CHI NHÁNH PHÁT ĐIỆN DẦU KHÍ
NHÀ MÁY NHIỆT ĐIỆN THÁI BÌNH 2

CỘNG HÒA XÃ HỘI CHỦ NGHĨA VIỆT NAM
Độc lập - Tự do - Hạnh phúc

Số: 344 /NMĐTB2-KTATMT
V/v dịch vụ BDSC thường xuyên hệ thống sản xuất Hydro – NMNĐ Thái Bình 2

Thái Bình, ngày 20 tháng 02 năm 2025

Kính gửi: Các Nhà cung cấp

Chi nhánh Phát điện Dầu khí/Nhà máy Nhiệt điện Thái Bình 2 đang có nhu cầu triển khai thực hiện gói thầu BDSC thường xuyên hệ thống sản xuất Hydro. Được biết Quý Công ty là đơn vị có năng lực, kinh nghiệm trong việc thực hiện các dịch vụ tương tự cho các Nhà máy Nhiệt điện, đề nghị Quý Công ty quan tâm, xem xét và cung cấp báo giá dịch vụ BDSC thường xuyên hệ thống sản xuất Hydro với nội dung như sau:

- Phạm vi công việc:
  - ✓ Như phụ lục 1 đính kèm.
- Tiến độ thực hiện: Dịch vụ được thực hiện trong 12 tháng kể từ ngày ký hợp đồng.
- Địa điểm thực hiện công việc: Nhà máy Nhiệt điện Thái Bình 2, xã Mỹ Lộc, huyện Thái Thụy, tỉnh Thái Bình.
- Hiệu lực báo giá: 60 ngày kể từ ngày báo giá.
- Thời gian gửi báo giá: không muộn hơn 15h00 ngày 27/02/2025.
- Báo giá được ký tên, đóng dấu bởi người đại diện đủ thẩm quyền của Công ty.
- Phương thức gửi báo giá: Gửi trực tiếp qua bưu điện theo địa chỉ tiếp nhận báo giá hoặc qua email, fax.
- Thông tin liên hệ:
  - ✓ Người nhận: Hoàng Bích Sơn, Phòng KTATMT;
  - ✓ Địa chỉ: Xã Mỹ Lộc, huyện Thái Thụy, tỉnh Thái Bình;
  - ✓ Số điện thoại liên hệ: 0982090189; Email:sonhb@pvpgb.vn; hungbb@pvpgb.vn.

Nhà máy Nhiệt điện Thái Bình 2 cảm ơn sự hợp tác của Quý Công ty.

Trân trọng./.

Nơi nhận:
- Như trên;
- CNPĐ DK (để b/c);
- GĐ NM (để b/c);
- Phòng: TM (để t/h);
- Lưu: VT, KTATMT (H.B.S: 1 b).

Đính kèm:
- Phụ lục 1(Phạm vi công việc);
- Tài liệu O&M.

TL. GIÁM ĐỐC CHI NHÁNH PĐDK
KT. GIÁM ĐỐC NMNĐ THÁI BÌNH 2
PHÓ GIÁM ĐỐC

M.S.C.N: 0100[illegible]992-039 CHI NHÁNH PHÁT ĐIỆN DẦU KHÍ TẬP ĐOÀN DẦU KHÍ VIỆT NAM THÀNH PHỐ HÀ NỘI

Nguyễn Văn Chung

Xã Mỹ Lộc - huyện Thái Thụy - tỉnh Thái Bình
ĐT: 02273.721.515; Fax: 02273.721.678

Phụ lục 01. Phạm vi công việc đơn hàng "Cung cấp dịch vụ BDSC thường xuyên hệ thống sản xuất hydro – NMNĐ Thái Bình 2"
(Đính kèm Công văn số 344 *NMĐTB2-KTATMT ngày* 20 *tháng 02 năm 2025)*

Stt	Tên thiết bị	Số lượng thiết bị	Nội dung công việc	Số lần bảo dưỡng 1 năm	Tần suất	Ghi chú
I	Máy điều chế khí hydro 1) Type: C10 2) Discharge Pressure: 30barg 3) Capacity: 10Nm3/hr 4) Operation Mode: Load following		**Phần cơ khí**			TB2-SDC.VP121-00QJA-GE-M17-MAN-0001/TB2-SDC.VP121-00QJA-GE-M17-MAN-0002
		2	Kiểm tra rò rỉ, các kết nối đường ống nước khử khoáng	2	6 tháng /1 lần	
		2	Kiểm tra rò rỉ tại các đường ống khí	2	6 tháng /1 lần	
		2	Kiểm tra các tấm lọc khí	2	6 tháng /1 lần	
		2	Kiểm tra, thay thế tấm lọc bơm	1	1 năm/ lần	
		2	Kiểm tra, thay thế lọc đầu vào A500	1	1 năm/ lần	
		2	Thay thế Guard Bed DI	1	1 năm/ lần	
		2	Thay thế bộ lọc H2 và Orifice	1	1 năm/ lần	
		2	Thay thế hạt hút ẩm Dryer	1	1 năm/ lần	
		2	Kiểm tra thay thế lọc RO	2	6 tháng /1 lần	
			Phần điện			
		2	Kiểm tra kết nối các nguồn điện động lực	1	1 năm/ lần	
		2	Kiểm tra nguồn điện AC, cầu chì	1	1 năm/ lần	
		2	Kiểm tra Surge Protector	1	1 năm/ lần	
		2	Kiểm tra các mạch điện an toàn	1	1 năm/ lần	
		2	Kiểm tra bảo dưỡng đầu cáp động cơ, siết chặt các mối nối điện, bu lông các chi tiết	1	1 năm/ lần	
		2	Kiểm tra hệ thống điện, kiểm tra dòng chạy động cơ, có báo cáo đánh giá nguyên nhân nếu có bất thường xảy ra	1	1 năm/ lần	
			Phần điện điều khiển			
		2	Kiểm tra và thực hiện hiệu chỉnh cảm biến đo H2 trong O2 CG220	2	6 tháng /1 lần	
		2	Kiểm tra và hiệu chỉnh cảm biến đo rò rỉ khí H2 trong tủ điều chế	2	6 tháng /1 lần	
		2	Kiểm tra và hiệu chỉnh cảm biến đo rò rỉ khí H2 trong phòng	2	6 tháng /1 lần	
		3	Kiểm tra và thay thế cảm biến đo điểm đọng sương	1	1 năm/ lần	
		1	Kiểm tra và hiệu chỉnh bộ đo khí H2 purity	1	1 năm/ lần	
		2	Kiểm tra và điều chỉnh thời gian tại bộ điều khiển	1	1 năm/ lần	
		2	Bảo dưỡng, kiểm tra các tủ điều khiển, đo lường	2	6 tháng /1 lần	
		2	Vệ sinh, siết chặt các các hàng kẹp đầu dây	1	1 năm/ lần	
		1	Kiểm tra, bảo dưỡng màn hình điều khiển	1	1 năm/ lần	
		1	Kiểm tra, bảo dưỡng các van điện từ	1	1 năm/ lần	
		2	Kiểm tra chương trình PLC/HMI và sao lưu chương trình	1	1 năm/ lần	
		1	Redundance test cho CPU/communication/ Power supply	1	1 năm/ lần	
		2	Kiểm tra tín hiệu các chức năng của công tắc áp suất PSW121, E-Stop, công tắc mức nước.	1	1 năm/ lần	
II	Máy Chiller	1	Kiểm tra định kì	1	1 năm/ lần	
		1	Kiểm tra các kết nối tất cả các công tắc tơ, khởi động và bộ điều khiển	1	1 năm/ lần	
		1	Kiểm tra điện áp đầu vào đảm bảo 10% điện áp thiết kế ch máy làm lạnh	1	1 năm/ lần	
		1	Kiểm tra bộ khuếch đại dẫn đến từng chân của máy nén (quạt hoặc máy thổi trên bộ phận làm mát không khí) và bơm	1	1 năm/ lần	
		1	Tháo và làm sạch bộ lọc chữ Y giữa kết nối đầu vào thiết bị bay hơi, làm sạch bình ngưng	1	1 năm/ lần	
		1	Kiểm tra làm sạch bề mặt cuộn dây ngung tụ làm mát	1	1 năm/ lần	
		1	Kiểm tra áp suất xả của bơm trên đồng hồ đở mặt sau của máy làm lạnh, Điều chỉnh nếu áp suất bắt đầu bị lệch khỏi áp suất vận hành bình thường	1	1 năm/ lần	
		1	Kiểm tra bơm tuần hoàn chất làm mát có bị rò rỉ ở khu vực bịt kín không, thay thế phớt bơm nếu bị rò rỉ	1	1 năm/ lần	
		1	Kiểm tra kính quan sát chất làm lạnh xem có bọt khí không,	1	1 năm/ lần	
		1	Kiểm tra mức chất làm mát trong bình chứa (Bổ xung thêm)	1	1 năm/ lần	

- Nhà thầu cung cấp vật tư nhỏ lẻ, vật tư tiêu hao thường xuyên : dẻ lau, dung dịch vệ sinh và các thiết bị bảo vệ an toàn cho nhân sự của Nhà thầu
- Công tác sửa chữa các bất thường được thực hiện theo kết quả kiểm tra
- Đối với vật tư thay thế: Nhà thầu đề xuất danh mục và chi phí (nếu cần thay thế) trình chủ đầu tư chấp thuận trước khi thực hiện
- Sau quá trình BDSC, nhà thầu có báo cáo kết quả và lập kế hoạch đại tu cho hệ thống dựa trên tình trạng thực tế của thiết bị

DOCUMENT SUBMISSION STATUS: FF

NOTE: Operation & Maintenance manuals for the Hydrogen Plant

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OWNER'S CONSULTANT

FICHTNER

PVPOWER PCC

EPC CONTRACTOR

PETROVIETNAM CONSTRUCTION JOINT STOCK CORPORATION (PVC)

EPC CONSTRACTOR'S CONSULTANT

WORLEYPARSONS

POWER ISLAND PACKAGE SUPPLIER

SOJITZ CORPORATION

DAELIM INDUSTRIAL CO., LTD.

PROJECT TITLE

THAI BINH 2 THERMAL POWER PLANT 2 x 600MW

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Hydrogen Generation Plant
Operation & Maintenance Manuals

Vendor's Logo:

PROTON ON SITE

THE LEADER IN ON SITE GAS GENERATION.

FUNCTION	NAME	SIGN	DATE
CREATED	J. Sieverman	Joe Sieverman	21-Sep-18
CHKD	D. Martel	Derek Martel	21-Sep-18
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Daelim's Approval Status

Daelim Industrial Co., Ltd.	
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	D - REJECTED
	N - NOT APPLICABLE(REFERENCE ONLY)
SIGNED BY :	**DATE :**

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VENDOR'S LOGO:

PROTON ON SITE™

THE LEADER IN ON SITE GAS GENERATION.

Table of Contents

THERMAL CARE

Installation & Operation Manual

NQ Series Portable and Remote Condenser Chillers

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Table of Contents

Foreword

The portable chiller is a packaged unit typically consisting of a refrigeration circuit, coolant reservoir, and pumping system in a cabinet. The purpose is to provide cooling water or coolant for cooling an industrial process.

This manual is to serve as a guide for installing, operating, and maintaining the equipment. Improper installation can lead to poor performance and/or equipment damage. We recommend the use of qualified installers and service technicians for all installation and maintenance of this equipment.

This manual is for our standard product. The information in this manual is general in nature. Unit-specific drawings and supplemental documents are included with the equipment as needed. Additional copies of documents are available upon request. We strive to maintain an accurate record of all equipment during the course of its useful life.

Due to the ever-changing nature of applicable codes, ordinances, and other local laws pertaining to the use and operation of this equipment, we do not reference them in this manual. There is no substitute for common sense and good operating practices when placing any mechanical equipment into operation. We encourage all personnel to familiarize themselves with this manual's contents. Failure to do so may unnecessarily prolong equipment down time.

The equipment uses a hydro fluorocarbon (HFC), trade named R-410A, as a chemical refrigerant for heat transfer purposes. This chemical is sealed and tested in a pressurized system containing ASME coded vessels; however, a system failure will release it. Refrigerant gas can cause toxic fumes if exposed to fire. Place these units in a well-ventilated area, especially if open flames are present. Failure to follow these instructions could result in a hazardous condition. We recommend the use of a refrigerant management program to document the type and quantity of refrigerant in the equipment. In addition, we recommend only licensed and EPA certified service technicians work on our refrigeration circuits.

Follow good piping practices and the information in this manual to ensure successful installation and operation of this equipment.

We trust your equipment will have a long and useful life. If you should have any questions, please contact our Customer Service Department specifying the serial number and model number of the unit as indicated on the nameplate.

Safety Guidelines

Observe all safety precautions during installation, start-up, and service of this equipment. The following is a list of symbols used in this manual and their meaning.

