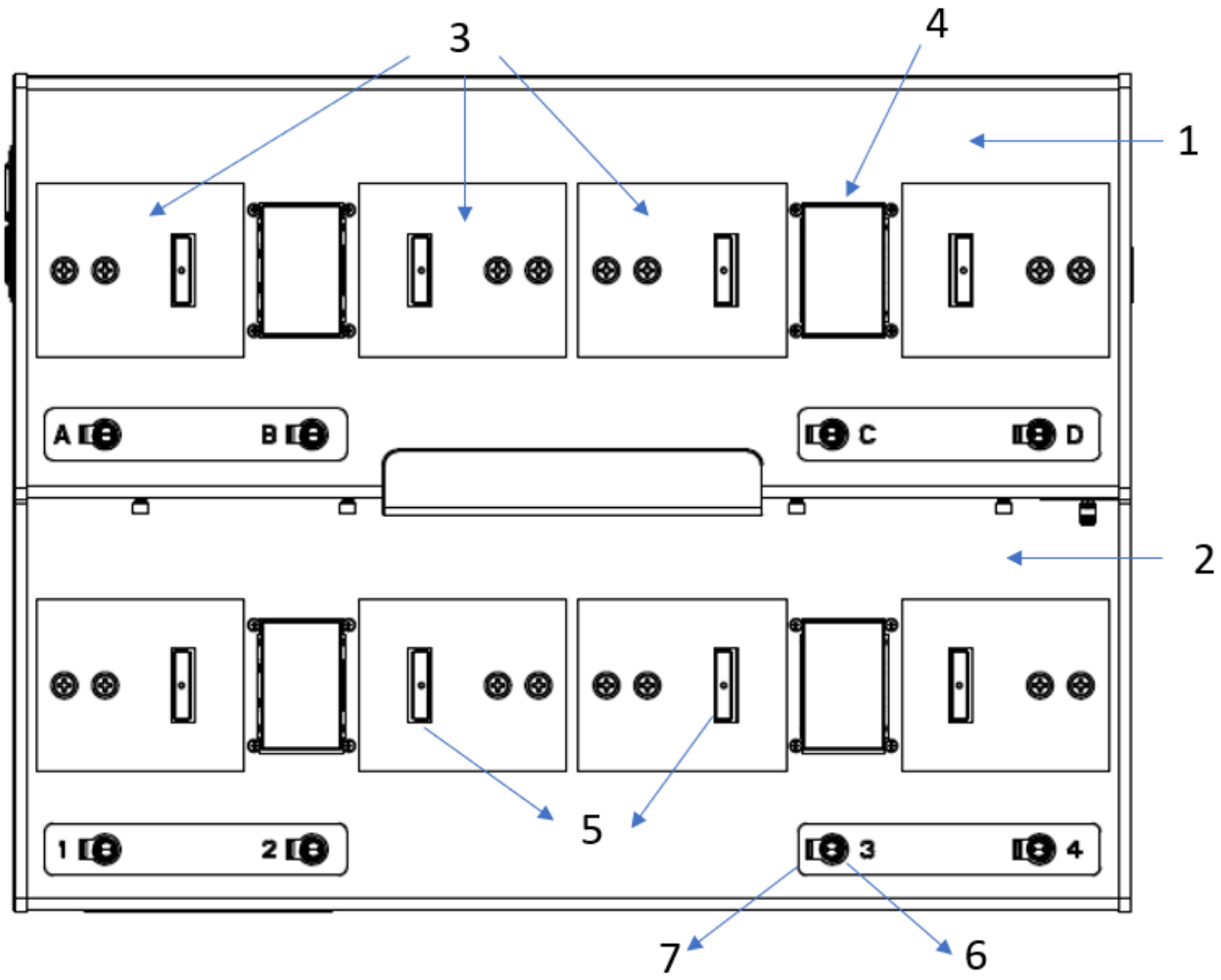

Figure 2-3: Top View Onboard Parts and Controls

Item	Name	Description
1	Upper Deck	Host 4 stations for testing
2	Lower Deck	Host 4 stations for conditioning
3	Test Cell Stations	Locations to place test cartridges
4	Test Cell Clamping Manifold	The carrier gas block to connect test cartridges
5	Test Cartridge Clamp Bar	The device used to clamp a Test Cartridge to the Test Cell gas ports.
6	Test Cell Clamp\Unclamp Button	The button used to clamp and unclamp a Test Cartridge.
7	Test Cell Status Indicator	The indicator used to annunciate the status of the Test Cell.

Table 2-3: Top View of Onboard Parts and Controls

Details of Other Onboard Parts and Controls

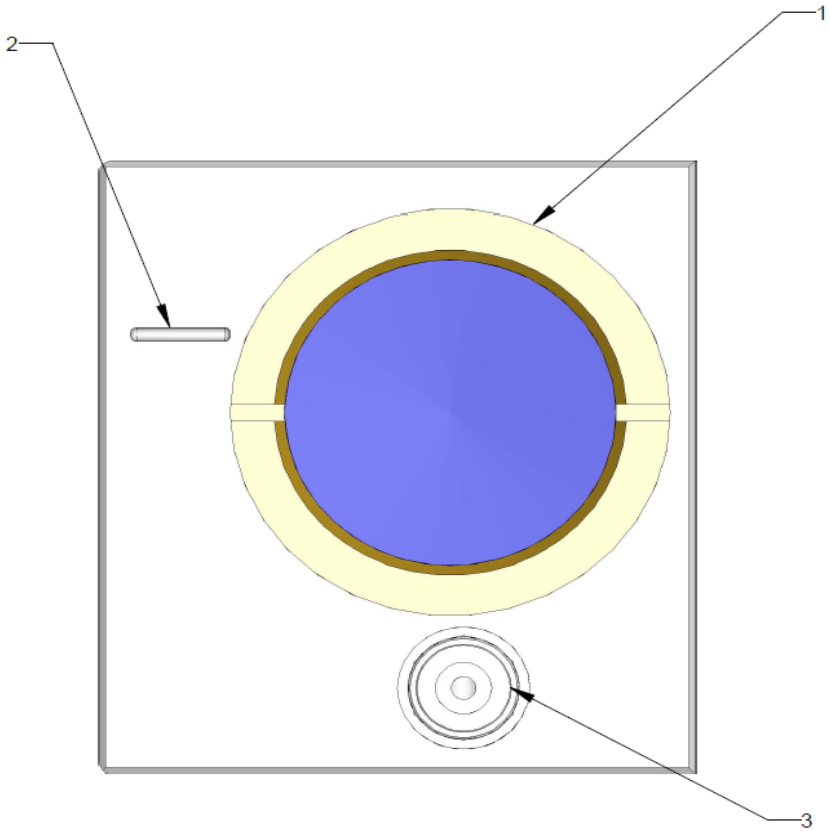

Figure 2-4: Carrier Gas Humidifier

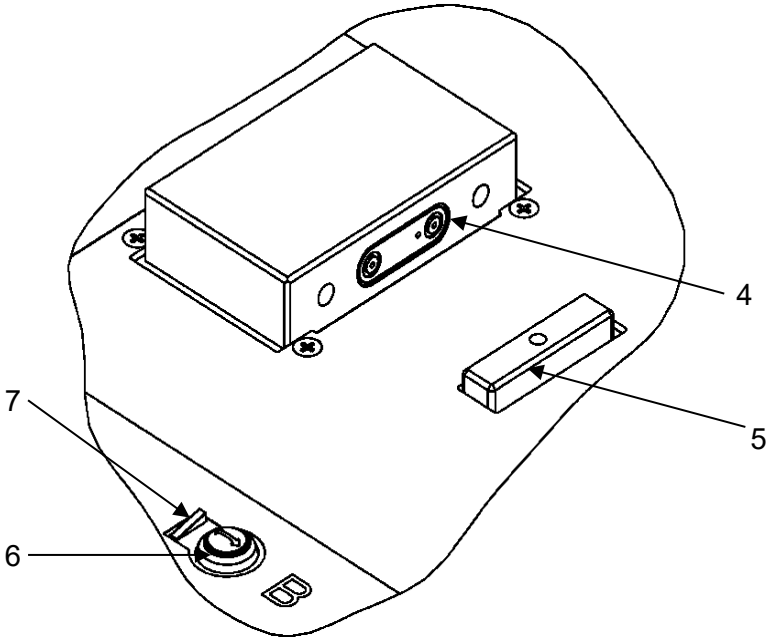

Figure 2-5: Test Cell Details

Item	Name	Description
1	Water Reservoir - Carrier Gas	Window showing the Carrier Gas Reservoir water level.
2	Reservoir Fill Line	The Carrier Gas Reservoir maximum level line.
3	Reservoir Fill Port	The fitting used to add water to the Carrier Gas reservoir.
4	Test Cell Gas Ports	The Test Cell Inlet, Outlet and TruSeal gas ports.
5	Test Cartridge Clamp Bar	The device used to clamp a Test Cartridge to the Test Cell gas ports.
6	Test Cell Clamp\Unclamp Button	The button used to clamp and unclamp a Test Cartridge.
7	Test Cell Status Indicator	The indicator used to annunciate the status of the Test Cell.

Table 2-4: Details of Other Onboard Parts and Controls

Carrier Gas

The OX-TRAN Model 2/48 requires a Carrier Gas mixture that is 98% nitrogen and 2% hydrogen. The specific percentage of each gas is not critical. The percentage of hydrogen in the mixture may be as low as 1% or as high as 3%. The hydrogen is used with a catalyst in the instrument to remove any residual oxygen in the Carrier Gas.

Compressed gas cylinders containing hydrogen require a "Hydrogen Regulator". The tank fitting on a Hydrogen Regulator uses left hand threads. The optional Regulator Assembly contains an approved Hydrogen Regulator. A standard T size cylinder should provide sufficient gas to operate a single instrument for several weeks.

Test Gas Supply

The OX-TRAN Model 2/48 utilizes ambient air as test gas supply.

Gas Distribution System

Each instrument ships with a local regulator/isolation device (called a Regulator Tee) that can be used to connect the instrument to a common Carrier Gas distribution system. Figure 2-6 illustrates how a gas distribution system for multiple instruments can be created using the provided Regulator Tee.

When using a compressed gas cylinder, 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.

Connecting the Carrier Gas Line

The OX-TRAN Model 2/48 has a gas inlet for connecting the Carrier Gas (nitrogen/hydrogen) supply. This compression fitting is intended for use with 1/8" copper tubing. Refer to Figure 2-6 for the location of this fitting and an example of plumbing system diagram.

The optional Startup Kit (052-734) contains 50 feet (14 meters) of tubing in addition to extra compression nuts, ferrules and grease.

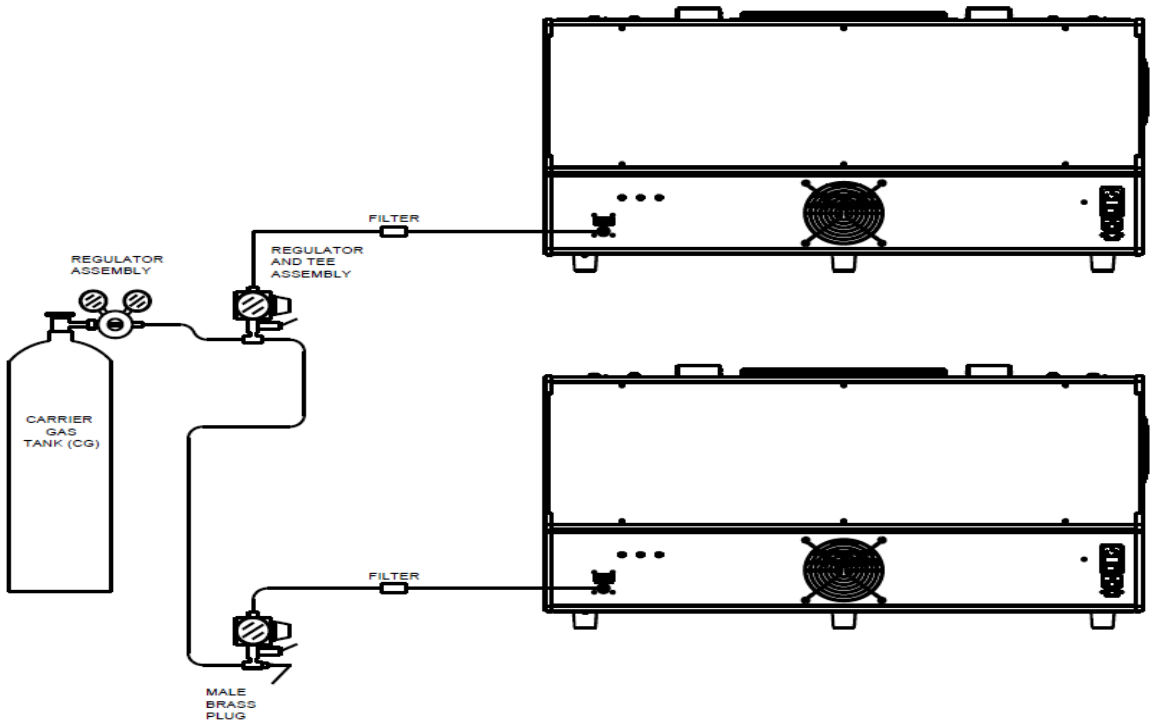

Figure 2-6: System Plumbing Connection Diagram

Connecting a Carrier Gas Supply

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 (33 cm).