General Warning

Electricity Warning

Sharp Element Warning

Hot Surface Warning

Flammable Material Warning

Explosive Material Warning

General Mandatory Action

Wear Eye Protection

Wear Protective Gloves

Wear Ear Protection

Disconnect Before Carrying Out Maintenance or Repair

Connect an Earth Terminal to Ground

Only qualified personnel should install, start-up, and service this equipment. When working on this equipment, observe precautions in this manual as well as tags, stickers, and labels on the equipment.

WARNING: Any use or misuse of this equipment outside of the design intent may cause injury or harm.

WARNING: Vent all refrigerant relief valves in accordance to ANSI/ASHRAE Standard 15, Safety Code for Mechanical Refrigeration. Locate this equipment in a well-ventilated area. Inhalation of refrigerant can be hazardous to your health and the accumulation of refrigerant within an enclosed space can displace oxygen and cause suffocation.

WARNING: This equipment contains hazardous voltages that can cause severe injury or death.

WARNING: This equipment contains refrigerant under pressure. Accidental release of refrigerant under pressure can cause personal injury and or property damage.

WARNING: This equipment may contain fan blades or other sharp edges. Make sure all fan guards and other protective shields are securely in place.

WARNING: The exposed surfaces of motors, refrigerant piping, and other fluid circuit components can be very hot and can cause burns if touched with unprotected hands.

CAUTION: Disconnect and lock out incoming power before installing, servicing, or maintaining the equipment. Connecting power to the main terminal block energizes the entire electric circuitry of the unit. A power supply provides 24 VDC control power. Shut off the electric power at the main disconnect before opening access panels for repair or maintenance.

CAUTION: Wear eye protection when installing, maintaining, or repairing the equipment to protect against any sparks, debris, or fluid leaks.

CAUTION: The equipment will exceed 70 dBA sound pressure at 1 meter distance and 1 meter elevation when operating. Wear ear protection as required for personal comfort when operating or working in close proximity to the chiller.

CAUTION: Wear protective gloves when installing, maintaining, or repairing the equipment to protect against any sparks, debris, or fluid leaks.

Pre-Installation

Receiving Inspection

When the unit arrives, verify the information on the unit nameplate agrees with the order acknowledgement and shipping papers. Inspect the equipment for any visible damage and verify all items shown on the bill of lading are present. If damage is evident, document it on the delivery receipt by clearly marking any item with damage as "unit damage" and notify the carrier. In addition, notify our Customer Service Department and they will provide assistance with preparing and filing freight damage claims, including arranging for an estimate on repair costs; however, filing the shipping damage claim is the responsibility of the receiving party. Do not install damaged equipment without getting the equipment repaired.

Shipping damage is the responsibility of the carrier. To protect against possible loss due to damage incurred during shipping and to expedite payment for damages, it is important to follow proper procedures and keep records. Photographs of damaged equipment are excellent documentation for your records.

Start unpacking the unit, inspect for concealed damage, and take photos of any damage found. Once received, equipment owners have the responsibility to provide reasonable evidence that the damage did not occur after delivery. Photos of the equipment damage while the equipment is still partially packed will help in this regard. Refrigerant lines can be susceptible to damage in transit. Check for broken lines, oil leaks, damaged controls, or any other major component torn loose from its mounting point.

Record any signs of concealed damage and file a shipping damage claim immediately with the shipping company. Most carriers require concealed damages be reported within 15 days of receipt of the equipment. In addition, notify our Customer Service Department and they will provide assistance with preparing and filing freight damage claims, including arranging for an estimate on repair costs; however, filing the shipping damage claim is the responsibility of the receiving party.

Chillers with an integral water-cooled or air-cooled condenser ship with a full refrigerant charge. Chillers designed for use with a remote air-cooled condenser and the remote condensers themselves ship with a nitrogen holding charge. Check the remote condenser for signs of leaks prior to rigging. This will ensure no coil damage has occurred after the unit left the factory. The condenser ships with the legs removed. Mount the legs to the condenser using the provided nuts, bolts, and washers.

Unit Storage

If the chiller is stored prior to installation, it is important to protect it from damage. Blow out any water from the evaporator and water-cooled condenser circuits to protect the unit from damage from freezing. Close any open refrigerant valves. Cover the equipment to keep dirt and debris from accumulating on it. Units charged with refrigerant should not be stored in areas warmer than 145°F.

Installation - Chiller

Foundation

Install the chiller on a rigid, non-warping mounting pad, concrete foundation, or level floor suitable to support the full operating weight of the equipment. When installed the equipment must be level within ¼ inch over its length and width.

Unit Location

The chiller is available in many different configurations for various environments. Refer to the proposal and order acknowledgement document for the equipment to verify the specific design conditions in which it can operate.

Allow a minimum of 48 inches of clearance between the chiller and any walls or obstructions. For installations with multiple chillers, allow a minimum of 96 inches between chillers placed side-by-side or 48 inches for chillers placed end-to-end.

When locating the chiller it is important to consider accessibility to the components to allow for proper maintenance and servicing of the unit. In general, allow a minimum of 36 inches of clearance around and above the unit. Avoid locating piping or conduit over the unit to ensure easy access with an overhead crane or lift to lift out heavier components during replacement or service.

Proper ventilation is another important consideration when locating the chiller. In general, locate the unit in an area that will not rise above 110°F. In addition, ensure the condenser and evaporator refrigerant pressure relief valves can vent in accordance with all local and national codes.

Chillers with an integral air-cooled condenser require a minimum of 36 inches of clearance at both the condenser air inlet and condenser air discharge, they are not as standard designed to have the condenser air discharge ducted. Improper clearance or poor ventilation will reduce the cooling capacity of the chiller and may cause high refrigerant pressure problems. In order to avoid possible low refrigerant pressure safety trips during start-up, maintain the inlet air temperature above 50°F. If outside air is ducted into an indoor chiller with an integral air-cooled condenser, there is an option for low ambient heat pressure controls which allow for incoming air temperatures down to 0°F. Cooler temperatures than this require custom modifications. High-pressure fans suitable for ducting and outdoor-duty low-ambient options are available. Before installing ductwork or locating a chiller outdoors, verify the chiller includes these options.

Rigging

The chiller has a frame to facilitate easy movement and positioning with a crane or forklift. Follow proper rigging methods to prevent damage to components. Avoid impact loading caused by sudden jerking when lifting or lowering the chiller. Use pads where abrasive surface contact may occur.

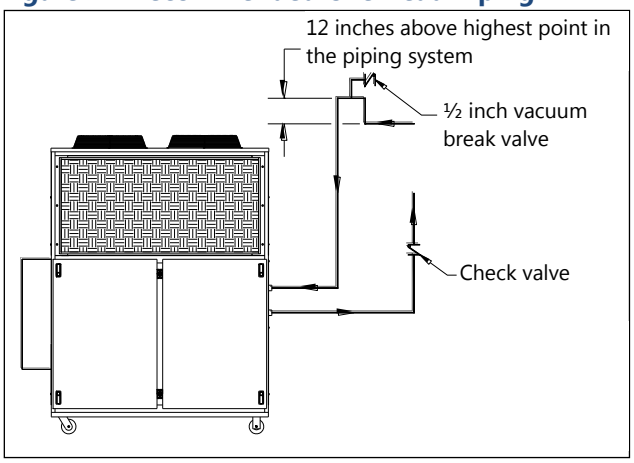
Chilled Process Fluid Piping

Proper insulation of chilled process fluid piping is crucial to prevent condensation. The formation of condensation adds a substantial heat load to the chiller.

The importance of properly sized piping between the chiller and process cannot be overemphasized. See the ASHRAE Handbook or other suitable design guide for proper pipe sizing. In general, run full size piping out to the process and reduce pipe size at connections as needed. One of the most common causes of unsatisfactory chiller performance is poor piping system design. Avoid long lengths of hoses, quick disconnect fittings, and manifolds wherever possible as they offer high resistance to water flow.

When manifolds are required, install them as close to the use point as possible. Provide flow-balancing valves at each machine to assure adequate water distribution in the entire system. Typically, when piping is overhead with a total run length over 90 feet there should be a valve in the supply line and an inverted P trap with a vacuum break valve installed as shown in Figure 1.

Figure 1 – Recommended Overhead Piping



All standard portable chillers include an internal coolant pump and reservoir. Nominal coolant flow rates assume a 10°F rise across the evaporator at 50°F set point and 85°F entering condenser water for water-cooled chillers or 95°F entering air for integral air-cooled or remote air-cooled condenser chillers.

Condenser Water Piping

(Water-Cooled Condenser Chillers Only) The performance of a water-cooled condenser is dependent on the flow and temperature of the cooling water used. Insufficient cooling of the condenser will result in the reduction of cooling capacity of the chiller and under extreme conditions may result in the chiller shutting down due to high refrigerant pressure. Allowing the condenser to plug up from contaminants in the condenser water stream adversely affects performance. In order to reduce maintenance costs and chiller downtime, a water treatment program is highly recommended for the condenser cooling water. Contact our Customer Service Department for assistance in the proper procedure for cleaning out any plugged condenser.

The nominal water-cooled condenser is design for 85°F condenser cooling water supply. Under normal operation there will be about a 10°F rise through the condenser resulting in 95°F exiting water. To ensure proper water flow through the condenser, ensure the condenser water pump provides at least 25 psi or water at a flow rate of 3 gpm per ton of chiller capacity.

Each condenser has a two-way condenser water-regulating valve. The condenser water-regulating valve controls the amount of water allowed to pass through the condenser in order to maintain proper refrigeration pressures in the circuit.

To prevent damage to the condenser and/or water-regulating valve, the water pressure should not exceed 150 psig.

Installation – Remote Air-Cooled Condenser

Chillers designed for use with a remote air-cooled condenser include a factory-selected remote condenser. The remote air-cooled condenser typically ships separately from a different location than the chiller.

Location

The remote air-cooled condenser is for outdoor use. Locate the remote condenser in an accessible area. Allow a minimum of 48 inches of clearance between the condenser and any walls or obstructions. For installations with multiple condensers, allow a minimum of 96 inches between condensers placed side-by-side or 48 inches for condensers placed end-to-end.

When locating the condenser it is important to consider access to the components to allow for proper maintenance and servicing of the unit. In general, allow a minimum of 36 inches of clearance around and above the unit. Avoid locating piping or conduit over the unit to ensure easy access with an overhead crane or lift to lift out heavier components during replacement or service.

Proper ventilation is another important consideration when locating the condenser. In general, locate the unit in an area that will not rise above 110°F.

Install the unit on a firm, level base no closer than its width from walls or other condensers. Avoid locations near exhaust fans, plumbing vents, flues, or

chimneys. Fasten the mounting legs at their base to the steel or concrete of the supporting structure. For units mounted on a roof structure, the steel support base holding the condenser should be elevated above the roof and attached to the building.

Avoid areas that can create a "micro-climate" such as an alcove with east, north, and west walls that can be significantly warmer than surrounding areas. The condenser needs to have unrestricted airways so it can easily move cool air in and heated air away. Consider locating the condenser where fan noise and vibration transmission into nearby workspaces is unlikely.

The unit ships on its side with the legs removed to reduce shipping dimensions and provide more protection to the coil from possible damage caused by impact loading over rough roads and transit conditions.

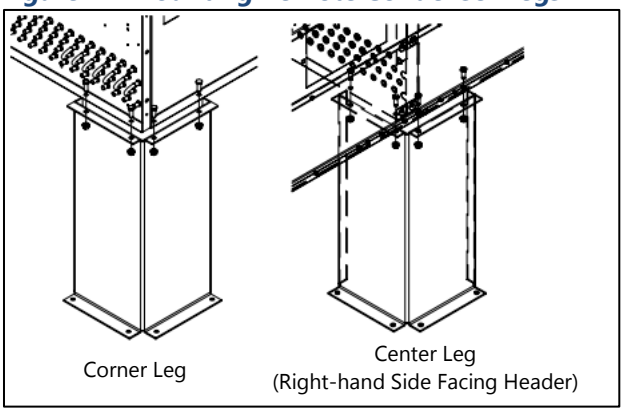
Lifting

Use only qualified personnel using the proper equipment when lifting and positioning the condenser. Lifting brackets or holes are at the corners for attaching lifting slings. Use spreader bars when lifting to apply the lifting force vertically. Under no circumstances use the coil headers or return bends in the lifting or moving of the condenser.

Mounting Legs

Assemble the four corner legs to the bottom flanges on the unit side panels and end panels using the hardware provided and the matching mounting hole-patterns. All corner legs are the same. For units that are longer than three fans, assemble the center leg. Remove two bolts from the bottom flange of the unit side panels that match the hole-pattern on the top flanges of both legs. Attached the center legs using the hardware provide at the center-divider panel location. Replace the bolts removed from the side panels to secure the leg assembly to the bottom flanges of the condenser side panels.