3. Cut a piece of tubing approximately 26 inches in length (33 cm).

4. Apply a thin coating of Apiezon grease to four compression ferrules.

5. 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.

6. Connect the input on the Filter to the output fitting on a regulator tee using the 26-inch length of tubing and two nuts and ferrules.

7. Apply a thin coating of Apiezon grease to two compression ferrules.

8. Cut a piece of tubing to connect the regulator tee to the Carrier Gas cylinder regulator.

9. Connect the Carrier Gas regulator tee to the Carrier Gas (Nitrogen) supply regulator using two nuts and ferrules.

10. If there are additional instruments to be connected, repeat steps 2 - 6 and 11 - 13 for each instrument.

11. Apply a thin coating of Apiezon grease to two compression ferrules.

12. Cut a piece of tubing to connect the regulator tee on the previous instrument to the regulator tee on the next instrument.

13. Connect the previous Carrier Gas regulator tee to the next Carrier Gas regulator tee using two nuts and ferrules.

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

15. Remove the dust caps installed on the regulator.

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Setting the Carrier Gas Supply Pressure

Set the Carrier Gas Supply Pressure as follows:

1. Verify dust caps installed on the regulator have been removed.

2. Set the Carrier 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 25 psi.

Caution:	**The maximum Carrier Gas pressure to the instrument must not exceed 29 psi. Input pressures greater than 28 psi (1.9 bar) will damage the system.**

System Outgassing

Before the system can be used any air trapped in the carrier gas lines and instrument must be purged out. After purging the carrier gas supply system, the instrument must be outgassed. 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 follows these steps:

1. Verify the Carrier Gas Supply Pressures are set correctly; see setting the Carrier Gas Supply Pressure on page 2-8.
2. Turn the instrument on.
3. To properly out-gas the instrument a Test Cartridge must be mounted in each of the four Test Stations. Mount a foil in four Test Cartridges. For more information on mounting a foil in the Test Cartridge see the "User Guide" provided with your Test Cartridges.
4. Load and Clamp a Test Cartridges in each of the stations. For more information refer to Loading and Unloading a Test Cartridge on page 3-9.
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
- Humidified Environment Testing

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 9) can be tested. Additional consideration is advised when setting up tests for samples that are Very Good or Very Poor barriers. A Very Good Barrier is generally considered any material with a transmission rate less than 0.0005 cc / (pkg • day) or 0.1 cc / (m^2 • day). A Very Poor Barrier is generally considered any material with a transmission rate greater than 0.5 cc / (pkg • day) or 100 cc / (m^2 • day).

Testing Very Good Barriers

When testing a Very Good Barrier, use a sample with the largest possible surface area. It may be necessary to combine multiple samples, using a common fixture, when testing Very Good Barrier packages with small individual surface areas. Longer Cell Examination and ReZero Examination times may be required. An Individual Zero test phase is recommended when testing Very Good Barriers.

Testing Very Poor Barriers

Use caution when testing Very Poor Barriers an excessively high transmission rate will over-range the oxygen sensor. Persistent or repeated over-range conditions can damage the Coulox sensor. Example of poor oxygen barrier materials include polyethylene, polycarbonate and acrylic.

Testing Mixed Barriers

Simultaneously testing barriers with widely divergent transmission rates is not recommended. The data for some or all of the individual samples may not be accurate when there is a large difference in the transmission rates between samples. If during a test there is a large difference in the transmission rates, set the divergent cells to Idle and continue testing the remaining cells. You may want to determine which samples will condition more rapidly and test those samples 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.

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 sample may deform, causing the gas ports in the Test Cartridge (ingress or egress) to be blocked. This will result in erroneous data.

To prevent this blockage, preconditioning of hygroscopic samples in an environment at the desired RH may be advisable. 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

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. 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 every two cell examination periods.

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 seal permeation and leakage in the Test Cartridge. This is done with Individual Zero Processing.

During individual zero processing an impermeable barrier made of aluminum foil (referred to as a foil) is mounted in the Test Cartridge. Any oxygen that is picked up on the carrier gas side is thus due to factors other than permeation through the barrier.

Note: When using a Test Cartridge that is not designed to utilize a Mounting Foil a "Test Loop" or other suitable method is employed. Figure 3-1.

The instrument uses the Individual Zero value obtained during the Individual Zero phase to automatically correct the oxygen transmission rate measurements made during the Test phase.

Whenever you test a Very Good barrier you should perform individual zero processing. The settings for the Individual Zero fields 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 Test Cell is measured. This value is used to correct the measured transmission rate to improve the accuracy of the reported results. 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 to make the correction. This mode is useful when making many tests on the same type of material and the user is confident that seal permeation and leakage is not a problem and every sample barrier is mounted the same.

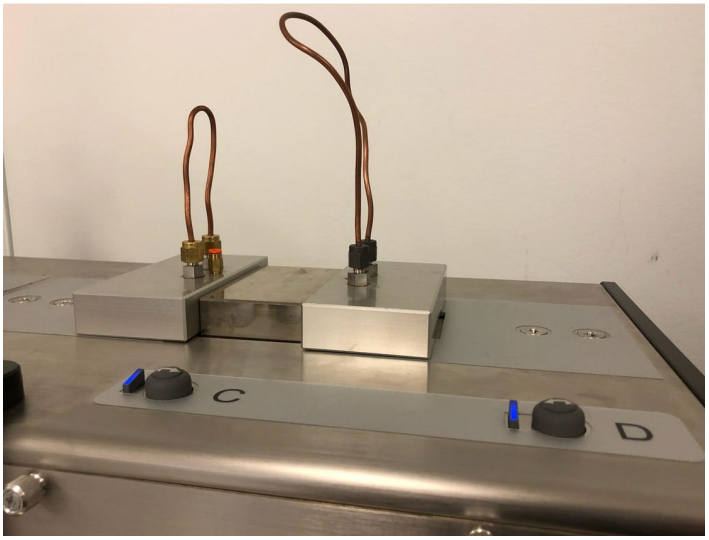


Figure 3-1: Individual Zero with a Loop

Purging the Sample

Most mounted package samples contain a significant volume of air on the Carrier side of the barrier material. Before the package cassette is loaded and clamped into a Test Cell this volume contains oxygen from the ambient environment. The oxygen in this volume must be removed before the carrier gas stream can safely by measured by the Permeant Sensor. Inadequate purging of the Test Cell can result in "Failed" tests and a reduction in Coulox sensor life.

The process of reducing the residual oxygen on the Carrier side of the test cell to a safe level is referred to as "Purging the Sample". The OX-TRAN Model 2/48 provides the capability to include a "Purge State" at the beginning of the Test phase.

When a Purge state is initiated the "High Purge" valve is activated to increase the Carrier Gas flow to all Test Cells. The increased Carrier Gas flow purges the test cells of ambient oxygen in less time than would be required at the normal rate.

Note: When you use Individual Zero processing, the Purge state will only occur during the Test Phase.

Whenever you use the Advanced Test method to test a sample that may take more time to safely purge than is provided by the initial ReZero state, consider using a Purge state. The settings for the High Purge mode fields are explained below.

Off	When the High Purge mode field is set to "Off", a Purge state will not be used. The default mode is "Off".
Auto	When the Purge mode is set to "Auto" the Carrier Gas exhaust of each cell set to "Auto" is monitored using the Purge Down oxygen sensor. The time required to reduce the oxygen level (at the exhaust of the cell) to a defined threshold is used to determine an appropriate time for the Purge state. The duration of the Purge state will not exceed the value specified in the "High Purge Time" field. After the Purge state terminates the system will automatically advance to the next Test state.
Manual	When the Purge mode is set to "Manual", the amount of time in minutes that the sample will be purged is specified using the "High Purge Time" field. After the specified time period has elapsed the system will automatically advance to the next Test state.

Note: When a permeation test is performed using an Auto Test Method the Automatic Purge mode is always used.

For more information on how the Automatic Purge mode works see Appendix D "Theory of Operation". For more information on using the Automatic Purge function see the Instrument Help system.

Conditioning the Sample

OX-TRAN Model 2/48 comes with 4 stations on the conditioning deck. Four samples can be conditioned while other four samples on being tested on the testing deck.

Sample Conditioning is a test state that allows the sample barrier to acclimate to the specified test conditions. During the conditioning stage, a sample is exposed to carrier gas and test gas in the same manner as during normal testing. However, the carrier gas is not routed to the Permeant Sensor.

It is common for many types of packages and Very Good barrier materials to take a long time to reach equilibrium. A Conditioning state offers two advantages when testing samples that take a long time to reach equilibrium:

- It prevents unnecessary exposure of the Coulox 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 meaning of the conditioning LED colors: Green - active conditioning, Blue – ready to test, Red – failed.

Note: When you use Individual Zero processing, the Conditioning state will only occur during the Test Phase.

Whenever you use an Advanced Test method to test a sample that takes a long time to reach equilibrium, consider using a Conditioning state. The settings for the Conditioning mode fields are explained below.

Off — When the Conditioning mode field is set to "Off", a Conditioning state will not be used. The default mode is "Off".

Auto — When the Conditioning mode field is set to "Auto", the Carrier Gas exhaust of the cell is monitored during the Conditioning State using the Purge Down oxygen sensor. The time required to reduce the oxygen level (at the exhaust of the cell) to a defined threshold is used to determine an appropriate Conditioning time. If the oxygen level does not reach the threshold within the specified "Conditioning Failure Time" the test will be set to the "Failed" state. After the Conditioning State completes the system will automatically begin testing.

Manual — When the Conditioning mode is set to "Manual", the amount of time in hours that the sample will be conditioned is specified using the "Conditioning Time" field. After the specified conditioning period the system will automatically begin testing.

Note: When a permeation test is performed using an Auto Test Method the Auto Conditioning mode is always used.

For more information on how the Automatic Conditioning mode works see Appendix D "Theory of Operation". For more information on using the Automatic Conditioning function see the Instrument Help system.

Using the Automatic Check Function

Mounting packages in a manner that ensures the Carrier Gas side of the cell is free of leaks can be very difficult. Any imperfections in the seals used to mount the sample package to the Package Cassette can result in excessive levels of oxygen entering the Carrier Gas side of the cell. The amount of oxygen entering the Carrier Gas side of the cell due to seal imperfections can easily exceed the maximum stated range of the instrument.

Exposing the Permeant Sensor to excessive levels of oxygen will result in "Failed" tests and a reduction in the life of the Coulox Sensor. The OX-TRAN Model 2/48 provides the capability to verify that the oxygen level at the output of the Test Cells is within the measurement range of the instrument. This feature is referred to as the "Automatic Check" function.

When the "Automatic Check" function is enabled, the Permeant Sensor is exposed to the output of the Test Cell in a quick controlled manner. If the oxygen level is above a defined threshold the test is set to the "Failed" state.

Note: When enabled the Automatic Check state only occurs during the Test Phase after the Purge and Conditioning states (when present) have completed.

For more information on how the Automatic Check function works see Appendix D "Theory of Operation". For more information on using the Automatic Check function see the Instrument Help system.

Using the Reference Check Function

The OX-TRAN Model 2/48 contains a dedicated "Reference" cell that can be used to track instrument performance. When the "Reference Check" function is enabled a "Reference Test" will be performed whenever a test is started and all Test Cells were previously idle. The Reference cell will be examined during the Test Phase after the Purge, Conditioning and Quick Check states (when present) have completed.

The Reference cell data is viewed using the Cell Status screen. The Cell Status screen will show the result for each Reference Cell examination. All transmission rate data will be normalized to a 23 °C test temperature and stated in cc/(pkg • day). A maximum of 365 days of data will be retained and displayed. The graph contains limit bars at 5% and 10% from the stated value of the Reference Cell.

For more information on how the Reference Check function works see Appendix D "Theory of Operation". For more information on using the Reference Check function see the Instrument Help system.

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 ruleset 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 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.

Humidified Environment Testing

The OX-TRAN Model 2/48 has the capability of generating a controlled RH for the Carrier Gas. The generated RH range for the Carrier Gas is 50% - 90% RH. For the minimum RH that can be generated refer to the section on "Sample Conditioning Capabilities" in Chapter 9.

Humidified Carrier gas is 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.

Before starting a test using Generated RH the water levels in the reservoirs should be checked and filled if necessary.

Water consumption for Carrier Gas RH generation is approximately 30 cc/month at 23 °C and 50% RH. The reservoir capacity is approximately 100 cc. For Carrier Gas RH generation, you must use HPLC grade water.

Note: The OX-TRAN Model 2/48 does not provide controlled RH for the Test Gas but uses ambient air, it is the operator's responsibility to determine whether the test sample needs to be tested in a humidity-controlled manner, if the sample is made of moisture sensitive materials.

Filling the Carrier Gas Water Reservoir

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

Note: Refer to Figure 3-2 for the location of the Carrier Gas Water Reservoir and Water Fill Port.

1. Access the Carrier Gas Water Reservoir located at the front panel of the upper deck.
2. Check the water level to determine if there is sufficient water to perform the test.
3. Connect a short piece of tubing to the hose barb on the quick disconnect fitting.
4. Attach the end of the tube without the quick disconnect to the Luer fitting on the syringe.
5. Fill the syringe by placing the quick disconnect fitting into a container containing HLPC-grade water and withdrawing the plunger.
6. Push the quick disconnect fitting onto Fill Port fitting until it locks it into place.
7. Slowly push in the plunger on the syringe to force the water into the reservoir.
8. Disconnect the syringe from the Fill Port.

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

Note: The syringe, tubing and quick disconnect fitting are supplied with the instrument.

Note: The tubing and quick disconnect fitting may remained attached to the syringe between uses.

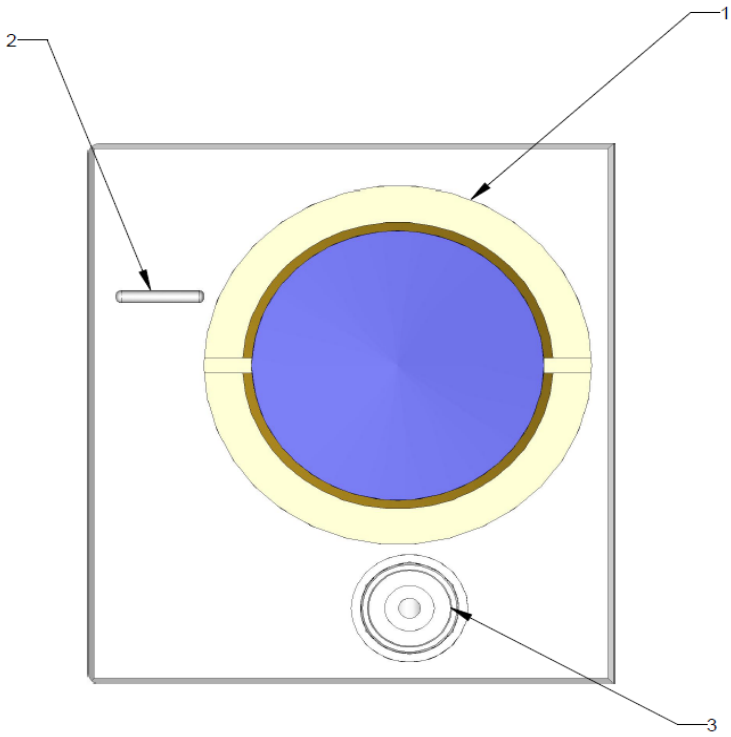


Figure 3-2: Humidifier Fill Port and Controls

Item	Name	Description
1	Water Reservoir Window	Window showing the Carrier Gas Reservoir water level
2	Reservoir Fill Line	The maximum level to which the reservoir should be filled.
3	Fill Valve - Carrier Gas	The screw used to open & close the Carrier Gas Drain/Fill Valve
Table 3-1: Carrier Gas Reservoir and Fill Port		

Loading and Unloading a Test Cartridge

The OX-TRAN Model 2/48 uses a pneumatic system to clamp and unclamp a Test Cartridge. The Test Cartridge must be manually loaded into and unloaded from the instrument.

To remove a Test Cartridge from the instrument, follow the instructions below (refer to Figure 3-3):

1. Press the Clamp/Unclamp button on the deck of the Test Cartridge to be removed.
2. Grasp the Test Cartridge firmly and lift straight up.

To install a Test Cartridge in the instrument, follow the instructions below (refer to Figure 3-3):

1. Orient the Test Cartridge so the Test Cartridge gas ports face the Test Cell gas ports.

2. Hold the Test Cartridge firmly and lower it straight down over the clamp bar.

3. Press the Clamp/Unclamp button on the deck of the Test Cartridge being installed.

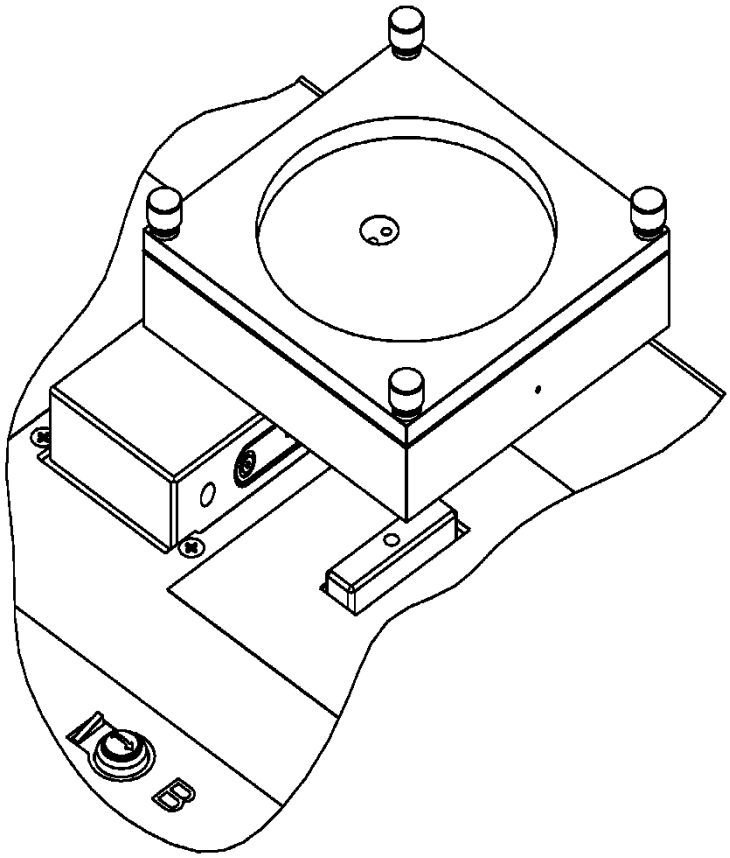


Figure 3-3: Installing a Test Cartridge

Chapter 4: Using the Instrument Software

This chapter provides an overview of the software system used to operate the OX-TRAN Model 2/48. 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 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.

Figure 4-1: Software Home Screen of OX-TRAN Model 2/48

When the instrument is started, the Home screen is automatically displayed in the workspace. The conditioning LED status lights are labeled 1-4 on top of the Home screen. 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 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: 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
- Package Testing Methods
- Package Mounting Methods
- Rigid Package Test Cartridge Overview
- Flexible Package Test Cartridge Overview
- Using a Package Adapter Cartridge
- Package Purging Overview
- Package Conditioning Overview
- Setting Up and Starting a Package Test
- Monitoring and Controlling a Package Test

Testing Suggestions

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

- Test at least 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.
- 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 all four 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.

Package Mounting Methods

There are many different types of packages and most of them can be tested on the OX-TRAN Model 2/48. Figure 5-1. To test packages a Diffusion Cell must be created to provide the required difference in permeant concentration across the barrier material. The creation of an effective Diffusion Cell is often the most difficult and complex part of performing a permeation test on a package.

The process of creating the Diffusion Cell is often referred to as "fixturing" or "mounting" the sample. When testing packages, the sample itself is often an important structural element of the Diffusion Cell. An important element of the Diffusion Cells used in the OX-TRAN Model 2/48 is the reusable components collectively referred to as a Test Cartridge.

Most packages can be classified as belonging to one of two categories, rigid (and semi-rigid) packages or flexible packages. The type of package (rigid or flexible) usually determines the approach used to mount the package. The design of the Test Cartridges is optimized for the type of samples to be tested. This chapter contains an overview of how the Test Cartridges designed for testing rigid packages and semi-rigid packages and those designed for testing flexible packages are used. More detailed information is provided in the "User Guide" included with each Test Cartridge.

Figure 5-1: Packages are testing on OX-TRAN MODEL 2/48

Mounting Rigid and Semi-Rigid Packages

A common characteristic of a rigid or semi-rigid package is an open area that must be sealed to create the Carrier Gas side of the Diffusion Cell. The perimeter of this open area usually contains a feature used to seal the filled package. This feature is also used to seal the package to an impermeable barrier material creating the Carrier Gas side of the cell. Figure 5-1.

The Test Cartridges intended for use with rigid and semi rigid packages are designed to use a disposable aluminum foil for this impermeable barrier. This barrier material is referred to as a "Mounting Foil" or as a "foil". A selection of Test Cartridge optimized for different sizes and styles of trays, cups and bottles is available to suit your specific needs. For convenience, each type of Test Cartridge is designed to use a precut mounting foil.

Figure 5-2: Rigid Package Test Cartridge

Mounting a package in a Test Cartridge designed to use a Mounting Foil consists of several basic steps. The opening in the package is sealed to a Mounting foil using an appropriate adhesive. If necessary, an opening is cut in the foil to allow the carrier gas to sweep the inside of the package. The foil containing the package is then mounted in the Test Cartridge.

More detailed information on using a Rigid Package Test Cartridge is provided in the "User Guide" included with each Test Cartridge. Also, visit MOCON website to watch a video demonstration for package mounting.

Mounting Flexible Packages

A flexible package such as a bag or pouch does not contain a rigid planar surface that can easily be sealed to a mounting foil. The Flexible Package Test Cartridge is designed for testing fully sealed flexible bags and pouches. A seal is made to the sample without requiring the use of adhesives. Figure 5-2.

A hole is punched through both sides of the fully sealed package near one of the edges. A device, referred to as the Carrier Plate, is then inserted into the package through the opening. The package is then mounted to the Test Cartridge using a "Clamp Plate". The Test Cartridge, Carrier Plate and Clamp Plate seal the openings in the package envelope and allow carrier gas to sweep the inside of package.

More detailed information on using the Flexible Package Test Cartridge is provided in the "User Guide" included with the Test Cartridge. Also, visit the MOCON website to watch a video demonstration for package mounting.

Figure 5-3: Flexible Package Test Cartridge

Mounting Packages using a Package Adapter Cartridge

Not all packages are compatible with the standard Test Cartridges which are designed for testing the most common types of rigid and flexible packages. These types of packages can be tested using a Package Adapter Cartridge. The Package Adapter Cartridge is designed to connect to the fixtured package using standard 1/8" tube compression fittings.

There are two basic methods to fixture a package when not using the standard Test Cartridges. The package could be "Plate Mounted" or individual tubes can be sealed into the package. The use of a Mounting Plate is very similar to using a Mounting Foil and will not be covered here. The use of individual tubes (referred to as tube-mounting can be adapted to almost any type of package or container.

Tube Mounting Packages

A "tube mount" package fixture is created by sealing all unnecessary openings and then sealing two tubes into the package envelope to allow the Carrier Gas to "sweep" the interior. When "tube mounting" packages the carrier gas tubes can enter the top or bottom of the package.

The procedure shown below along with Figure 5-3 illustrates how a package can be tube mounted.

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.
3. Move the package slightly so the ends of the tubing move 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. 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.