Figure 2 - Mounting Remote Condenser Legs



Interconnecting Refrigerant Piping

The chiller and remote condenser ship with a nitrogen holding charge. Evacuation of this charge is required before charging with refrigerant. The chiller is for use only with the air-cooled condenser provided with the unit. The following section covers the required piping between the chiller and the provided air-cooled condenser.

The discharge and liquid lines leaving the chiller have caps. These line sizes do not necessarily reflect the actual line sizes required for the piping between the chiller and the air-cooled condenser.

Refrigerant piping size and piping design have a significant impact on system performance and reliability. All piping should conform to the applicable local and state codes.

CAUTION: Use refrigerant grade copper tubing ASTM B280 only and isolate the refrigeration lines from building structures to prevent transfer of vibration. All copper tubing must have a pressure rating suitable for R-410A: tubing that is ¾" OD or larger must be Type K rigid tubing. ACR annealed tubing coil may be used for sizes ⅝" ODS or smaller.

Do not use a saw to remove end caps. This might allow copper chips to contaminate the system. Use a tube cutter or heat to remove the caps. When sweating copper joints it is important to evacuate all refrigerant present and flow dry nitrogen through the system. This prevents the formation of toxic gases, corrosive acids, and scale.

CAUTION: Do not use soft solders. For copper-to-copper joints use a copper-phosphorus braze alloy (BCuP per the American Welding Society) with 5% (BCuP-3) to 15% (BCuP-5) silver content. Only use a high silver content brazing alloy (BAg per AWS) for copper-to-brass or copper-to-steel joints such as a 45% (BAg-5) silver content. Only use oxy-acetylene brazing.

WARNING: The POE oil contained within the compressor is hygroscopic and has the ability to absorb water vapor from the atmosphere. Take necessary steps to prevent an open system from exposure to the atmosphere for extended periods while installing the interconnecting refrigerant tubing.

Refrigeration Piping Design

The system is configurable in any of the arrangements as shown in Figure 3, Figure 4, and Figure 5. The configuration and its associated elevation, along with the total distance between the chiller and the air-cooled condenser are important factors in determining the liquid line and discharge line sizes. This will also affect the field refrigerant charges. Consequently, it is important to adhere to certain physical limitations to ensure the system operates as designed.

General design considerations are:

1. The total distance between the chiller and the air-cooled condenser must not exceed 200 actual feet or 300 equivalent feet. Keep the distance as short as possible.
2. Liquid line risers must not exceed 15 feet in height from the condenser liquid line connection.
3. Discharge line risers cannot exceed an elevation difference greater than 100 actual feet without a minimum of 2% efficiency decrease.
4. To form a proper liquid seal at the condenser, immediately drop at least 15 inches down from the liquid outlet before routing the piping to the chiller. Make the drop leg before any bends or angles connecting to the remainder of the liquid connection piping.

Figure 3 – Condenser Located at Chiller Level

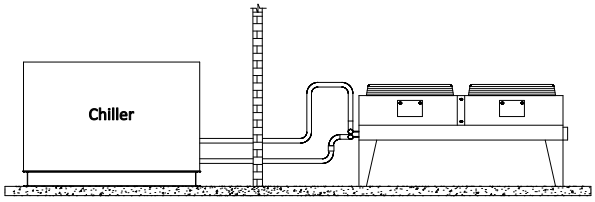


Figure 4 – Condenser Located Above Chiller Unit

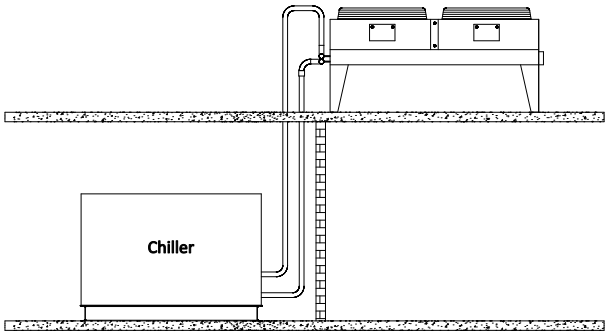
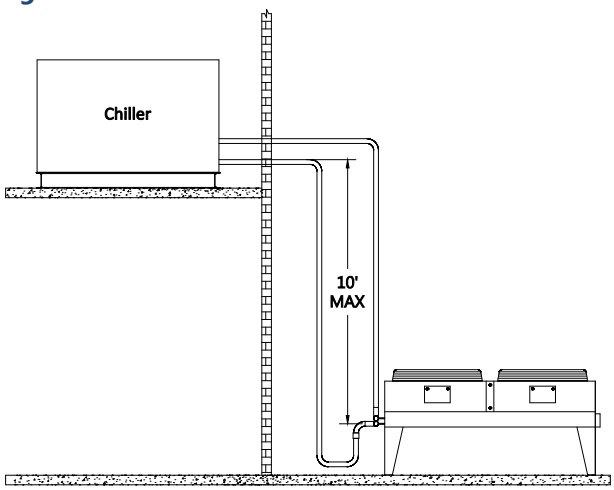


Figure 5 - Condenser Located Below Chiller Unit



Caution: Liquid line sizing for each chiller capacity is in Table 2. These line sizes are listed per circuit and apply where leaving water temperature (LWT) is 40°F or higher. For applications where the LWT is below 40°F, size lines using the ASHRAE Refrigeration Handbook or other suitable design guide.

Determining Equivalent Line Length

To determine the appropriate size for field installed liquid and discharge lines, it is first necessary to establish the equivalent length of pipe for each line. The equivalent length is the approximate friction loss from the combined linear run of pipe and the equivalent feet of elbows, valves, and other components in the refrigeration piping. The sum total is the equivalent length of pipe that would have the same pressure loss. See the ASHRAE Refrigeration Handbook for more information.

Follow these steps when calculating line size:

1. Start with an initial approximation of equivalent length by assuming that the equivalent length of pipe is 1.5 times the actual pipe length.
2. Determine approximate line sizes by referring to Table 2 for liquid lines, Table 3 and Table 4 for the discharge lines.
3. Check the line size by calculating the actual equivalent length using the equivalent lengths as shown in Table 1.

CAUTION: When calculating the equivalent length, do not include piping of the chiller unit. Only field piping must be considered.

Table 1 – Equivalent Lengths of Elbows

Line Size OD (in)	Equivalent Lengths of Refrigerant Pipe (feet)				
	90° Standard	90° Long Radius	90° Street	45° Standard	45° Street
⅞	2.0	1.4	3.2	0.9	1.6
1⅛	2.6	1.7	4.1	1.3	2.1
1⅜	3.3	2.3	5.6	1.7	3.0
1⅝	4.0	2.6	6.3	2.1	3.4
2⅛	5.0	3.3	8.2	2.6	4.5
2⅝	6.0	4.1	10.0	3.2	5.2
3⅛	7.5	5.0	12.0	4.0	6.4
3⅝	9.0	5.9	15.0	4.7	7.3
4⅛	10.0	6.7	17.0	5.2	8.5

Liquid Line Sizing

The liquid line diameter should be as small as possible while maintaining acceptable pressure drop. This is necessary to minimize refrigerant charge. The total length between the chiller unit and the air-cooled condenser must not exceed 200 actual feet or 300 equivalent feet. It is best to pipe the liquid line so that there is an immediate drop of at least 15 inches at the condenser outlets to make a liquid seal.

Liquid line risers in the system will require an additional 0.5 psig pressure drop per foot of vertical rise. When it is necessary to have a liquid line riser, make the vertical run immediately after the condenser before any additional restrictions. The liquid line risers must not exceed 10 feet in height from the condenser liquid line connection. The liquid line does not require pitching. Install a pressure tap valve at the condenser to facilitate measuring pressure for service.

Liquid lines do not typically require insulation. However, if exposing the lines to solar heat gain or temperatures exceeding 110 °F, there is a negative effect on sub-cooling. In these situations, insulate the liquid lines.

Table 2 – Liquid Line Sizes for R410A

5 Ton Circuit (R410A) Liquid Line Size (Inch OD)					7½ Ton Circuit (R410A) Liquid Line Size (Inch OD)				
Equivalent Length (Ft)	Horizontal or Down Flow	Up Flow (Feet of Run)			Equivalent Length (Ft)	Horizontal or Down Flow	Up Flow (Feet of Run)		
		0 to 5	6 to 10	11 to 15			0 to 5	6 to 10	11 to 15
25	½	½	½	½	25	⅝	⅝	⅝	⅝
50	½	½	½	½	50	⅝	⅝	⅝	⅝
75	½	½	½	½	75	⅝	⅝	⅝	⅝
100	½	½	½	¾	100	⅝	⅝	⅝	⅝
125	½	½	½	⅝	125	⅝	⅝	⅝	¾
150	½	½	⅝	⅝	150	⅝	⅝	⅝	¾
175	½	⅝	⅝	⅝	175	⅝	⅝	⅝	¾
200	½	⅝	⅝	⅝	200	⅝	⅝	⅝	¾
225	⅝	⅝	⅝	⅝	225	⅝	⅝	⅝	¾
250	⅝	⅝	⅝	⅝	250	⅝	⅝	¾	¾
275	⅝	⅝	⅝	⅝	275	⅝	⅝	¾	¾
300	⅝	⅝	⅝	⅝	300	⅝	⅝	¾	¾
10 Ton Circuit (R410A) Liquid Line Size (Inch OD)					**15 Ton Circuit (R410A) Liquid Line Size (Inch OD)**				
Equivalent Length (Ft)	Horizontal or Down Flow	Up Flow (Feet of Run)			Equivalent Length (Ft)	Horizontal or Down Flow	Up Flow (Feet of Run)		
		0 to 5	6 to 10	11 to 15			0 to 5	6 to 10	11 to 15
25	⅝	⅝	⅝	¾	25	⅞	⅞	⅞	⅞
50	⅝	⅝	¾	¾	50	⅞	⅞	⅞	⅞
75	⅝	⅝	¾	¾	75	⅞	⅞	⅞	⅞
100	⅝	¾	¾	¾	100	⅞	⅞	⅞	1⅛
125	¾	¾	¾	⅞	125	⅞	⅞	⅞	1⅛
150	¾	¾	¾	⅞	150	⅞	⅞	⅞	1⅛
175	¾	¾	¾	⅞	175	⅞	⅞	⅞	1⅛
200	¾	¾	¾	⅞	200	⅞	⅞	⅞	1⅛
225	¾	¾	¾	⅞	225	⅞	⅞	⅞	1⅜
250	¾	¾	¾	⅞	250	⅞	⅞	⅞	1⅜
275	¾	¾	¾	1⅛	275	⅞	⅞	⅞	1⅜
300	⅞	⅞	⅞	1⅛	300	⅞	⅞	⅞	1⅜
20 Ton Circuit (R410A) Liquid Line Size (Inch OD)					**25 Ton Circuit (R410A) Liquid Line Size (Inch OD)**				
Equivalent Length (Ft)	Horizontal or Down Flow	Up Flow (Feet of Run)			Equivalent Length (Ft)	Horizontal or Down Flow	Up Flow (Feet of Run)		
		0 to 5	6 to 10	11 to 15			0 to 5	6 to 10	11 to 15
25	⅞	⅞	⅞	1⅛	25	1⅛	1⅛	1⅛	1⅛
50	⅞	⅞	⅞	1⅛	50	1⅛	1⅛	1⅛	1⅛
75	⅞	⅞	⅞	1⅛	75	1⅛	1⅛	1⅛	1⅛
100	⅞	⅞	1⅛	1⅛	100	1⅛	1⅛	1⅛	1⅜
125	⅞	⅞	1⅛	1⅛	125	1⅛	1⅛	1⅛	1⅜
150	⅞	1⅛	1⅛	1⅜	150	1⅛	1⅛	1⅛	1⅜
175	⅞	1⅛	1⅛	1⅜	175	1⅛	1⅛	1⅛	1⅜
200	1⅛	1⅛	1⅛	1⅜	200	1⅛	1⅛	1⅛	1⅜
225	1⅛	1⅛	1⅛	1⅜	225	1⅛	1⅛	1⅜	1⅜
250	1⅛	1⅛	1⅛	1⅜	250	1⅛	1⅛	1⅜	1⅜
275	1⅛	1⅛	1⅛	1⅜	275	1⅛	1⅛	1⅜	1⅜
300	1⅛	1⅛	1⅛	1⅜	300	1⅛	1⅛	1⅜	1⅜

Table 2 – Liquid Line Sizes for R410A (continued)

30 Ton Circuit (R410A) Liquid Line Size (Inch OD)				
Equivalent Length (Ft)	Horizontal or Down Flow	Up Flow (Feet of Run)		
		0 to 5	6 to 10	11 to 15
25	1⅛	1⅛	1⅛	1⅛
50	1⅛	1⅛	1⅛	1⅛
75	1⅛	1⅛	1⅛	1⅛
100	1⅛	1⅛	1⅛	1⅛
125	1⅛	1⅛	1⅛	1⅛
150	1⅛	1⅛	1⅛	1⅛
175	1⅛	1⅛	1⅛	1⅛
200	1⅛	1⅛	1⅛	1⅛
225	1⅛	1⅛	1⅛	1⅛
250	1⅛	1⅛	1⅛	1⅛
275	1⅛	1⅛	1⅛	1⅛
300	1⅛	1⅛	1⅛	1⅜

35 Ton Circuit (R410A) Liquid Line Size (Inch OD)				
Equivalent Length (Ft)	Horizontal or Down Flow	Up Flow (Feet of Run)		
		0 to 5	6 to 10	11 to 15
25	1⅛	1⅛	1⅛	1⅛
50	1⅛	1⅛	1⅛	1⅛
75	1⅛	1⅛	1⅛	1⅛
100	1⅛	1⅛	1⅛	1⅛
125	1⅛	1⅛	1⅛	1⅛
150	1⅛	1⅛	1⅛	1⅛
175	1⅛	1⅛	1⅛	1⅜
200	1⅛	1⅛	1⅛	1⅜
225	1⅛	1⅛	1⅛	1⅜
250	1⅛	1⅛	1⅜	1⅜
275	1⅛	1⅛	1⅜	1⅜
300	1⅛	1⅛	1⅜	1⅜

40 Ton Circuit (R410A) Liquid Line Size (Inch OD)				
Equivalent Length (Ft)	Horizontal or Down Flow	Up Flow (Feet of Run)		
		0 to 5	6 to 10	11 to 15
25	1⅛	1⅛	1⅛	1⅛
50	1⅛	1⅛	1⅛	1⅜
75	1⅛	1⅛	1⅛	1⅜
100	1⅛	1⅛	1⅜	1⅜
125	1⅛	1⅛	1⅜	1⅜
150	1⅛	1⅜	1⅜	1⅝
175	1⅛	1⅜	1⅜	1⅝
200	1⅜	1⅜	1⅜	1⅝
225	1⅜	1⅜	1⅜	1⅝
250	1⅜	1⅜	1⅝	2⅛
275	1⅜	1⅜	1⅝	2⅛
300	1⅜	1⅜	1⅝	2⅛

Discharge (Hot Gas) Line Sizing

The discharge line sizes depend on the velocity needed to obtain sufficient oil return. It is very important to minimize line length and restrictions to reduce pressure drop and maximize capacity.

Upflow hot gas risers need to have a trap at the bottom and reverse trap at the top. In addition, a trap and reverse trap arrangement needs to be spaced every 15 feet in the rise for oil management (see Figure 7).

The discharge lines should pitch downward, in the direction of the hot gas flow, at the rate of ½ inch per each 10 foot of horizontal run. If the chiller unit is below the condenser, loop the discharge line to at least 1 inch above the top of the condenser. Install a pressure tap valve at the condenser to facilitate measuring pressure for service. Take careful consideration in the design of the discharge gas riser.

Check the oil-level sight glass in the compressor to ensure it is at the appropriate level to verify there is no trapping of oil in the piping. The chiller is equipped with hot-gas bypass capacity control and the gas in the upflow discharge lines may have problems moving the oil against gravity when completely unloaded if a single rise system is used. We recommend a double riser system to ensure proper oil return under low load operation. See Figure 8 and Table 4 for double riser constructions.

Figure 7 – Vertical Riser Traps

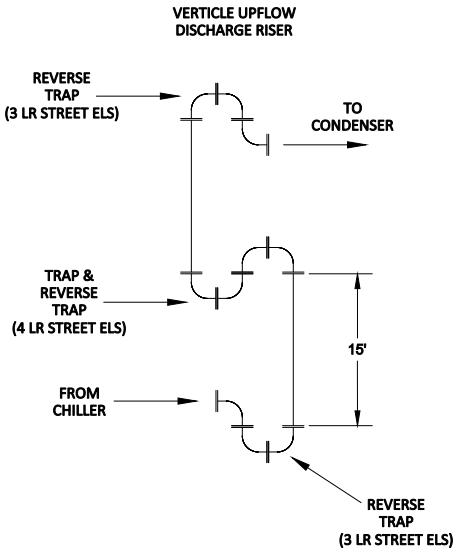
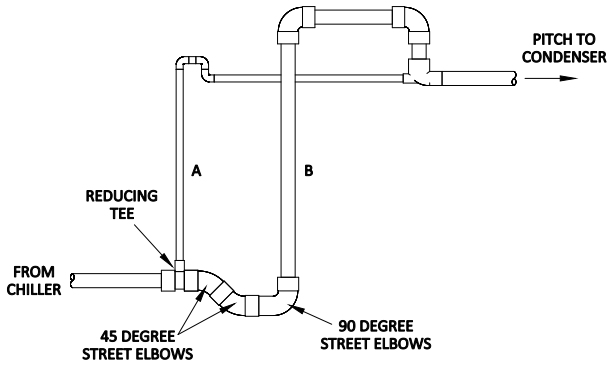


Figure 8 - Double Discharge Riser



Note: Discharge line sizing shown in Table 3 and Table 4 are listed per circuit and apply where leaving water temperature (LWT) is 40°F or higher. For applications where LWT is below 40°F, size lines using the ASHRAE Refrigeration Handbook or other suitable design guide.

Table 3 - Horizontal or Downflow Discharge Line Sizes for R410A (inches OD)

Circuit Tons	Total Equivalent Length (Ft)											
	25	50	75	100	125	150	175	200	225	250	275	300
5	⅝	⅝	⅝	⅝	¾	¾	¾	¾	¾	¾	¾	⅞
7½	⅞	⅞	⅞	⅞	⅞	⅞	⅞	⅞	⅞	⅞	⅞	⅞
10	⅞	⅞	⅞	⅞	⅞	⅞	⅞	1⅛	1⅛	1⅛	1⅛	1⅛
15	⅞	⅞	1⅛	1⅛	1⅛	1⅛	1⅛	1⅛	1⅛	1⅛	1⅜	1⅜
20	⅞	1⅛	1⅛	1⅜	1⅜	1⅜	1⅜	1⅜	1⅜	1⅜	1⅝	1⅝
25	1⅛	1⅛	1⅛	1⅛	1⅜	1⅜	1⅜	1⅜	1⅜	1⅜	1⅝	1⅝
30	1⅛	1⅛	1⅛	1⅜	1⅜	1⅜	1⅜	1⅜	1⅜	1⅝	1⅝	1⅝
35	1⅜	1⅜	1⅜	1⅝	1⅝	1⅝	1⅝	2⅛	2⅛	2⅛	2⅛	2⅛
40	1⅝	1⅝	1⅝	1⅝	1⅝	1⅝	2⅛	2⅛	2⅛	2⅛	2⅛	2⅛

Table 4 - Upflow Discharge Line Sizes for R410A (inches OD)

Circuit Tons	Total Equivalent Length (Ft)											
	25	50	75	100	125	150	175	200	225	250	275	300
5	A - ⅜ B - ½	A - ⅜ B - ½	A - ⅜ B - ½	A - ⅜ B - ½	A - ⅜ B -⅝	A - ⅜ B -⅝	A - ⅜ B -⅝	A - ⅜ B -⅝	A - ⅜ B -⅝	A - ⅜ B -⅝	A - ⅜ B -⅝	A - ⅜ B - ¾
7½	A - ⅜ B - ¾	A - ⅜ B - ¾	A - ⅜ B - ¾	A - ⅜ B - ¾	A - ⅜ B - ¾	A - ⅜ B - ¾	A - ⅜ B - ¾	A - ⅜ B - ¾	A - ⅜ B - ¾	A - ⅜ B - ¾	A - ⅜ B - ¾	A - ⅜ B - ¾
10	A - ⅜ B - ¾	A - ⅜ B - ¾	A - ⅜ B - ¾	A - ⅜ B - ¾	A - ⅜ B - ¾	A - ⅜ B - ¾	A - ⅜ B - ¾	A - ⅜ B - ⅞	A - ⅜ B - ⅞	A - ⅜ B - ⅞	A - ⅜ B - ⅞	A - ⅜ B - ⅞
15	A - ⅜ B - ¾	A - ⅜ B - ¾	A - ⅜ B - ⅞	A - ⅜ B - ⅞	A - ⅜ B - ⅞	A - ⅜ B - ⅞	A - ⅜ B - ⅞	A - ⅜ B - ⅞	A - ⅜ B - ⅞	A - ⅜ B - ⅞	A - ½ B - 1⅛	A - ½ B - 1⅛
20	A - ⅜ B - ¾	A - ⅜ B - ⅞	A - ⅜ B - ⅞	A - ½ B - 1⅛	A - ½ B - 1⅛	A - ½ B - 1⅛	A - ½ B - 1⅛	A - ½ B - 1⅛	A - ½ B - 1⅛	A - ½ B - 1⅛	A - ⅝ B - 1⅜	A - ⅝ B - 1⅜
25	A - ⅜ B - ⅞	A - ⅜ B - ⅞	A - ⅜ B - ⅞	A - ½ B - 1⅛	A - ½ B - 1⅛	A - ½ B - 1⅛	A - ½ B - 1⅛	A - ½ B - 1⅛	A - ½ B - 1⅛	A - ½ B - 1⅛	A - ⅝ B - 1⅜	A - ⅝ B - 1⅜
30	A - ½ B - ⅞	A - ½ B - ⅞	A - ½ B - ⅞	A - ¾ B - 1⅛	A - ¾ B - 1⅛	A - ¾ B - 1⅛	A - ¾ B - 1⅛	A - ¾ B - 1⅛	A - ¾ B - 1⅛	A - ¾ B - 1⅜	A - ¾ B - 1⅜	A - ¾ B - 1⅜
35	A - ¾ B - 1⅛	A - ¾ B - 1⅛	A - ¾ B - 1⅛	A - ¾ B - 1⅜	A - ¾ B - 1⅜	A - ¾ B - 1⅜	A - ¾ B - 1⅜	A - ¾ B - 1⅝	A - ¾ B - 1⅝	A - ¾ B - 1⅝	A - ¾ B - 1⅝	A - ¾ B - 1⅝
40	A - ¾ B - 1⅜	A - ¾ B - 1⅜	A - ¾ B - 1⅜	A - ¾ B - 1⅜	A - ¾ B - 1⅜	A - ¾ B - 1⅜	A - ¾ B - 1⅝	A - ¾ B - 1⅝	A - ¾ B - 1⅝	A - ¾ B - 1⅝	A - ¾ B - 1⅝	A - ¾ B - 1⅝

Calculating Refrigerant and Oil Charge

To determine the approximate charge, first refer to Table 5 and establish the required charge for the condenser and chiller. Then refer to Table 6 to determine the charge required for the field-installed piping per circuit. The approximate charge per circuit is therefore the sum of the values from Table 5 and Table 6.

Table 5 – Combined Chiller and Remote Condenser Summer Refrigerant Charge

Circuit Capacity (tons)	Refrigerant Charge (lbs)
5	7.6
7½	11.1
10	15.3
15	22.2
20	30.2
25	37.2
30	44.3
35	51.9
40	59.4

Table 6 - Field Piping R-410A Refrigerant Charges

Line Size OD (inches)	Discharge Line (Lbs/100′ run)	Liquid Line (Lbs/100′ run)
⅜	0.4	3.7
½	0.7	6.8
⅝	1.1	11
¾	1.6	16.4
⅞	2.2	22.8
1⅛	3.6	36.7
1⅜	5.6	57.4
1⅝	7.9	81.2
2⅛	13.9	142.1
2⅝	21.4	219.5

Oil Charge Determination

The chiller is factory charged with the amount of oil required by the chiller only and not the total system. The amount of oil required is dependent upon the amount of refrigerant added to the system for the field-installed piping. Use the following to determine the amount of oil needed for the system.

Pints of Oil = Pounds of refrigerant in system / 100

Oil level should be checked after the chiller has run for 15 minutes.

Setting Condenser Fan Controls

Depending on the number of condenser fans present there will be different fan cycling pressure control setting requirements. It is important that these settings be correct in order to maintain proper capacity control and operation of the system. Each refrigerant circuit has a separate head-pressure control circuit. Refer to Table 7 for the proper pressure settings.