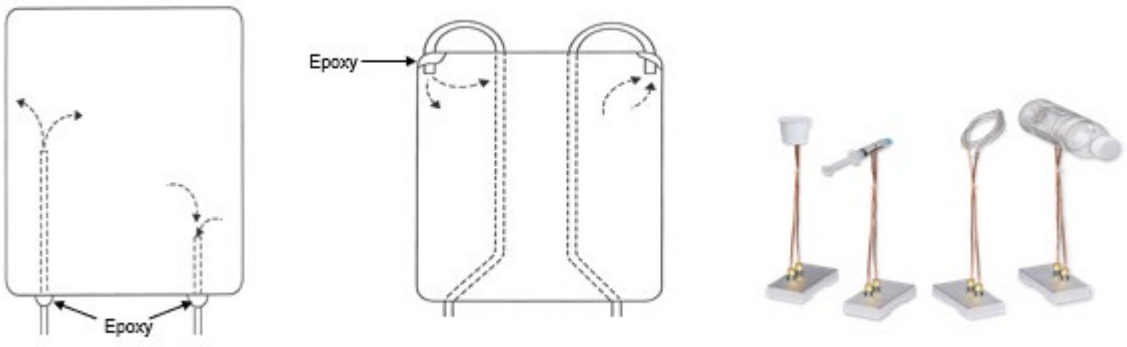


Figure 5-4: Tube Mounted Packages

Package Purging

The amount of time required to properly purge a package can be unpredictable. The use of the "Automatic Purge" function should be considered when testing packages with significant internal volume. For more information on Purging Samples see "Purging the Sample" in Chapter 3 and the Instrument Help System for more information.

Package Conditioning

The barrier materials used in packages are generally thicker than film samples. Thicker materials often require a longer time to condition to the test environment. The amount of time required to properly condition a package can be unpredictable. The use of "Automatic Conditioning" should be considered when testing samples that may take a long time to reach equilibrium. For more information on Conditioning Samples see "Conditioning the Sample" in Chapter 3 and the Instrument Help System for more information.

Setting Up and Starting a Package Test

After the samples are loaded and the instrument is ready there are several 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 (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 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
- Conducting a Film Test

The OX-TRAN Model 2/48 is primarily intended as a package test instrument. An optional Film Test Cartridge is available for testing flat film samples. A Film Test Cartridge is provided as part of the optional Starter Kit (052-734). The information provided in this chapter assumes the standard Film Test Cartridge will be used when testing film samples.

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 Water Reservoirs have sufficient water in them. OX-TRAN Model 2/48 only provide controlled RH on the carrier gas side, while using ambient air for test gas. Make sure your samples are suitable for testing on those conditions.

- 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 several tasks that must be performed: The samples to be tested must be prepared. The samples must be mounted in a Film Test Cartridge and Loaded into the instrument. If the test requires a Generated RH the Water Reservoirs must be 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 a Film Cartridge" in this chapter and "Loading and Unloading a Test Cartridge" in Chapter 3.

For information on fill the Water Reservoirs refer to "Humidified Environment Testing" in Chapter 3.

Sample Size

The film sample should be approximately 4" x 4" (10.16 x 10.16 cm), with a thickness not exceeding 2 mm (0.08 inches). Smaller samples can be masked to allow them to be mounted in the Film Test Cartridge, 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 Cartridge. Mocon provides a film template (available as part of optional Starter Kit 052-734) 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 200 cc / (m^2 • day) (such as polyethylene or polycarbonate). 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 allowing a sample with an un-masked (50 cm^2 area) transmission rate of 2000 cc / (m2 • 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.
- Visit MOCON website to watch a video showing how to use foil masks for film testing.

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.

Mounting a Sample in a Film Cartridge

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 cartridge surface refer to Figure 6-1.

1. Remove the Test Cartridge from the instrument. See Loading and Unloading a Test Cartridge" on page 3-9
2. Remove the four screws securing the two parts of the Test Cartridge.
3. Separate the top part from bottom part of the cartridge and remove the old film sample.
4. Clean the film sealing surfaces of the cell to remove the old grease.
5. Apply new Apiezon grease to the sealing surfaces.
6. Inspect the TruSeal flushing ring and ports, remove any excess grease.
7. Place the film on the greased sealing surface, remove any wrinkles as necessary.
8. Replace the top of the Test Cartridge and tighten the screws securely.
9. Install the Film Cartridge in one of the four test stations and clamp it into place.

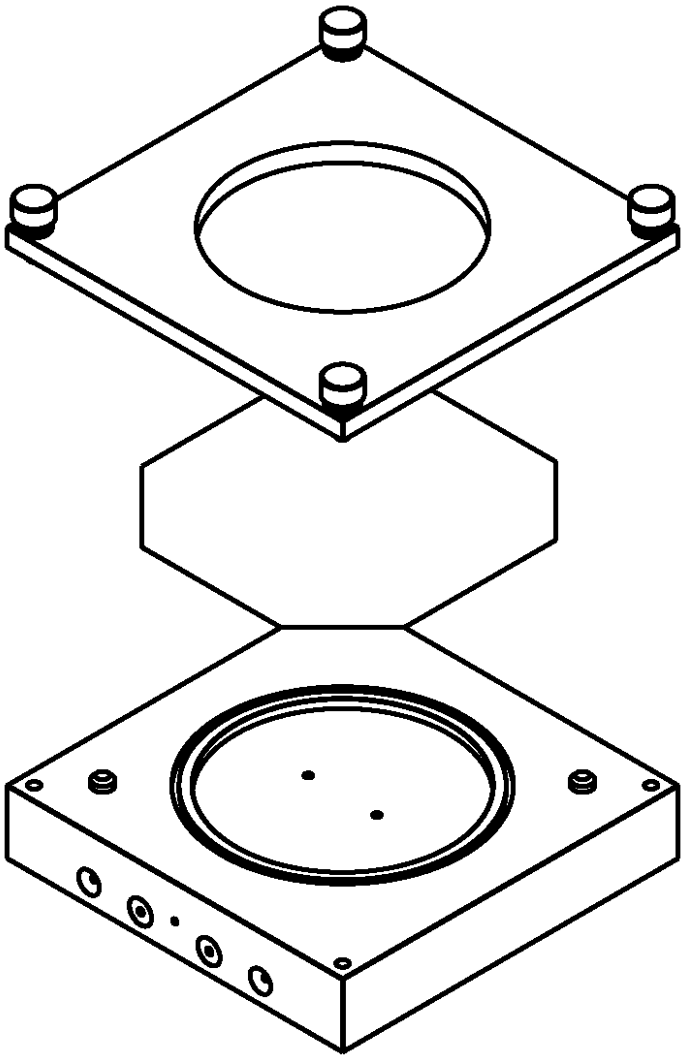


Figure 6-1: Mounting a Film Sample

Sample Purging

The Film Test Cartridge does not normally need to be purged after mounting a sample. A permeation test always starts with a ReZero state. The time required to complete the ReZero is normally sufficient to properly purge the Film Test Cartridge.

Sample Conditioning

The time required to condition a flat film sample is usually less than required to condition a package. Conditioning film samples, however, does offer the same advantages as when conditioning packages. For more information see "Conditioning the Sample" in Chapter 3.

Setting Up and Starting a Film Test

After the samples are loaded and the instrument is ready there are several 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 (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: Maintenance

This contains information on how to clean and maintain the OX-TRAN Model 2/48.

Read this chapter to learn about:

- Cleaning the Instrument
- Maintaining the Test Cells
- Maintaining the Oxygen (Coulox) Sensor
- System Standby
- System Shutdown, Relocation and Storage

The following information will assist in the daily operation and maintenance of the OX-TRAN Model 2/48 system. Included are answers to the questions most asked of the MOCON Technical Services Group.

Cleaning the Instrument

The OX-TRAN Model 2/48 is housed in a textured stainless steel 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:

- Do not get liquids in the instrument.
- Never use alcohols or solvents on the plastic instrument case components. These chemicals could damage the instruments as well as the case.

NOTE: There are no user serviceable parts inside the OX-TRAN Model 2/48. A MOCON service representative should perform all internal maintenance and adjustments.

Maintaining the Test Cells

Periodically the test cell gas ports should be examined and any excess buildup of grease should be removed. Alcohol can be used to remove any residue from the Apiezon grease. Inspect the gas ports and TruSeal flush port and remove any grease that could obstruct the flow of gas.

Periodically the test cell O-rings should be examined and any damaged, deformed, cracked or brittle O-rings replaced. The parts of the test cell and the associated O-ring part numbers are illustrated in Figure 7-1 and
Table 7-1.

Test Station O-Rings and Part Numbers

The serviceable parts of the test station are shown in Figure 7-1 below. Refer to Table 7-1 for the associated part numbers and the quantity used. To order replacement parts contact MOCON in the USA at (763) 493-6370.

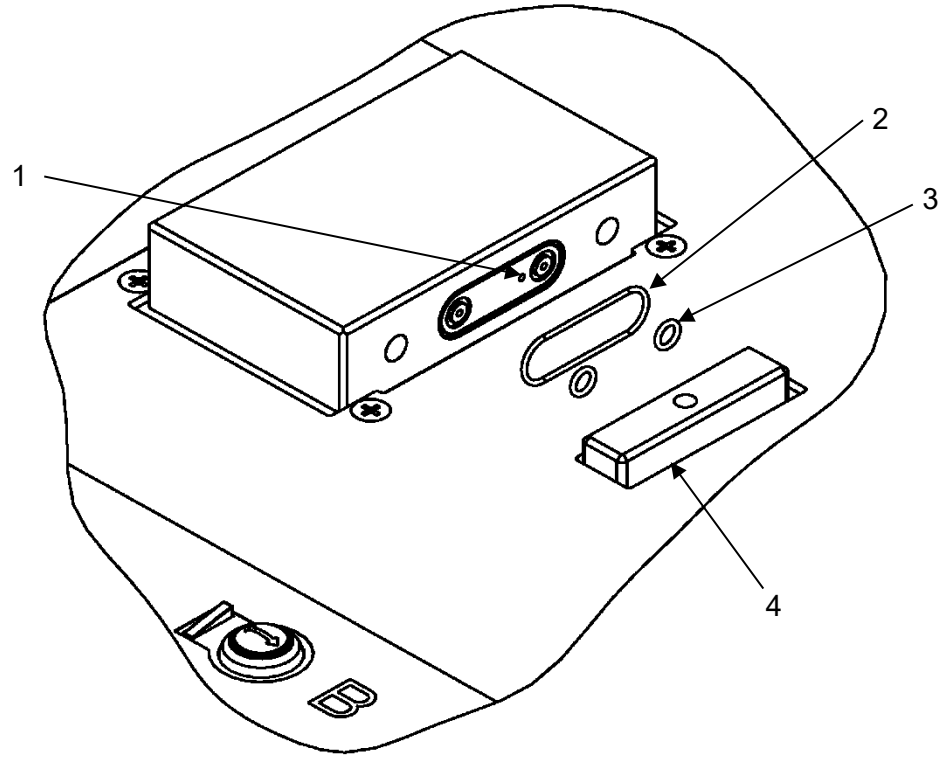


Figure 7-1: Test Station Components

Item	Quantity	Part Number	Description
1	N/A	N/A	TruSeal flush gas supply port
2	4	052-595	O-Ring, 1.024 ID X 0.047 CS, Buna N (may or may not be present)
3	8	033-340	O-Ring, 0.187 ID X 0.050 CS, Buna N
4	N/A	N/A	Test Cell Clamp Bar

Table 7-1: Test Station Replacement Components

Maintaining the Oxygen (Coulox) Sensor

Under normal use, the Coulox sensor supplied with your OX-TRAN Model 2/48 should last a year or more. The sensor could be damaged by accidents or by misuse such as continual exposure to high concentrations of oxygen. The coulometric oxygen sensor (Coulox) does not require calibration. If you choose to calibrate the sensor the procedures are described in Appendix F.

Verifying Oxygen Sensor (Coulox) Performance

You may want to occasionally verify sensor performance by measuring the transmission rate of material with known characteristics. Certified films are available for this purpose. The "Permeant Sensor Adjustment Test " described in Appendix F should be performed using a Certified Film.

Replacing the Coulox Sensor

When the Coulox sensor needs to be replaced please contact MOCON in the USA at (763) 493-6370.

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

When a sensor is becoming depleted, you will notice a decrease in its response. The best time to observe this is when the sensor is bypassed after a test; a healthy sensor will react quickly and drop to 5 percent of the test reading in less than 10 minutes. A damaged or depleted sensor will take much longer to respond.

Usually, a depleted sensor exhibits a reduction in efficiency and the measured values tend to read on the low side. When you observe these symptoms the Coulox sensor should be replaced.

Maximizing Coulox Sensor Life

The useful life of the Coulox sensor is determined by the following factors:

Cathode depletion — A new unused sensor has a nickel cadmium anode. Oxygen entering the sensor reacts with the cathode material to produce cadmium hydroxide. When most of the cadmium has been converted to cadmium hydroxide, the sensor response time slows and efficiency declines.