Table 7 - Condenser Fan Pressure Settings (psig)

Stage Number	Setting	Number of Fan Stages			
		1	**2**	**3**	**4**
Stage 1	Max Speed	410	410	410	410
	Min Speed	320	320	320	320
Stage 2	Fan On		400	400	370
	Fan Off		340	340	305
Stage 3	Fan On			435	385
	Fan Off			375	325
Stage 4	Fan On				400
	Fan Off				340

Installation - Electrical

All wiring must comply with local codes and the National Electric Code. Minimum circuit amps (MCA) and other unit electrical data are on the unit nameplate. A unit specific electrical schematic ships with the unit. Measure each leg of the main power supply voltage at the main power source. Voltage must be within the voltage utilization range given on the drawings included with the unit. If the measured voltage on any leg is not within the specified range, notify the supplier and correct before operating the unit. Voltage imbalance must not exceed two percent. Excessive voltage imbalance between the phases of a three-phase system can cause motors to overheat and eventually fail. Voltage imbalance is determined using the following calculations:

%Imbalance = (Vavg – Vx) x 100 / Vavg

Vavg = (V1 + V2 + V3) / 3

Vx = phase with greatest difference from Vavg

For example, if the three measured voltages were 442, 460, and 454 volts, the average would be:

(442 + 460 + 454) / 3 = 452

The percentage of imbalance is then:

(452 – 442) x 100 / 452 = 2.2 %

This exceeds the maximum allowable of 2%.
There is a terminal block for main power connection to the main power source. The main power source should be connected to the terminal block through

an appropriate disconnect switch. There is a separate lug in the main control panel for grounding the unit. Check the electrical phase sequence at installation and prior to start-up. Operation of the compressor with incorrect electrical phase sequencing will result in mechanical damage to the compressors. Check the phasing with a phase sequence meter prior to applying power. The proper sequence should read "ABC" on the meter. If the meter reads "CBA", open the main power disconnect and switch two line leads on the line power terminal blocks (or the unit mounted disconnect). Do not interchange any load leads that are from the unit contactors or the motor terminals.

WARNING: This equipment contains hazardous voltages that can cause severe injury or death.

WARNING: This equipment contains refrigerant under pressure. Accidental release of refrigerant under pressure can cause personal injury and or property damage.

WARNING: This equipment may contain fan blades or other sharp edges. Make sure all fan guards and other protective shields are securely in place.

WARNING: The exposed surfaces of motors, refrigerant piping, and other fluid circuit components can be very hot and can cause burns if touched with unprotected hands.

CAUTION: Disconnect and lock out incoming power before installing, servicing, or maintaining the equipment. Connecting power to the main terminal block energizes the entire electric circuitry of the unit. A power supply provides 24 VDC control power. Electric power at the main disconnect should be shut off before opening access panels for repair or maintenance.

CAUTION: Wear eye protection when installing, maintaining, or repairing the equipment to protect against any sparks, debris, or fluid leaks.

CAUTION: Wear protective gloves when installing, maintaining, or repairing the equipment to protect against any sparks, debris, or fluid leaks.

CAUTION: Ground the unit properly in compliance with local and national codes.

CAUTION: The unit requires the main power to remain connected during off-hours to energize the compressor's crankcase heater. Disconnect main power only when servicing the chiller. The crankcase heater should remain on when the compressor is off to ensure liquid refrigerant does not accumulate in the compressor crankcase. Connect main power at least 24 hours prior to initial start-up.

Standard Controller Operation

The chiller includes a controller to perform all control functions directly from the front panel. When Control Power is applied, the controller initiates a diagnostic test of each indicating light and display segments by briefly lighting each sequentially. As part of this initial diagnostic test, the program revision level displays for a moment. After the initial diagnostic sequence is completed, the controller is ready for operation.

Operating Buttons

Button	Description of Operation
Start	Depressing the Start button will start the pump and enable the compressor. The compressor (and condenser fans if the chiller is air-cooled) will start only if the microprocessor is calling for cooling because the actual To Process temperature is higher than the Set Point temperature. If the Autostart feature is enabled the Autostart signal will have precedence over the Start Button. See the Program Menu section for instructions on how to enable or disable the Autostart feature. The Start button also performs an "Enter" function while in the programming menu.
Stop	Depressing the Stop button will shut off the compressor, pump, condenser fans (if the chiller is air-cooled), and clear all fault signals. If the Autostart feature is enabled and an Autostart signal is present, the Stop button will not stop the chiller. See the Program Menu section for instructions on how to enable or disable the Autostart feature. The Start button also performs a "Cancel" function while in the programming menu.
Alarm Silence / Alarm Reset	When an alarm condition is present, the alarm light is on and red. The first Alarm Silence/Reset button press will silence the alarm horn (optional), open the remote alarm contact (optional), and the alarm light changes from red to yellow. The alarm horn and/or remote alarm contact remain disabled until a subsequent alarm occurs. A second press of the Alarm Silence/Reset button resets the state from Alarm to Normal Operation. The High Refrigerant Pressure and Pump Overload require a mechanical safety manual reset before the control board reset. If the fault is still present, the unit will immediately go into a new alarm state.
Compressor Running Hours	Press and hold the Compressor Running Hours Button to display the amount of time that each compressor in the system has run. The Set Point window will show which compressor's usage is being displayed (for units with two compressors). The running hours show in the process display window. Display of running hours is in units of hundreds so a display value of 10 would mean 1,000 hours. The running hours show while holding the button. For units with two compressors, the display will toggle between the two compressors every three seconds. The hours show while holding the button. Control is not disturbed while displaying the running hours.
Pump Running Hours	Press and hold the Pump Running Hours Button to display the amount of time the pump has run. The running hours show in the process display window. Display of running hours is in units of hundreds so a display value of 10 would mean 1,000 hours. The running hours will show while holding the button. Control is not disturbed while displaying the pump running hours.
Pump Test	With the chiller stopped, pressing this button briefly engages the pump to test its operation. The pump will not run if there are any active alarms. The pump shuts down by either pressing the Stop button or pressing the Pump Test button a second time. The pump will shut down after one minute of operation.
Display/Program	The Display/Program button will change the temperature displayed in the Process screen from Supply to Return. When the display is set to supply temperature, there will be an orange indicating light in the lower right corner of the Process temperature display. When the display is set to return temperature, there will be no orange indicating light in the lower right corner of the Process temperature display. To toggle the process temperature display from supply to return temperature, press and release the Display/Program button. The display will return to the default Supply temperature automatically after 5 seconds without a button press. In addition to switching between the supply and return process temperature displays, the Display/Program button will initiate and navigate through the program menu. See the Program Menu section for more detail.
Up	The Up button raises the set point temperature. Pressing the Up button and releasing it increases the set point temperature by one degree. Pressing the Up button and holding it increases the set point temperature until reaching the maximum allowable set point temperature. In addition to adjusting the set point temperature, the Up button adjusts various alarms and set point values when the unit in the programming mode.
Down	The Down button decreases the set point temperature. Pressing the Down button and releasing it decreases the set point temperature by one degree. Pressing the Down button and holding it decreases the set point temperature until reaching the minimum allowable set point temperature. In addition to adjusting the set point temperature, the Down button adjusts various alarms and set point values when the unit is in the programming mode.

Temperature Displays

Display	Description of Operation
Set Point	The Set Point display normally shows the set point temperature. A decimal point in the lower right corner of this display indicates the temperature unit of measure is set to °F, no decimal point indicates the temperature unit of measure is set to °C. See the Program Menu section to change the temperature scale units of measure. This display also shows alarm codes and programming information.
Process	The Process Temperature display normally shows supply temperature. A decimal point in the lower right corner of the display indicates the temperature displayed is the supply temperature, no decimal point indicates the temperature displayed is the return temperature. To change the display from supply to return temperature, press and release the Display/Program button. The display will return to the default Supply temperature automatically after 5 seconds without a button press. This display also shows alarm codes and programming information.

Operating Lights

Light	Description of Operation
Control Power	The Control Power light is green when 24VDC control voltage is present.
Autostart Signal	The Autostart Signal light is green when closed (run), yellow when open (stop), and unlit if this feature is disabled. This feature allows starting and stopping of the unit by a remote contact closure. From the factory, the Autostart feature is disabled. See the Program Menu section for instructions on how to enable or disable the Autostart feature. ***Do not introduce any external voltage to the Autostart contacts, as this will result in damage to the controller.***
Pump	The Pump light is solid green when the pump is running and flashes red if the pump motor overload trips.
Hot Gas Bypass	The Hot Gas Bypass light will pulse or light solidly when the chiller is operating at partial load and the hot gas bypass valve opens. The light stays on for longer periods of time when the chiller is under smaller loads. If the light stays off the chiller is under full load. If the light stays on the chiller is fully unloaded. If this condition persists, the To Process temperature may begin to drop below the Set Point temperature, eventually cycling off compressor(s).
Compressor #1	The Compressor #1 light is solid green when Compressor #1 is running, flashes red if a compressor overload or fault occurs, and is solid red if the controller is attempting to start the compressor before the anti-recycle timer has timed out. Compressor #1 is enabled when the temperature of the coolant leaving the chiller rises above the Set Point by an amount equal to the control parameter PS1 (Compressor #1 Positive Spread). PS1 is equal to 2 °F by default. The compressor is disabled if the temperature of the coolant leaving the chiller drops below the Set Point by an amount equal to the control parameter nS1 (Compressor #1 Negative Spread). The parameter nS1 is set to 4 °F by default. See the Program Menu section for instructions on how to adjust PS1 and nS1.
Compressor #2	The Compressor #2 light is solid green when Compressor #2 is running, flashes red if a compressor overload or fault occurs, and is solid red if the controller is attempting to start the compressor before the anti-recycle timer has timed out. Compressor #2 is enabled when the temperature of the coolant leaving the chiller rises above the Set Point by an amount equal to the control parameter PS2 (Compressor #2 Positive Spread). PS2 is equal to 3 °F by default. The compressor is disabled if the temperature of the coolant leaving the chiller drops below the Set Point by an amount equal to the control parameter nS2 (Compressor #2 Negative Spread). The parameter nS2 is set to 5 °F by default. See the Program Menu section for instructions on how to adjust PS2 and nS2.
Temperature Limit	The Temperature Limit light flashes yellow if a high or low temperature limit warning occurs and flashes red if a high or low temperature limit safety occurs. A temperature limit safety stops all compressors and pumps. Pushing the Alarm Reset button will reset this alarm.
Electrical Phase Error	The Electrical Phase Error light flashes red when a line voltage problem exists (loss of phase, phase reversal, or phase imbalance). This safety stops all compressors and pumps. Pushing the Alarm Reset button will reset this alarm.
Low Flow	The Low Flow light is red if the flow through the chiller is too low. This safety is defeated for 5 seconds after starting the chiller to allow the pump to establish flow. This safety stops all compressors and pumps. Pressing the Start button resets the safety and restarts the chiller.
Freezestat	The Freezstat light is red if the coolant leaving the chiller drops below the Freezestat Limit (FLS) setting. This safety stops all compressors but allows pumps to continue running. Set the Freezestat Limit 10°F above the freezing point of the coolant in the chiller. The Freezestat is factory set at 38°F. Pressing the Alarm Reset button resets the Freezestat fault if the coolant temperature has risen 5°F above the Freezestat Limit. See the Program Menu section for instructions on how to adjust FLS.
Reservoir Level	The Low Reservoir Level light is red when the water level in the reservoir drops below the lower limit of the float switch. This safety stops all compressors and pumps. Pressing the Alarm Reset button resets the Low Reservoir Level fault if the coolant level in the reservoir has risen about the lower limit of the float switch.
Compressor Recycle	The Compressor Recycle light is yellow when the number of compressor starts per hour exceeds the number allowed. This limit maximizes compressor life and ensures proper return of oil to the compressor crankcase. This light is illuminated yellow whenever there is a wait period before a compressor can start.
High Refrig Pressure	The High Refrigerant Pressure light is red when the compressor discharge refrigerant pressure exceeds the setting of the high refrigerant pressure safety. This safety stops all compressors but allows pumps to continue running. Pressing the Alarm Reset button resets the fault if the compressor discharge refrigerant pressure is less than the setting of the high refrigerant pressure safety.
Low Refrig Pressure	The Low Refrigerant Pressure light is red when the compressor suction pressure drops below the setting on the low refrigerant pressure safety. This safety sops all compressors but allows pumps to continue running. Pressing the Alarm Reset button resets the fault if the compressor suction pressure is above the setting of the low refrigerant pressure safety.
Program Mode	The Program Mode LED flashes yellow when the control system is in the programming menu.

Program Menu

The program menu is password protected to prevent unintended alteration to the program settings and parameters. The unit must be in a stopped state for menu access.

To enter the password press and hold the Display/Program button for 5 seconds. The Program Mode light flashes yellow, the Set Point display shows “000”, and the Process display shows “PAS”. The unit is now ready to have the password entered. Use the up and down arrows to change the number to the correct password and press the Start button to enter. The default password is “000”.

If the password entered is incorrect, the Set Point displays “no” and the Process display shows "PAS" for 5 seconds and then waits for another attempt to enter the correct password. If no activity occurs for 5 seconds, the controller exits the programming mode and returns to the Stopped state.

Once in the program menu, use the Display/Program button to scroll through the different adjustable parameter as shown in Table 8.

To change an item, press the Display/Program button until the item code displays in the Process display. Pressing the Alarm Reset button and Display/Program button at the same time reverses the direction the Display/Program button indexes through the menu items. Once the desired menu item code is shown in the Process display, use the Up and Down arrow buttons to adjust the value shown in the Set Point display until the desired value shows. Press the Start button to enter the new value. Press the Stop button to cancel and revert to the previous value.

There is a Master Reset function to restore all User menu parameters to their factory default values. The unit must be in a stopped state for this function to work. To initiate a Master Reset press and hold the Alarm Silence/Reset button and Stop button simultaneously for 10 consecutive seconds until “PRG” shows on the Set Point display and "RSt" shows on the Process display. Release all buttons and press the Start button within 10 seconds. Failure to push the Start button within 10 seconds aborts the Master Reset.

Table 8 - Controller Program Menu

Item Name	Item Code	Default Value	Range
Alarm Delay - High Deviation	AdH	30	10 to 60
Alarm Delay - Low Deviation	AdL	30	10 to 60
Autostart Enabled	ASE	DIS	Disabled (DIS) or Enabled (EnA)
Brownout Enabled	brn	EnA	Disabled (DIS) or Enabled (EnA)
Comm Baud Rate	bAU	96	12 to 96
Comm Modbus ID	id	1	1 to 247
Comm SPI Address	SPA	32	32 to 63
Communications Type	COt	OFF	OFF, Retransmit (rEt), SPI (SPI) or ModBus (bUS)
Compressor 1 Negative Spread	nS1	4	1 to 10
Compressor 1 Positive Spread	PS1	2	1 to 10
Compressor 2 Enabled	CO2	DIS	Disabled (DIS) or Enabled (EnA)
Compressor 2 Negative Spread	nS2	5	1 to 10
Compressor 2 Positive Spread	PS2	3	1 to 10
Derivative	dEr	3	0 to 200
Display Units	Unt	F	F to C
Freezestat Limit	FSL	40	-50 to 40
High Deviation Alarm Limit	HId	10	5 to 100
Integral	Int	25	1 to 800
Low Deviation Alarm Limit	Lod	10	5 to 100
Proportional Band	bnd	8	1 to 300
Remote Setpoint High Limit	rSH	65	Between rSL and 999
Remote Setpoint Low Limit	rSL	20	Between -99 and rSH
Remote SP Enabled	rSE	DIS	Disabled (DIS) or Enabled (EnA)
Retransmit Range High	rEH	150	Between 999 and rEL
Retransmit Range Low	rEL	0	Between -99 and rEH
User High Safety Limit	HSU	140	Between factory low and high limits
User Low Safety Limit	LSU	10	Between factory low and high limits
User Password	UPA	000	0 to 999

Table 9 – Controller Control Fault Logic

Fault[1]	Alarm Indication	Component Shut-Off		Required Resets	
		Pump	Compressor	Panel[2]	Sensor[3]
Low Reservoir Level	Reservoir Level Light flashes red	Yes	Yes	Yes	Yes
Temperature Limit Safety	Set Point and Process Temperatures Flash, Temperature Limit Light flashes red	Yes	Yes	Yes	No
Temperature Limit Warning	Temperature Limit Light flashes yellow	No	No	Yes	No
Pump Motor Overload	Pump Light flashes red	Yes	Yes	Yes	Yes
Compressor Motor Overload	Compressor Light flashes red	No	Yes	Yes	No
High Refrigerant Pressure	High Refrig Pressure Light flashes red	No	Yes	Yes	Yes
Low Refrigerant Pressure	Low Refrig Pressure Light flashes red	No	Yes	Yes	No
Low Evaporator Temperature	Freezestat Light flashes red	No	Yes	Yes	No
Supply Probe Fault Hi	Set Point Temperature Display shows PRS, Process Temperature Display shows EHi	Yes	Yes	Yes	No
Supply Probe Fault Lo	Set Point Temperature Display shows PRS, Process Temperature Display shows ELo	Yes	Yes	Yes	No
Return Probe Fault Hi	Set Point Temperature Display shows PRR, Process Temperature Display shows EHi	Yes	Yes	Yes	No
Return Probe Fault Lo	Set Point Temperature Display shows PRR, Process Temperature Display shows ELo	Yes	Yes	Yes	No
Freezestat Probe Fault Hi	Set Point Temperature Display shows PRF, Process Temperature Display shows EHi	Yes	Yes	Yes	No
Freezestat Probe Fault Lo	Set Point Temperature Display shows PRF, Process Temperature Display shows ELo	Yes	Yes	Yes	No
Brownout	Set Point Temperature Display shows Brn, Process Temperature Display shows Out	Yes	Yes	Yes	No
3-Phase Power Error	Electrical Phase Error list flashes red	Yes	Yes	Yes	No
Low Flow	Low Flow Light flashes red	Yes	Yes	No	No

[1] Activates the alarm horn and closes the alarm contact if the remote alarm contact option has been purchased.
[2] Alarm Silence/Reset button on control panel must be pressed.
[3] Safety control device must be manually reset before the controller can be reset.

SPI Communications (Optional)

Several members of SPI: The Plastics Industry Trade Association defined a communications standard to various pieces of plastic processing equipment to communicate. They chose to adopt the Serial Peripheral Interface bus (SPI bus) which coincidently has the same abbreviation as the trade association. To allow our unit to operate as a slave unit in a plastic processing system using this protocol, we offer an option that includes an expansion module for the control board and a RS-485 communication port on the unit. The communication hardware firmware is SPI 3.01 standard compliant.

Units ordered with this option will have this feature activated at the factory. If for some reason this feature is inactive it may be activated using the program menu Communication Type function as shown in Table 10. In addition to activating the communication type a baud rate and SPI address must be set. These are set using the Communication Baud Rate and SPI Address functions as shown.

If multiple pieces of equipment are going to be on the same SPI communications network, the base addresses of each machine has to be unique. The communication baud rate may also need adjustment.

Table 10 - SPI Parameters

Command	Poll	Select	Description
Echo	20 20	20 21	This is the controller integrity command used to accept and retain data and provide it in response to a poll inquiry. This is an open 4 byte ASCII format with ASCII units.
Version	20 22		This is the controller version command used to provide a version number following format: AABB, where AA = SPI assigned version level, BB = vendor assigned version level. This is in an open 4 byte ASCII format with ASCII units.
Setpoint Process Temperature	20 30	20 31	This is the temperature target for the supply coolant leaving the chiller. This is a numeric format in °F.
Alarm, High Temperature Deviation	20 32	20 33	This is the value in conjunction with the process setpoint that determines the high alarm temperature. This value must always be positive. This is a numeric format in °F.
Alarm, Low Temperature Deviation	20 34	20 35	This is the value in conjunction with the process setpoint that determines the low alarm temperature. This value must always be positive. This is a numeric format in °F.
Status, Process	20 40		This is the process status in a 16 bit format as follows: 0=Controlling 1 = An alarm is present 2 = An alarm affecting the process has occurred (high or low temperature deviation) 3 = An alarm affecting the machine has occurred (probe fault or pump fault) 4 = The controller has exceeded its over setpoint deviation 5 = The controller has exceeded its below setpoint deviation
Status, Machine 1	20 42		This is the machine status in a 16 bit format as follows: 0 = Controlling 1 = An alarm is present 2 = An alarm affecting the process has occurred (high or low temperature deviation) 3 = An alarm affecting the machine operation has occurred (probe fault or pump fault) 4 = The controller has exceeded its over setpoint deviation 5 = The controller has exceeded its below setpoint deviation
Status, Machine 2	20 44		This is the machine status in a 16 bit format as follows: 0 = Controlling 1 = An alarm is present 2 = An alarm affecting the process has occurred (high or low temperature deviation) 3 = A sensor error has been detected 4 = An alarm affecting the machine operation has occurred
Mode, Machine	20 48	20 40	This is the machine mode in two 8-bit bytes. When polling 20 48 bit 0 indicated the machine is off. 20 40 bit 0 commands the unit to be turned on or off (on when high or off when low), 20 40 bit 1 is used to recognized the alarm condition
Temperature, To Process (Supply)	20 70		Returns the process supply temperature. This is a numeric format in °F.
Temperature, To Process (Return)	20 72		Returns the process return temperature. This is a numeric format in °F.

Modbus RTU (Optional)

This option provides a RS-485 communications port for Modbus RTU communications. See Table 8 for details on how to enable this feature. Note the ModBus Parity = None, Stop Bits = 1, and default Baud Rate = 9,600.

Table 11 – Standard Controller Modbus RTU Option Parameters

Register	Description	Read/Write	Format	Notes
4002	Machine State	R	Integer	0 = Off 1 = Stop 2 = Run 3 = Run Fault 2 4 = Run Fault 3 5 = Fault 1 6 = Factory Menu 7 = User Menu 8 = Get User Password 9 = Master Reset
4007	Derivative	R/W	Integer	
4008	Integral	R/W	Integer	
4011	Low Alarm Delay	R	Integer	
4012	High Alarm Delay	R	Integer	
4013	Temperature Display Units	R	Integer	0 = °F, 1 = °C
4015	Brownout Enabled	R	Integer	0 = Disabled, 1 = Enabled
4024	Remote Setpoint Enabled	R	Integer	0 = Disabled, 1 = Enabled
4025	Autostart Enabled	R	Integer	0 = Disabled, 1 = Enabled
4027	Communication BAUD Rate	R/W	Integer	0 = 1200, 1 = 2400, 2 = 4800, 3 = 9600
4028	MODBUS Identification	R/W	Integer	
4030	SPI Communications Address	R/W	Integer	
4033	Compressor 2 Enabled	R	Integer	0 = Disabled, 1 = Enabled
4038	Hot Gas Bypass PID Output	R	Integer	-100 to 100 PID algorithm output
4039	MODBUS Command	R/W	Integer	0 = Do Nothing, 1 = Start, 2 = Stop
8000	Freezestat Temperature (°C)	R	Floating Point	Error Hi = 9.9E05, Error Low = -9.9E05
8002	Supply Fluid Temperature (°C)	R	Floating Point	Error Hi = 9.9E05, Error Low = -9.9E05
8004	Return Fluid Temperature (°C)	R	Floating Point	Error Hi = 9.9E05, Error Low = -9.9E05
8010	Low Temperature Deviation (°C)	R/W	Floating Point	
8012	High Temperature Deviation (°C)	R/W	Floating Point	
8014	Low Setpoint Limit Temperature (°C)	R	Floating Point	
8016	High Setpoint Limit Temperature (°C)	R	Floating Point	
8018	Supply Temperature Retransmit Range Low (°C)	R	Floating Point	
8020	Supply Temperature Retransmit Range High (°C)	R	Floating Point	
8022	Low Temperature Safety – User Set (°C)	R/W	Floating Point	
8024	High Temperature Safety – User Set (°C)	R/W	Floating Point	
8026	Proportional Band (°C)	R/W	Floating Point	
8052	Pump Running Hours	R	Floating Point	
8054	Setpoint Temperature (°C)	R/W	Floating Point	
8056	Low Temperature Safety – Factory Set (°C)	R	Floating Point	
8058	High Temperature Safety – Factory Set (°C)	R	Floating Point	
8060	Negative Compressor 1 Spread (°C)	R	Floating Point	
8062	Negative Compressor 2 Spread (°C)	R	Floating Point	
8064	Positive Compressor 1 Spread (°C)	R	Floating Point	
8066	Positive Compressor 2 Spread (°C)	R	Floating Point	
8068	Freezestat Limit Temperature (°C)	R	Floating Point	
8070	Supply Temperature Input Offset	R	Floating Point	
8072	Return Temperature Input Offset	R	Floating Point	
8074	Remote Setpoint Temperature Input Offset	R	Floating Point	
8078	Freezestat Temperature Input Offset	R	Floating Point	
8080	Remote Setpoint Limit Temperature (°C)	R	Floating Point	
8082	Remote Setpoint High Temperature Limit (°C)	R	Floating Point	
8110	Compressor 1 Running Hours	R	Floating Point	
8112	Compressor 2 Running Hours	R	Floating Point	

Note: All temperatures are in °C regardless of unit display configuration.

Optional PLC Operation

As an option, the chiller is available with a Programmable Logic Controller (PLC) and touch-screen operator interface display (this is standard control for chillers with the variable-speed compressor option, the NQV Series). There are a number of different screens for each option and configuration to allow for extensive monitoring and control of various aspects of the chiller operation. Due to the vast number of screens and variations possible, we have not attempted to capture all possible screens in this manual and instead have included some of main screens with some general comments. We are confident you will find the menus and items are straightforward and easy to understand and use.