Cathode depletion is proportional to the Oxygen Input Rate. The most effective way to increase sensor life is to reduce the oxygen input rate.

Electrolyte depletion — Electrolyte depletion is usually caused by water loss. The Coulox sensor uses a patented system that minimizes moisture loss. It is, however, possible to dry-out the sensor by exposing it to excessive levels of dry carrier gas.

The amount of oxygen input to the sensor can be reduced by the following means:

- 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.
- When testing films, 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.

The instrument contains a dedicated "Reference" cell that is used to track instrument performance over time. Refer to Appendix D on page D-5 for details.

Emptying the Carrier Gas Water Reservoir

Before shutting down the instrument for long term storage or repair the Carrier Gas Water Reservoir must be drained and the chamber dried out to prevent any corrosion from occurring during storage or transport.

To prepare the Carrier Gas Water Reservoir for storage or transport follow the procedure below:

1. Advance all active tests to the Idle state.
2. While holding a container under the fill port, connect the Luer fitting used to fill the reservoir to the fill port.
3. The pressure of the Carrier gas will force all the water out of the Water Reservoir.
4. After the Water Reservoir has been drained allow gas to vent out the fill port until all residual water that is visible has been removed.

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 sample mounted and clamped in the test cells. Turning off the power and gas supplies to instrument is not recommended. If 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. Unclamp and remove any Test Cartridges in the chamber.
3. Set the Chamber 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.**

4. Remove the water from the Reservoirs see "Emptying the Carrier Gas Water Reservoir" in this chapter.
5. Turn off power to the instrument.
6. Disconnect the gas lines at the rear of the module and use a brass fitting plug (025-382) to seal the Carrier gas connection fitting on the rear of the instrument.

Chapter 8: 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 "Permeant Sensor Performance Check" in Appendix F.

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.

Recovering from a Sensor Over-Range Condition

A severe over range condition will terminate the test sequence on all test cells and the instrument will automatically start a Coulox sensor protection sequence. This sequence automatically starts flushing the Coulox sensor until it is below a defined threshold.

If you see a red Cell Status indicator (next to a Test Cell Clamp\Unclamp button), 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.
- The sample has pinholes, cracks or a poor-sealing surface.
- The Test Cartridge is not installed, not clamped or no barrier is present.
- The O-ring seals on the side 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 9 Specifications

This chapter contains the specifications of the OX-TRAN Model 2/48.

Read this chapter for details about:

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

Environmental Requirements

Temperature	Operation	21 °C ± 2 °C
	Storage	10 °C to 30 °C
Humidity	Operation	10% to 60% 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 9-1: Environmental Requirements

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

Electrical Requirements

Voltage	120 / 240 VAC 50/60 Hz
Maximum Power Draw	Less than 700 VA
Current Draw at 100 VAC 50 Hz	0.79 A nominal
Current Draw at 120 VAC 60 Hz	0.66 A nominal
Current Draw at 220 VAC 50 Hz	0.36 A nominal
Current Draw at 240 VAC 50 Hz	0.33 A nominal
Daily electrical consumption (inactive)	1.9kWh/day
Maximum daily electrical consumption (active test)	1.9kWh/day

Table 9-2: Electrical Specifications

Physical Specifications

	Height	Width	Depth	Weight
Uncrated	16.25 inches	32.35 inches	22.25 inches	110 pounds
Crated	22 inches	36.5 inches	29.5 inches	<140 pounds

Table 9-3: Physical Specifications

Gas Supply Requirements

Carrier Gas	Gas Composition	Nitrogen/Hydrogen Mix (98%/2%)
	Supply Pressure, Nominal	25 PSI, (1.72 Bar), (172 kPa)
	Supply Pressure, Maximum	28 PSI, (1.93 Bar), (193 kPa)
	Supply Pressure, Minimum	23 PSI, (1.59 Bar), 159 kPa)
	Total Cell Flow Rate, Nominal, Test Active	80 cc/minute
	Average daily gas consumption	230,400 cc/day
	Max daily gas consumption	296,640cc/day* * Does not include High Purge mode
Test Gas*	Gas Composition	Ambient Air

Table 9-4: Gas Supply Specifications

Note: The Test Gas is ambient environmental air, with no temperature and RH control. It is the operator's responsibility to decide whether temperature and RH control is critical to test your specific samples.

Sample Conditioning Capabilities

Temperature Control	Range	Ambient temperature (Monitored by the instrument)	
	Range	21± 2°C	0%, 30 to 90% RH

Humidity Control, Carrier Gas	Repeatability	± 0.6% RH per 1°C change in ambient temperature
	Accuracy	± 5% RH

Table 9.5: Sample Conditioning Capabilities

Transmission Rate Measurement Capabilities

Test Range, Package	0.0003 to 1.0 cc/(pkg • day)	@ 20.9% Oxygen
	0.0013 to 5.0 cc/(pkg • day)	Compensated to 100%
Test Range, Film, 50 cm^2	0.05 to 200 cc/(m^2 • day)	@ 20.9% Oxygen
	0.25 to 1000 cc/(m^2 • day)	Compensated to 100%
Resolution	0.0001 cc/(pkg • day)	@ 20.9% Oxygen
	0.02 cc/(m^2 • day)	@ 20.9% Oxygen (50 cm^2)
Repeatability	± 0.0001 cc/(pkg • day)	@ 20.9% Oxygen
	± 0.0005 cc/(pkg • day)	Compensated to 100% O_2
	± 0.02 cc/(m^2 • day))	@ 20.9% Oxygen
	± 0.10 cc/(pkg • day)	Compensated to 100% O_2
		or +/-2% of value, whichever is greater*

Table 9.6: Transmission Rate Specifications - OX-TRAN Model 2/48 H

Note: A minimum Exam Time of 30 minutes is required to meet the specifications stated above.

*of reading/degree C in ambient whichever is greater

Test Range, Package	0.00003 to 1.0 cc/(pkg • day)	@ 20.9% Oxygen
	0.00013 to 5.0 cc/(pkg • day)	Compensated to 100%
Test Range, Film, 50 cm^2	0.005 to 200 cc/(m^2 • day)	@ 20.9% Oxygen
	0.025 to 1000 cc/(m^2 • day)	Compensated to 100%

Resolution	0.00001 cc/(pkg • day)	@ 20.9% Oxygen
	0.002 cc/(m^2 • day)	@ 20.9% Oxygen (50 cm^2)
Repeatability	± 0.00001 cc/(pkg • day)	@ 20.9% Oxygen
	± 0.00005 cc/(pkg • day)	Compensated to 100% O_2
	± 0.002 cc/(m^2 • day))	@ 20.9% Oxygen
	± 0.010 cc/(pkg • day)	Compensated to 100% O_2
		or 1% of value, whichever is greater

Table 9.7: Transmission Rate Specifications - OX-TRAN Model 2/48 L

Note: A minimum Exam Time of 45 minutes is required to meet the specifications stated above.

Appendix A: Site Preparation Instructions

Part Number 140-225

(See next page)

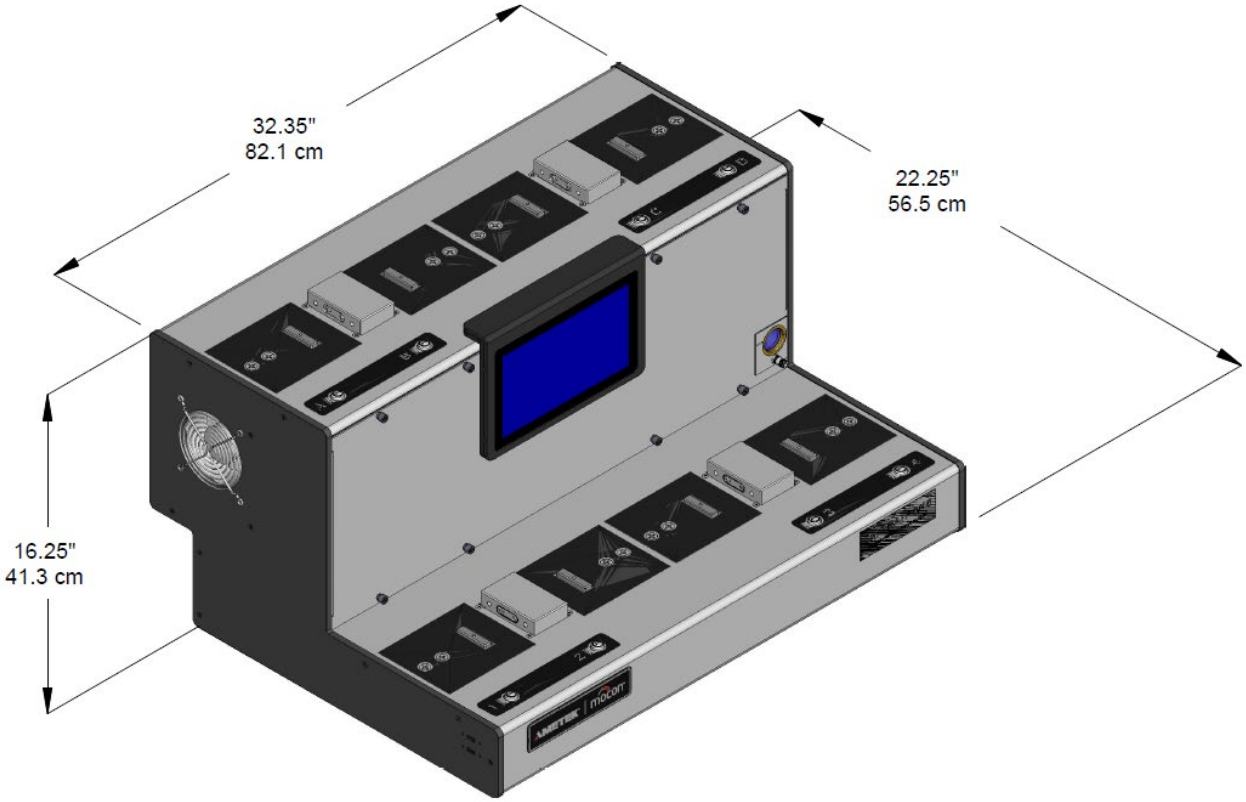
Part Number 140-225
Revision A

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 2/48 H SYSTEM

The following must be furnished by the customer before a new OX-TRAN Model 2/48 H 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. **HANDLING REQUIREMENTS -** The size and weight of the OX-TRAN Model 2/48 H should be considered before attempting unpack and transport the instrument to the location where it will be installed. A minimum clearance of 17 3/4 inches (45 cm) at the smallest door opening is required to allow passage of the instrument. The shipping container requires a minimum clearance of 22 inches (56 cm) at the smallest door opening. The instrument weighs approximately 110 pounds (50 kilograms). Mechanical assistance is recommended when moving or lifting the instrument. If mechanical assistance is not used a minimum of two (2) people should be used when lifting the instrument.



2. **SPACE REQUIREMENTS -** Each instrument requires 44.25 inches (112.4 cm) of open space on the work surface. The instrument requires a work surface depth of 22.25 inches (56.5 cm). A minimum of 23.75 inches (60.3 cm) from the work surface to any overhead obstruction is required. A minimum

clearance of 6 inches (15.2 cm) is required at the sides and top of the instrument. The surface upon which the instrument will be placed must safely support a minimum of 110 pounds (50 kilograms).

3. **ENVIRONMENTAL REQUIREMENTS -** The OX-TRAN Model 2/48 H should be operated in an environment with a stable room RH between 10% and 60% non-condensing, and at an ambient temperature of
21 °C ± 2 °C. It is important to locate the instrument in a relatively stable environment free from drafts and temperature fluctuations.

4. **POWER REQUIREMENTS** - The OX-TRAN Model 2/48 H requires 120 / 240 VAC ± 10% at 50/60 Hz. Maximum power consumption for each instrument is less than 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.

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

"RECOMMENDED ELECTRICAL INSTALLATION"

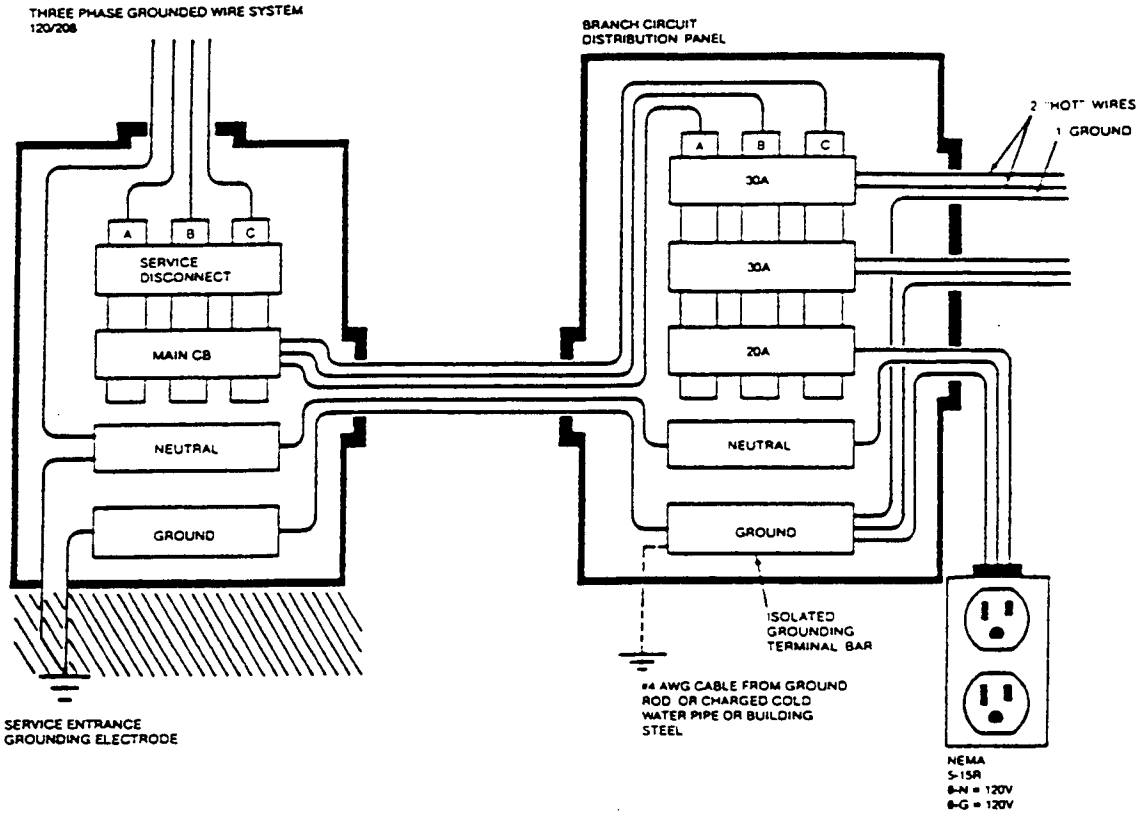
5. **CARRIER GAS** - The required carrier gas is a special nitrogen\hydrogen mixture consisting of 98% nitrogen and 2% hydrogen. These percentages are not critical, and the actual hydrogen percentage may vary from 1% to 3%. This mixture is readily available from gas suppliers for a nominal charge in most principal cities. Regulations stipulate that a hydrogen regulator with left-hand threads be used (Verify this with your gas supplier). MOCON requires that this regulator be a two-stage model. A standard "T" size cylinder will provide several weeks of operation. The carrier gas mixture must contain less than 500 ppm residual oxygen.

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

7. **CARRIER GAS SUPPLY TUBING -** Metallic tubing is required for connecting the carrier gas supply 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.

8. **WATER REQUIREMENTS** - For Carrier Gas RH generation you must use HPLC grade water. Obtain this water through a local supplier. Water consumption for Carrier Gas RH generation is approximately 44 cc/month at 23 °C and 50% RH.

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 2/48 H 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 2/48 H. 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
024-383	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
027-271	Regulator, N2/H2, High Purity CGA 350 Left Hand, 0 to 80 psi	1	EA
027-326	Kit, Knife With Cutting Mat	1	EA
027-343	Regulator Tee, Tested	1	EA
034-285	Assy, Package Mounting Fixture, 5 X 5	1	EA
033-340	O-Ring, 0.187 ID X 0.050 CS, Buna N	10	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
051-931	Certified Film, #3, 2/22, 1 sq cm, 23.0 °C, 0% RH, Red/White	1	EA
051-932	Certified Film, #4, 2/22, 1 sq cm, 23.0 °C, 0% RH, Gold/Black	1	EA
052-590	Coupling, Quick-Disconnect, Plug	1	EA
052-595	O-Ring, 1.024 ID X 0.047 CS, Buna N	10	EA
052-703	Assy, Cartridge, Large Trays, Vertical, Right Mount	1	EA
052-704	Assy, Cartridge, Large Trays, Vertical, Left Mount	1	EA
052-705	Assy, Cartridge, Package Adapter, Package Instruments	1	EA
052-706	Assy, Cartridge, Package, Pouch, Flexible	1	EA
052-719	Adapter, Conversion, 1/4-18 NPT to 1/4-19 BSPP	1	EA
052-720	Syringe, Disposable, 140mL, Luer Tip	1	EA
052-721	Assy, Package Cartridge, 80 cm2, Package Instruments	1	EA
052-737	Assy, Cartridge, Film 50 cm2, Package Instruments	1	EA
052-878	Assy, Filter, Water Tank	1	EA
054-010	Coupling, Air Hose, 1/4 Sleeve Lock, 1/4 NPT Female	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
105-259	Foil Mask, Blank, No Hole, 10Pk	1	PK
052-707	Thin foil plates, 80 cm2, w/hole, 10Pk	1	PK
052-708	Thin foil plates, 80 cm2 package test cartridge, No hole,10Pk	1	PK

Part Number	Description	Quantity	Unit of Measure
052-709	Thin foil plates, Large package test cartridge, w/hole, 10Pk	1	PK
052-710	Thin foil plates, Large package test cartridge, No hole, 10Pk	1	PK
054-036	Set of 4 package cartridges, 80 cm2 (4 x PN 052-721)	1	PK
143-218	Manuscript, OX-TRAN 2/48, On Flash Drive	1	EA

Appendix C: Warranty and Service Policies

Part Number: 032-846, Warranty Policy
Part Number: 032-847, International Service Policy
Part Number: 032-848, Domestic Service Policy

(See next pages)

Part Number 032-846
Revision G

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.

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

Part Number 032-847
Revision E

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.

7500 Mendelssohn Avenue North
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Web Site: www.ametekmocon.com

Part Number 032-848
REVISION E

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 Coulox 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 sensor has a cadmium anode and a graphite cathode. The cathodic and anodic reactions respectively:

$$1/2O_2 + H_2O + 2e \rightarrow 2OH^-$$
$$Cd + 2OH^- - 2e \rightarrow Cd(OH)_2$$

The electrons create a current which can be used to calculate the amount of oxygen entering the Coulox sensor. As noted, each oxygen molecule entering the sensor results in four free electrons creating an electrical current. One mole of oxygen (22.4 liters at 0 °C and 760 mmHg) would produce four Faradays of current.

Because one Faraday = 96,500 Ampere-seconds, each mole of oxygen will produce 4 x 96,500 = 3.86×10^5 Ampere-seconds. In more practical terms one cc of oxygen in 24 hours = 0.000199 Amperes of current.

How the Transmission Rate is measured

The OX-TRAN Model 2/48 H 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 and area 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 2/48 H 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 Carrier Gas is Generated

Humidified Carrier Gas is 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 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%. An RH sensor is used to measure the actual RH delivered. 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 a Humidified Test Gas is Generated

OX-TRAN Model 2/48 does not use generated humidity but uses the actual environmental humidity.

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 Automatic Purge Function Works

The Automatic Purge function determines an appropriate Purge Time by monitoring the amount of oxygen in the Carrier Gas exhaust of the Conditioning Cell. The oxygen in the exhaust of each Conditioning Cell is measured using dedicated Purge Down sensors.

The Automatic Purge function is implemented as a variation on the standard Purge State. The Automatic Purge state contains a measurement interval and a purge interval.

When an Automatic mode Purge State is initiated a "count up" timer is displayed. While the count up timer is displayed the oxygen level in the Test Cell exhaust is monitored. When the oxygen level falls below a defined threshold the measurement interval is terminated.

The elapsed time is used to calculate a time for the purge interval. At the beginning of the purge interval a countdown timer is initialized and displayed using the calculated Purge Time.

The purge interval will not exceed the value specified in the High Purge Time field. If the calculated Purge Time exceeds the specified time, the High Purge Time will be used for the purge interval.

How the Automatic Conditioning Function Works

The Automatic Conditioning function determines an appropriate Conditioning Time by monitoring the amount of oxygen in the Carrier Gas exhaust of the Test Cell or Conditioning Cell. The oxygen in the exhaust of each test cell is measured using the dedicated Purge Down sensors.

The Automatic Conditioning function is implemented as a variation on the standard Conditioning State. The Automatic Conditioning State contains a measurement interval and a conditioning interval.

When an Automatic mode Conditioning State is initiated a "count up" timer is displayed. While the count up timer is displayed the oxygen level in the Test Cell exhaust is monitored using the Purge Down sensor. When the oxygen level falls below a defined threshold the measurement interval is terminated.

The elapsed time is used to calculate the appropriate time for the conditioning interval. At the beginning of the conditioning interval a countdown timer is initialized and displayed using the calculated Conditioning Time.

If the oxygen level at the test cell exhaust does not reach the threshold in the time specified by the Conditioning Failure Time field, the test will be terminated and set to the "Failed" state.

How the Automatic Check Function Works

The Automatic Check function is used to verify that the oxygen level at the output of the Test Cell is within the measurement range of the instrument.

The Automatic Check function is implemented as the Automatic Check State. The Automatic Check State has two intervals, a Zero interval followed by a Check interval. When an Automatic Check State is initiated the output of the ReZero cell is routed to the Permeant Sensor for a fixed time interval (the Zero interval).

During the Check interval the output of the ReZero Cell is still being routed to the Permeant Sensor. During the Check interval the output of the Test Cell being 'checked' is also routed to the Permeant Sensor for a short, controlled time interval. In practical terms, a small amount of gas from the Test Cell being "Checked" is injected into the flow from the ReZero cell.

The small amount of gas introduced from the cell being checked is diluted by the flow from the ReZero cell reducing the total amount of potential oxygen the Permeant sensor is exposed to. The amount of oxygen measured by the Permeant sensor remains quantifiable due to the controlled process used to acquire the sample. If the amount of oxygen measured by the Permeant sensor exceeds a defined threshold, the test is terminated and set to the "Failed" state.

How the Reference Check Function Works

The instrument contains a dedicated "Reference" cell that is used to track instrument performance over time. The Permeable barrier material used in the Reference Cell is located inside the front panel of the upper Test Deck. The Reference Cell barrier is therefore exposed to the same test conditions as the samples mounted in the Test Cells. The Reference Check function is used to measure the transmission rate of the Reference Cell.

This data over time to build a historical baseline and can be used to see if the instrument is functioning close to that established baseline. The best method to check the instrument performance is a certified NIST film but this provides a long-term stability check.

When the "Reference Check" function is enabled a "Reference Test" will be performed whenever a test is started on any Test Cell and all the Test Cells were previously idle. The Reference Check function is an Instrument Level test parameter located on the "Instrument" test method screens.

The Reference cell will be examined during the Test Phase after the Purge, Conditioning and Quick Check states (when present) have completed. The Examination Time of the Reference cell is not user accessible.

After the Reference Test has completed the measured transmission rate is normalized to 23 °C. The transmission rate of the barrier material used in the Reference Cell is not significantly affected by changes of the ambient RH.

The Reference cell data is accessed using the Cell Status screen. The result for each Reference Cell examination is shown in cc/(pkg • day). A maximum of 365 days of data will be retained and displayed. The graph contains limit bars at 5% and 10% from the stated value of the Reference Cell.

The Reference cell data can be printed and exported using the controls on the Reference Cell Status screen.

How the Auto-Test Method Works

The Auto-Test Method utilizes an internal ruleset 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 ruleset.

The measured transmission rate and internal ruleset 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.