Some screens are password protected to prevent unintended changes. There are two levels of passwords:

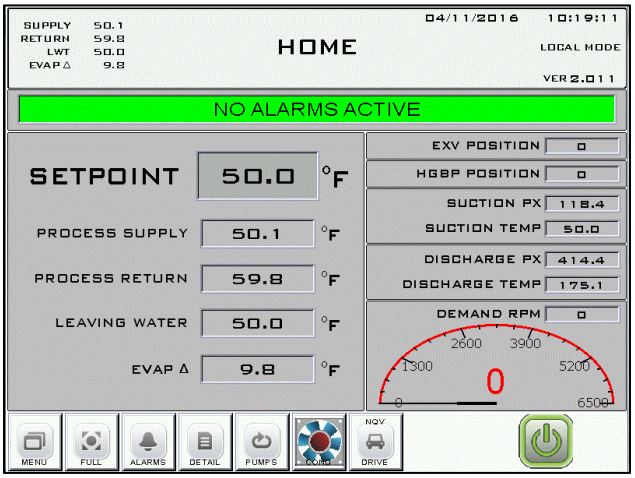
User Level Password	= 9999
Technician Level Password	= 7720

When navigating to a screen any areas that are user adjustable appear in a slightly different color or are sunken. Touching one of these areas brings up a keypad. Use the keypad to enter the appropriate password as shown above.

In most cases the user-level password is all that are needed for most common functions; however, there are a few screens protected with a technician-level password and we strongly recommend you refrain from making changes in these case unless you fully understand the impact as it may lead to improper or poor performance of the chiller. Please consult our Customer Service department for assistance if you have any question about changes impact before you make them.

If you suspect changes were made to parameters that caused poor or improper performance, there is a master reset function on Menu 2, which will allow you to restore the unit to factory default settings. When this is done you will need to follow the on-screen prompts to reconfigure the chiller based on the options present. For assistance with this process please contact the Customer Service Department and have the unit Serial Number ready for reference so they can pull up the details of your unit.

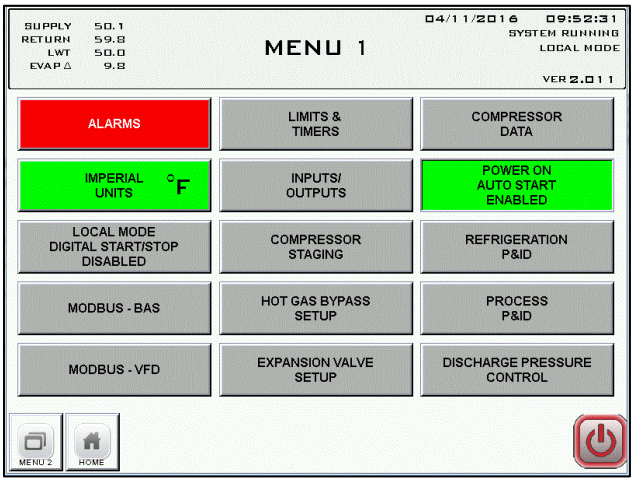
Home Screen



Note: This is an example of a NQVA10 with the most extensive set of options; your screen may appear slightly differently based on your actual chiller configuration.

When power is applied, you will see the main screen similar to the above. From the main screen, you can navigate to other screes and menus, each of which may have several sub-screens or menus depending on your chiller's configuration. The menu and screen buttons are located at the bottom of all screens. Touch any one of these to navigate to that menu or screen. For instance, touching the Menu 1 button at the bottom of the Home screen opens the Menu 1 Screen as shown below.

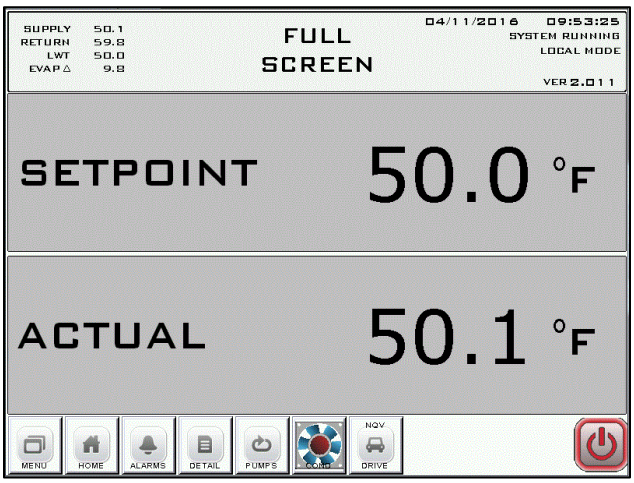
Menu 1 Screen



To return to the Home screen simply touch the Home button. Some screens have links to sub-screens or menus but all have a Home button to allow you to return to the Home screen.

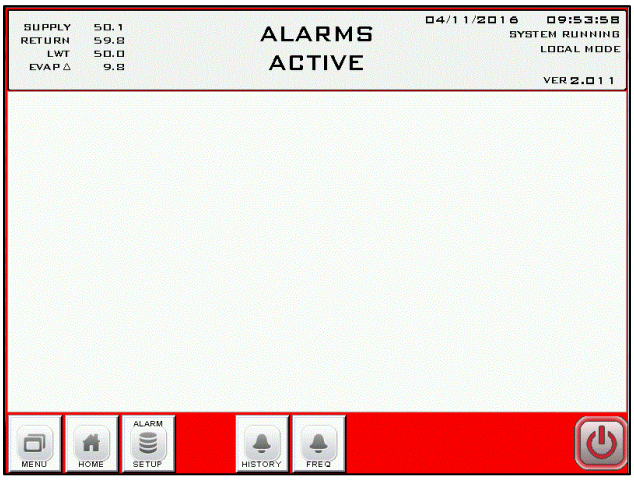
The most widely used monitoring data is the set point and actual temperatures. To allow for the largest possible display of these popular data points while removing unwanted data, we have created a Full Screen with just these data points shown. To get to this screen touch the Full Screen button located at the bottom of the Home screen.

Full Screen



If there is a warning or alarm condition, an alarm or warning will appear. Touch the Alarms button to view any active alarms.

Alarms Screen

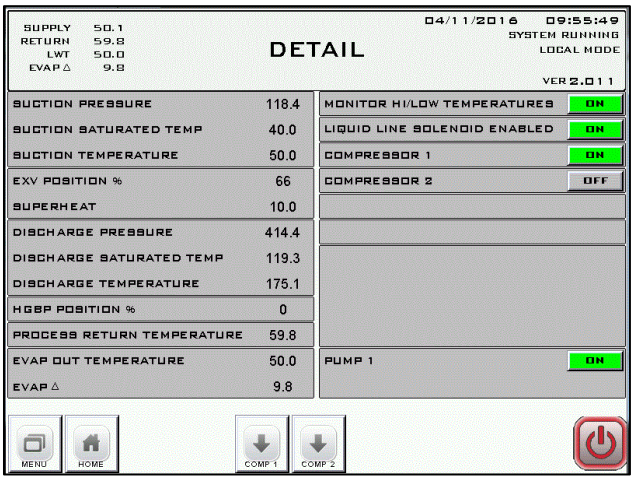


Note: The above shows there are no alarms; if an alarm condition were present, it would appear in this window.

At the bottom of the Alarms Screen there are buttons to allow for viewing alarm history, alarm frequency, as well as a button to allow access to any alarm set up screens available.

The last major screen is the Details screen, which shows in-depth information about the chiller operation as well as specifics for various components such as the compressor(s), fans, VFD, or other optional devices that may be present in the system.

Detail Screen



In the process of navigating through the various screens, you will find various menu and screen buttons appear at the bottom of the screen to allow quick access to related screens or menus. In all cases, there is a Home button to allow for quick and easy access to the main Home screen.

Modbus RTU (Optional)

As an option, the PLC controller is available with a Modbus output on the PLC. The Modbus default set up uses a Baud Rate of 57,600, Data Length of 8 bits, Odd Parity, and Stop Bit of 1, Com Port 1.

See Table 12 for the Modbus RTU parameters.

Table 12 – PLC Controller Modbus RTU Parameters

Modbus Register	Data Format	Data	Access Level	Description
3009	BOOL		Write	Modbus Start
3010	BOOL		Write	Modbus Stop
30001	WORD		Read	SYSTEM STATUS
	BOOL	Bit 0	Read	System Running
	BOOL	Bit 1	Read	Remote Mode
	BOOL	Bit 2	Read	Compressor 1 Enable
	BOOL	Bit 3	Read	Compressor 2 Enable
	BOOL	Bit 4	Read	Compressor 3 Enable
	BOOL	Bit 5	Read	Water Pump 1 Enable
	BOOL	Bit 6	Read	Water Pump 2 Enable
	BOOL	Bit 7	Read	Fan 1 Enable
	BOOL	Bit 8	Read	Fan 2 Enable
	BOOL	Bit 9	Read	Fan 3 Enable
	BOOL	Bit 10	Read	Fan 4 Enable
	BOOL	Bit 11	Read	Fan 5 Enable
	BOOL	Bit 12	Read	Fan 6 Enable
	BOOL	Bit 13	Read	Monitor High/Low
	BOOL	Bit 14	Read	NQV Option Enable
	BOOL	Bit 15	Read	System Stopping
30002	WORD		Read	SYSTEM ALARMS/WARNINGS
	BOOL	Bit 0	Read	Water Pump 1 Overload Alarm
	BOOL	Bit 1	Read	Tank Low Level Alarm
	BOOL	Bit 2	Read	Pump 1 Flow Alarm
	BOOL	Bit 3	Read	Freezestat Alarm
	BOOL	Bit 4	Read	High Supply Water
	BOOL	Bit 5	Read	Supply Water Sensor Alarm
	BOOL	Bit 6	Read	Evaporator Leaving Water Temperature Sensor Alarm
	BOOL	Bit 7	Read	High High Supply Water
	BOOL	Bit 8	Read	Low Supply Water Warning
	BOOL	Bit 9	Read	Low Low Supply Water Alarm
	BOOL	Bit 10	Read	High Refrigerant Pressure Alarm
	BOOL	Bit 11	Read	Low Refrigerant Pressure Alarm
	BOOL	Bit 12	Read	Modbus Fault
	BOOL	Bit 13	Read	Water Pump 2 Overload
	BOOL	Bit 14	Read	Fan 1 Overload Alarm
	BOOL	Bit 15	Read	Fan 2 Overload Alarm
30003	WORD		Read	SYSTEM ALARMS/WARNINGS
	BOOL	Bit 0	Read	Return Water High
	BOOL	Bit 1	Read	Return Water High High
	BOOL	Bit 2	Read	Suction Pressure Sensor Alarm
	BOOL	Bit 3	Read	Discharge Pressure Sensor Alarm
	BOOL	Bit 4	Read	Suciton Temperature Sensor Alarm
	BOOL	Bit 5	Read	Discharge Temperature Sensor Alarm
	BOOL	Bit 6	Read	Fan 3 Overload Alarm
	BOOL	Bit 7	Read	Fan 4 Overload Alarm
	BOOL	Bit 8	Read	Fan 5 Overload Alarm
	BOOL	Bit 9	Read	Fan 6 Overload Alarm
	BOOL	Bit 10	Read	Return Water Sensor
	BOOL	Bit 11	Read	Phase Loss
	BOOL	Bit 12	Read	Compressor 1 Fault
	BOOL	Bit 13	Read	Low Low Pressure Alarm
	BOOL	Bit 14	Read	System Stopping
	BOOL	Bit 15	Read	System Starting

Table 12 – PLC Controller Modbus RTU Parameters (continued)

Modbus Register	Data Format	Data	Access Level	Description
30004	WORD		Read	SYSTEM ALARMS/WARNINGS
	BOOL	Bit 0	Read	PLC Battery Alarm
	BOOL	Bit 1	Read	Discharge Pressure Soft Alarm
	BOOL	Bit 2	Read	Compressor 2 Fault
	BOOL	Bit 3	Read	Compressor 3 Fault
	BOOL	Bit 4	Read	Not used
	BOOL	Bit 5	Read	Not used
	BOOL	Bit 6	Read	Not used
	BOOL	Bit 7	Read	Not used
	BOOL	Bit 8	Read	Not used
	BOOL	Bit 9	Read	Not used
	BOOL	Bit 10	Read	Not used
	BOOL	Bit 11	Read	Not used
	BOOL	Bit 12	Read	Not used
	BOOL	Bit 13	Read	Not used
	BOOL	Bit 14	Read	Not used
	BOOL	Bit 15	Read	Not used
30005	WORD		Read	PLC INPUT STATUS
	BOOL	Bit 0	Read	PLC Input 0
	BOOL	Bit 1	Read	PLC Input 1
	BOOL	Bit 2	Read	PLC Input 2
	BOOL	Bit 3	Read	PLC Input 3
	BOOL	Bit 4	Read	PLC Input 4
	BOOL	Bit 5	Read	PLC Input 5
	BOOL	Bit 6	Read	PLC Input 6
	BOOL	Bit 7	Read	PLC Input 7
	BOOL	Bit 8	Read	PLC Input 8
	BOOL	Bit 9	Read	PLC Input 9
	BOOL	Bit 10	Read	PLC Input 10
	BOOL	Bit 11	Read	PLC Input 11
	BOOL	Bit 12	Read	PLC Input 12
	BOOL	Bit 13	Read	PLC Input 13
	BOOL	Bit 14	Read	PLC Input 14
	BOOL	Bit 15	Read	PLC Input 15
30006	WORD		Read	PLC OUTPUT STATUS
	BOOL	Bit 0	Read	PLC Output 0
	BOOL	Bit 1	Read	PLC Output 1
	BOOL	Bit 2	Read	PLC Output 2
	BOOL	Bit 3	Read	PLC Output 3
	BOOL	Bit 4	Read	PLC Output 4
	BOOL	Bit 5	Read	PLC Output 5
	BOOL	Bit 6	Read	PLC Output 6
	BOOL	Bit 7	Read	PLC Output 7
	BOOL	Bit 8	Read	PLC Output 8
	BOOL	Bit 9	Read	PLC Output 9
	BOOL	Bit 10	Read	PLC Output A
	BOOL	Bit 11	Read	PLC Output B
	BOOL	Bit 12	Read	PLC Output C
	BOOL	Bit 13	Read	PLC Output D
	BOOL	Bit 14	Read	Not used
	BOOL	Bit 15	Read	Not used