Appendix E: Electrical and Plumbing Diagrams

Title	Part Number
Electrical Diagram, OX-TRAN Model 2/48	054-334
Plumbing Diagram, OX-TRAN Model 2/48	054-333

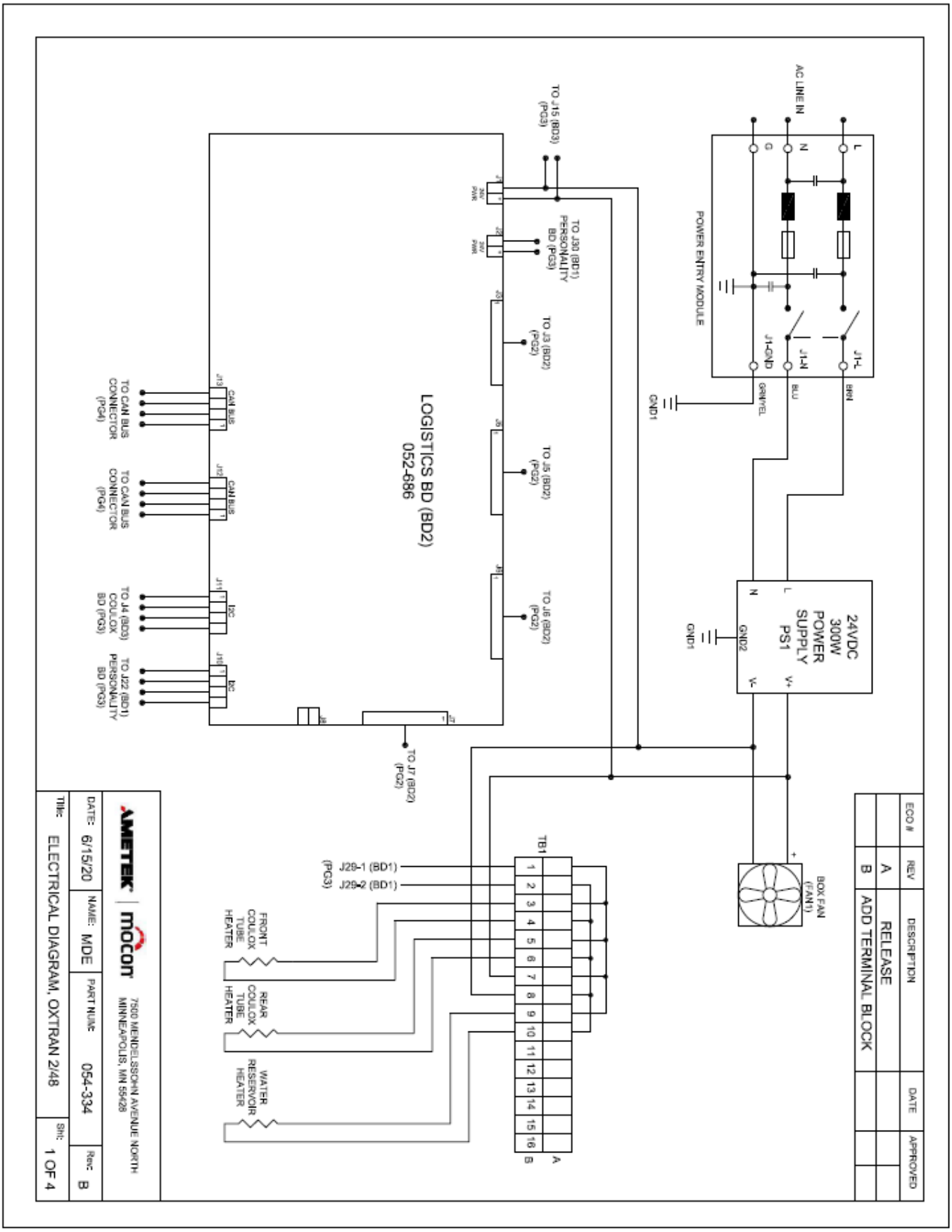

Figure 9-1: Electrical Diagram Page 1

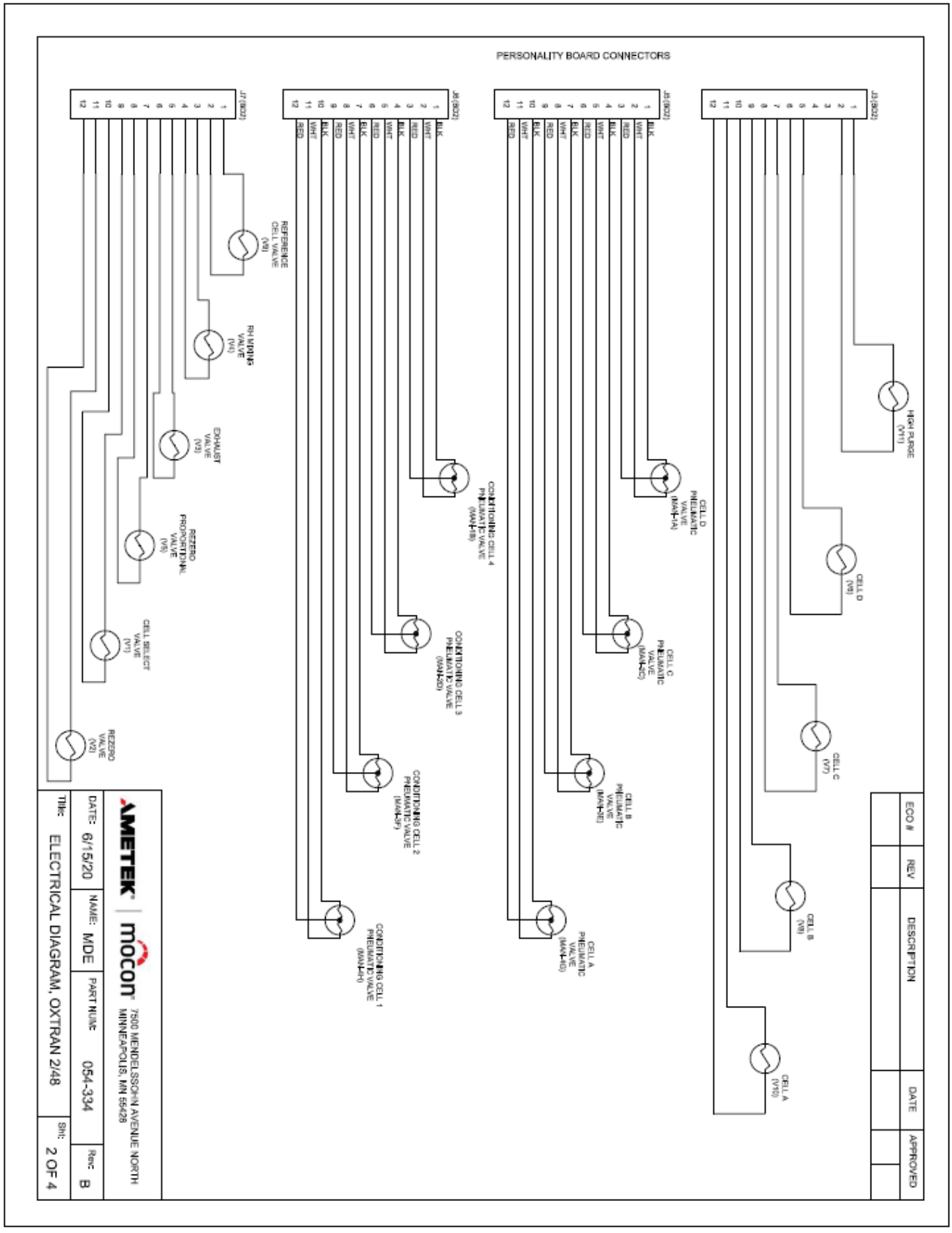

Figure 9-2: Electrical Diagram Page 2

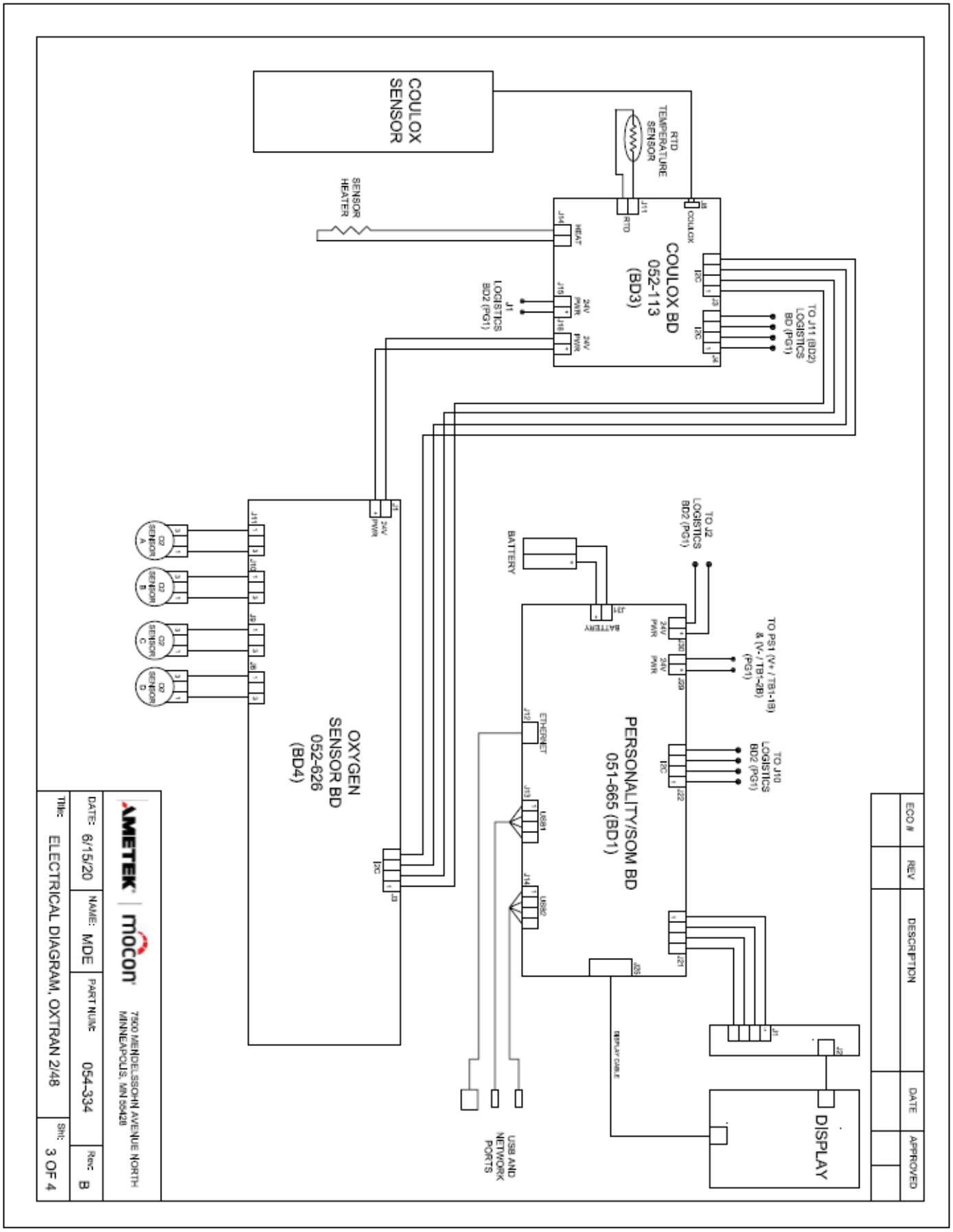

Figure 9-3: Electrical Diagram Page 3

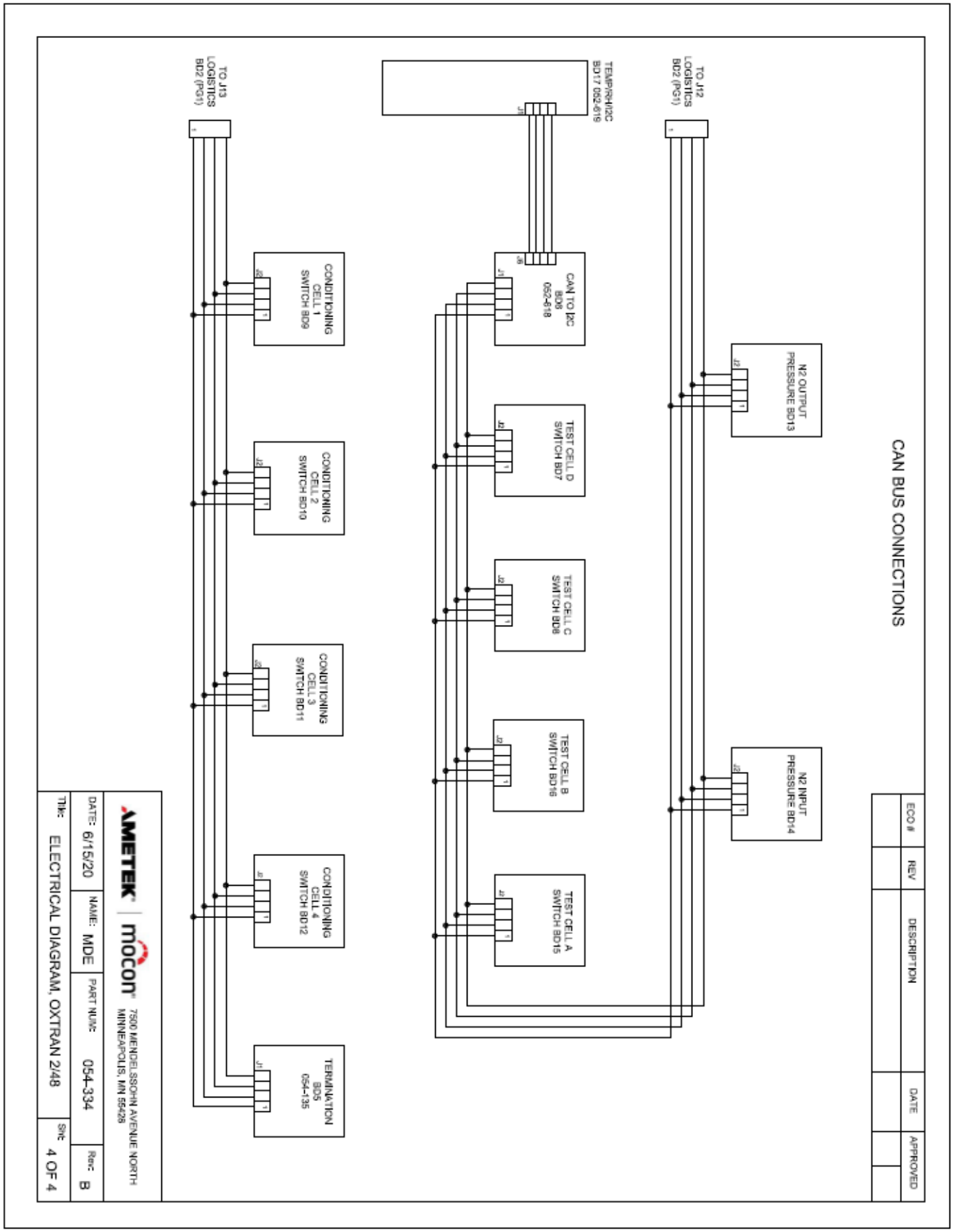

Figure 9-4: Electrical Diagram Page 4

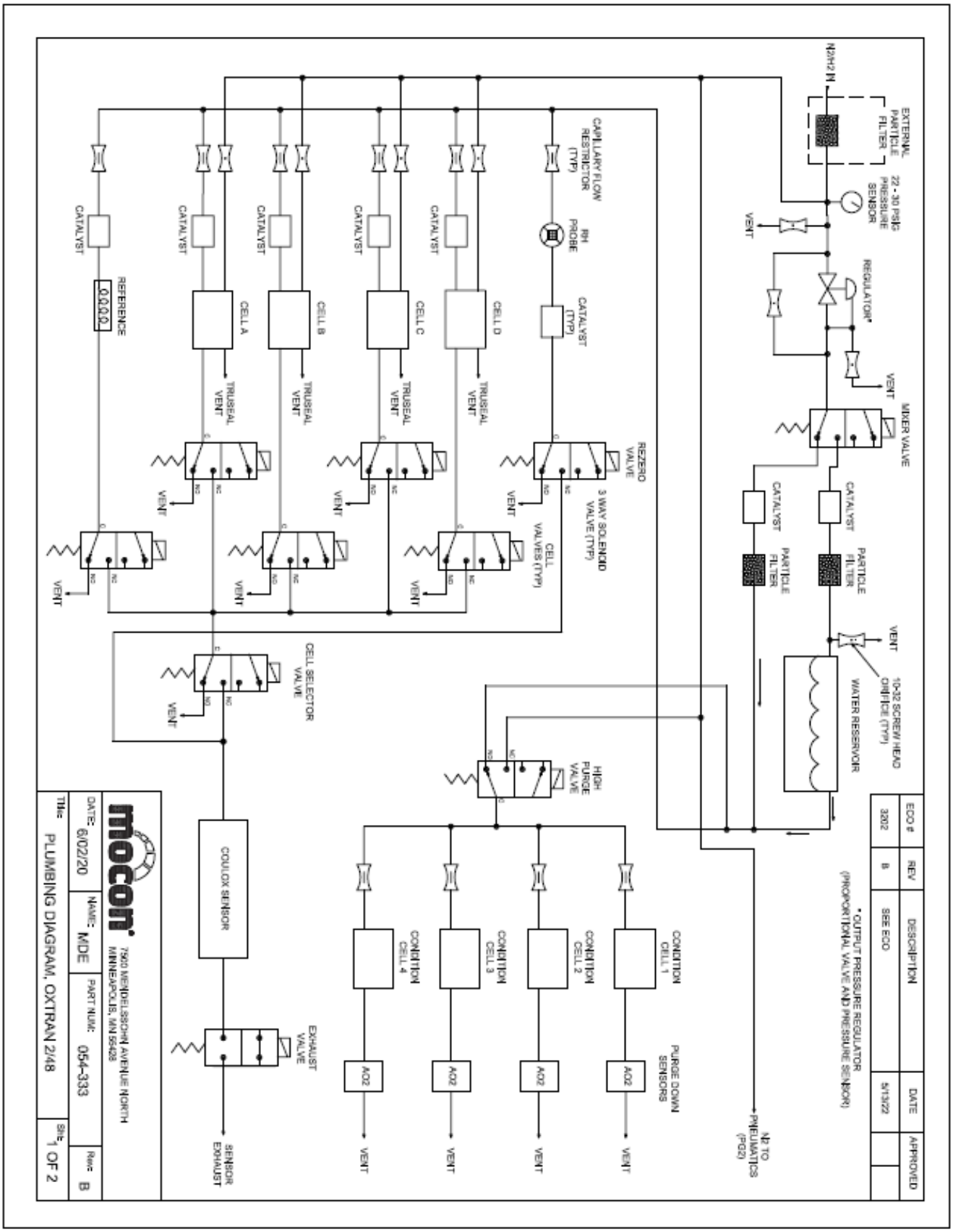

Figure 9-5: Plumbing Diagram Page 1

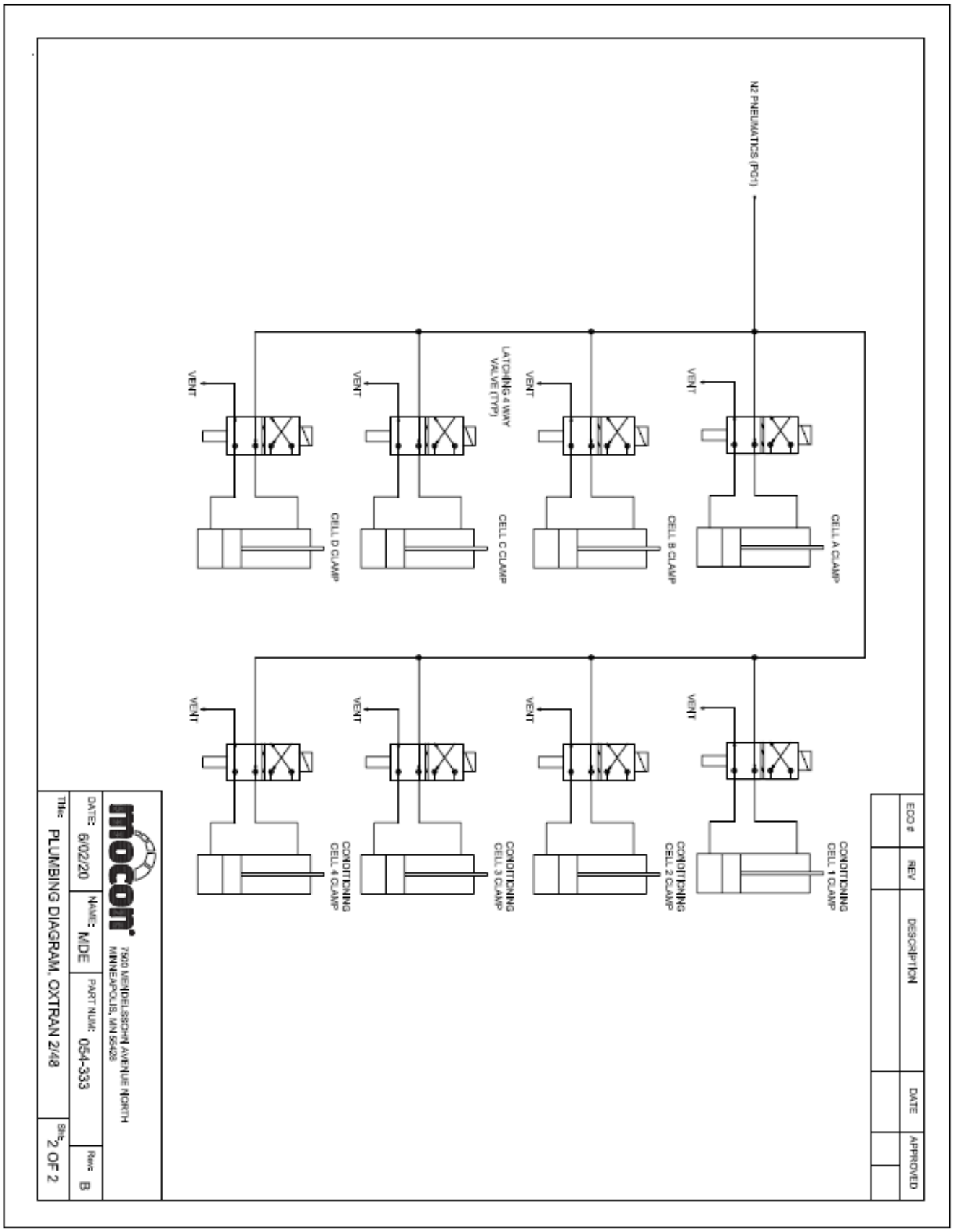

Figure 9-6: Plumbing Diagram Page 2

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Appendix F: Permeant Sensor Adjustment

The Permeant Sensor in the OX-TRAN Model 2/48 H is a coulometric oxygen detector. The patented Coulox sensor has a high degree of intrinsic accuracy. It is not necessary to calibrate a Coulox Permeant Sensor.

However, there are slight differences in efficiency between Coulox sensors. This may result in a small bias in the values reported between instruments. The reproducibility between instruments can be improved by adjusting the Permeant Sensor output. Adjustment of the Permeant Sensor is usually beneficial only when testing very good barriers and reproducibility between instruments is required.

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

Permeant Sensor Performance Check

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 NIST 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. Refer to the "Permeant Sensor Adjustment Test Setup" in this chapter for information on setting up a test to check the accuracy of the oxygen sensor.

NOTE: Mocon has available sets of certified NIST traceable films that cover the usual testing range. A fourth certified NIST traceable film is available for extreme low transmission rate testing. Call MOCON in the USA at (763) 493-6370 for more information.

Performing a Permeant Sensor Adjustment

Adjustment of the permeant (Coulox) sensor is a two-step process. First, a film sample with a known transmission rate must be tested. Refer to the "Permeant Sensor Adjustment 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 Adjustment" 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 Adjustment" screens. Refer to the Instrument Help System for more information on using the "OTR Adjustment" screens.

Permeant Sensor Adjustment Test Setup

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

NOTE: Mocon has available Certified NIST 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 samples you will be testing.

7. If necessary, unclamp and remove the Film Test Cartridge from the instrument.

8. Mount the Certified Film (or other reference material) in the Test Cartridge. For information on mounting films see "Mounting a Sample" on page 6-4.

9. Replace the test cell and clamp it in place. See "Loading and Unloading a Test Cartridge" on page 3-9.

10. 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.

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

Cell Temperature:	Ambient Temperature	
Instrument ReZero:	Instrument ReZero	Enabled
	ReZero Frequency	1
	ReZero Exam Minutes	25

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

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

Package/Film selection:	Verify that Package is selected if using a Certified film. If using another film, set the Package/Film buttons to the appropriate selection for the method used to establish the reference transmission rate.
Area/Cell:	Verify the area is set correctly when not using Package mode.

13. 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 25 minutes is recommended.
Individual Zero Mode:	When the use of an Individual Zero Phase is required, set the Individual Zero control to the "On" position. Set the Individual Zero Mode parameter to "Beginning".

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

15. 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 certified film is at equilibrium.

16. Adjust the output of the Permeant Sensor using the "OTR Adjustment" 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 a module needs re-calibration.

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 Model 2/48

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+A1:2016
EN 61326-1:2013

Class A Radiated & Conducted
Basic Immunity Test Requirements

EN 61000-3-2:2014/ IEC 61000-3-2:2018/AMD1:2020
EN 61000-3-3:2013/ IEC 61000-3-3:2013/AMD2:2021

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