Table 12 – PLC Controller Modbus RTU Parameters (continued)

Modbus Register	Data Format	Data	Access Level	Description
32001	INTEGER		Read	Supply Water Temperature
32002	INTEGER		Read	Return Water Temperature
32003	INTEGER		Read	Set Point Water Temperature
32004	INTEGER		Read	Compressor 1 Running Hours
32005	INTEGER		Read	Compressor 2 Running Hours
32006	INTEGER		Read	Compressor 3 Running Hours
32007	INTEGER		Read	Evaporator Leaving Water Temperature
32008	INTEGER		Read	Suction Temperature
32009	INTEGER		Read	Discharge Temperature
32010	INTEGER		Read	Suction Pressure
32011	INTEGER		Read	Discharge Pressure
32012	INTEGER		Read	Compressor 1 Anti-Cycle Time
32013	INTEGER		Read	Compressor 2 Anti-Cycle Time
32014	INTEGER		Read	Compressor 3 Anti-Cycle Time
32015	INTEGER		Read	Superheat
32016	INTEGER		Read	PLC Version
32017	INTEGER		Read	Electronic Expansion Valve Percent
32018	INTEGER		Read	Variable-Speed Drive Speed Feedback
32019	INTEGER		Read	Hot Gas Bypass Valve Percent
40001	BOOL		Write	Set Point Temperature Setpoint (x 10, ie. 50.0° = 505)

Start-Up

Every unit is factory set to deliver chilled water in accordance with the standard operating specifications for that particular chiller. Due to variables involved with different applications and different installations, minor adjustments may be required during the initial start-up to ensure proper operation. We recommend a qualified refrigeration technician perform the start-up and that they follow the start-up procedure in sequence. The following serves as a checklist for the initial start-up and for subsequent start-ups if the chiller is out of service for a prolonged time.

WARNING: This equipment contains hazardous voltages that can cause severe injury or death.

WARNING: This equipment contains refrigerant under pressure. Accidental release of refrigerant under pressure can cause personal injury and or property damage.

WARNING: This equipment may contain fan blades or other sharp edges. Make sure all fan guards and other protective shields are securely in place.

WARNING: The exposed surfaces of motors, refrigerant piping, and other fluid circuit components can be very hot and can cause burns if touched with unprotected hands.

CAUTION: Disconnect and lock out incoming power before installing, servicing, or maintaining the equipment. Connecting power to the main terminal block energizes the entire electric circuitry of the unit. A power supply provides 24 VDC control power. Electric power at the main disconnect should be shut off before opening access panels for repair or maintenance.

CAUTION: Wear eye protection when installing, maintaining, or repairing the equipment to protect against any sparks, debris, or fluid leaks.

CAUTION: Wear protective gloves when installing, maintaining, or repairing the equipment to protect against any sparks, debris, or fluid leaks.

CAUTION: Ground the unit properly in compliance with local and national codes.

CAUTION: The unit requires the main power to remain connected during off-hours to energize the compressor's crankcase heater. Disconnect main power only when servicing the chiller. The crankcase heater should remain on when the compressor is off to ensure liquid refrigerant does not accumulate in the compressor crankcase. Connect main power at least 24 hours prior to initial start-up.

Step 1 - Connect Main Power

Connect main power properly ensuring it matches the voltage shown on the nameplate of the unit. Check the electrical phase sequence prior to start-up. Operation of the compressor with incorrect electrical phase sequencing will damage to the compressors. Check the phasing prior to applying power. The proper sequence is "ABC". If the phasing is incorrect, open the main power disconnect and switch two line leads on the main power terminal blocks (or the unit mounted disconnect). All electrical components are in-phase at the factory. Do not interchange any load leads that are from the unit contactors or the motor terminals. After making proper power connection and grounding, turn the main power on.

Step 2 - Fill Coolant Circuit

Check to make sure all process chilled-water piping connections are secure. Open the chiller cabinet and fill the coolant reservoir with the proper water or water/glycol solution following the guidelines shown below. When using a glycol solution only use glycol with a corrosion inhibitor.

System Fill Water Chemistry Requirements

The properties of water make it ideal for heat transfer applications. It is safe, non-flammable, non-poisonous, easy to handle, widely available, and inexpensive in most industrialized areas.

When using water as a heat transfer fluid it is important to keep it within certain chemistry limits to avoid unwanted side effects. Water is a "universal solvent" because it can dissolve many solid substances and absorb gases. As a result, water can cause the corrosion of metals used in a cooling system. Often water is in an open system (exposed to air) and when the water evaporates, the dissolved minerals remain in the process fluid. When the concentration exceeds the solubility of some minerals, scale forms. The life giving properties of

water can also encourage biological growth that can foul heat transfer surfaces.

To avoid the unwanted side effects associated with water cooling, proper chemical treatment and preventive maintenance is required for continuous plant productivity.

Unwanted Side Effects of Improper Water Quality

- Corrosion
- Scale
- Fouling
- Biological Contamination

Cooling Water Chemistry Properties

- Electrical Conductivity
- pH
- Alkalinity
- Total Hardness
- Dissolved gases

Chillers at their simplest have two main heat exchangers: one that absorbs the heat from the process (evaporator) and one that removes the heat from the chiller (condenser). All our chillers use stainless steel brazed plate evaporators. Our air-cooled chillers use air to remove heat from the chiller; however, our water-cooled chillers use either a tube-in-tube or shell-in-tube condenser which has copper refrigerant tubes and a steel shell. These, as are all heat exchangers, are susceptible to fouling of heat transfer surfaces due to scale or debris. Fouling of these surfaces reduces the heat-transfer surface area while increasing the fluid velocities and pressure drop through the heat exchanger. All of these effects reduce the heat transfer and affect the efficiency of the chiller.

The complex nature of water chemistry requires a specialist to evaluate and implement appropriate sensing, measurement and treatment needed for satisfactory performance and life. The recommendations of the specialist may include filtration, monitoring, treatment and control devices. With the ever-changing regulations on water usage and treatment chemicals, the information is usually up-to-date when a specialist in the industry is involved. Table 13 shows the list of water characteristics and quality limitations.

Table 13 – Fill Water Chemistry Requirements

Water Characteristic	Quality Limitation
Alkalinity (HCO_3^-)	70-300 ppm
Aluminum (Al)	Less than 0.2 ppm
Ammonium (NH_3)	Less than 2 ppm
Chlorides (Cl^-)	Less than 300 ppm
Electrical Conductivity	10-500µS/cm
Free (aggressive) Carbon Dioxide (CO_2)†	Less than 5 ppm
Free Chlorine(Cl_2)	Less than 1 PPM
HCO_3^-/SO_4^{2-}	Greater than 1.0
Hydrogen Sulfide (H_2S)	Less than 0.05 ppm
Iron (Fe)	Less than 0.2 ppm
Manganese (Mn)	Less than 0.1 ppm
Nitrate (NO_3)	Less than 100 ppm
pH	7.5-9.0
Sulfate (SO_4^{2-})	Less than 70 ppm
Total Hardness (dH)k	4.0-8.5

† Dissolved carbon dioxide calculation is from the pH and total alkalinity values shown below or measured on the site using a test kit. Dissolved Carbon Dioxide, PPM = TA x $2^{[(6.3-pH)/0.3]}$ where TA = Total Alkalinity, PPM as $CaCO_3$

Table 14 - Recommended Glycol Solutions

Chilled Water Temperature	Percent Glycol By Volume
50°F (10°C)	Not required
45°F (7.2°C)	5 %
40°F (4.4°C)	10 %
35°F (1.7°C)	15 %
30°F (-1.1°C)	20 %
25°F (-3.9°C)	25 %
20°F (-6.7°C)	30 %

CAUTION: When your application requires the use of glycol, use industrial grade glycol specifically designed for heat transfer systems and equipment. Never use glycol designed for automotive applications. Automotive glycols typically have additives engineered to benefit the materials and conditions found in an automotive engine; however, these additives can gel and foul heat exchange surfaces and result in loss of performance or even failure of the chiller. In addition, these additives can react with the materials of the pump shaft seals resulting in leaks or premature pump failures.

WARNING: Ethylene Glycol is flammable at higher temperatures in a vapor state. Carefully handle this material and keep away from open flames or other possible ignition sources.

Step 3 - Check Condenser

There are three possible types of condenser present in the chiller: Integral air-cooled, water-cooled, or remote air-cooled. It is important to verify the chiller will have adequate condenser cooling for proper chiller operation.

Integral Air-Cooled Condenser Check

Verify the installation is as described in the mechanical installation section of this manual. Check to make sure the chiller condenser is clear of obstructions and has at least 36 inches of open air on the air inlet and outlets for proper airflow.

Water-Cooled Condenser Check

Check the condenser water lines to make sure all connections are secure. Make sure sufficient condenser water flow and pressure are available and all shut-off valves are open.

Remote Air-Cooled Condenser Check

Check the refrigerant lines to make sure all connections are secure and that a proper evacuation of the chiller, the field piping, and the remote condenser has occurred. Verify the refrigeration piping is installed as described in the installation section of this manual. Check the remote condenser main power and control wiring to ensure all connections are secure.

Step 4 – Check Refrigerant Valves

During shipment or installation it is possible valves where closed. Verify that all refrigerant valves are open.

CAUTION: Do not operate the unit with the compressor, oil line, or liquid line service valves "CLOSED". Failure to have these "OPEN" may cause serious compressor damage.

Step 5 – Verify Freezestat Setting

Make sure the Freezestat setting is appropriate for the operating conditions of the chiller. The Freezestat setting is in a password protected menu of the chiller controller. It should be set at 10°F below the minimum chilled water temperature setting that the chiller will be operating. Reference Table 14 to be sure the coolant solution has sufficient freeze protection (glycol) to handle at least 5°F below the Freezestat setting. All chillers ship from the factory with the Freezestat set at 38°F to protect against a possible freeze-up if no glycol is in the coolant. Once the proper glycol solution is present, adjust the Freezstat to the appropriate setting.

CAUTION: The manufacturer's warranty does not cover the evaporator from freezing. It is vital that the Freezestat is set properly.

Step 6 – Turn On Control Power

Some chillers may have a control power switch. If present, turn the control power switch on. If not present, turning the main power on should turn the control power on. When the control power is on, the panel displays are illuminated. Due to extreme ambient temperatures that may occur during shipment, the High Refrigerant Pressure switch may have tripped. If this is the case, disconnect the main power and reset the High Refrigerant Pressure by depressing the manual reset button located on the switch. Reconnect the main power, turn the control power on, and clear the alarm condition by pressing the Alarm Reset button.

Step 7 – Establish Coolant Flow

Standard units have an internal pump. To energize the pump press the Start button. If the unit does not have an internal pump, energize the external pump to establish flow through the chiller.

Note: The compressor will not start as long as the flow switch is open. A positive flow through the evaporator is required before the compressor can operate.

Set water flow using a discharge throttling valve or flow control valve (by others). The valve should be the same size as the To Process connection of the chiller. Standard chillers require approximately 2.4 gpm/ton of nominal capacity. A significant increase in flow beyond this in a standard chiller may result in excessive pressure loss and negatively impact chiller efficiency and in extreme cases may cause premature wear or damage of internal components.

Step 8 – Intial Unit Operation

Enter the desired leaving fluid temperature on the control panel. Unless otherwise specified, the chiller is factory set to deliver coolant at 50°F. Adjust to the desired operating temperature. The chiller should now be controlling to the selected temperature. Please note that if there is insufficient load the compressor may cycle on and off causing swings in temperature.

Note: For chillers with the variable-speed compressor option (the NQV Series) under low load conditions with the compressor speed at its minimum, the hot gas system will maintain temperature 1° below setpoint.

WARNING: Never deactivate the High Refrigerant Pressure or the Low Compressor Pressure switch. Failure to heed this warning can cause serious compressor damage, severe personal injury, or death.

Note: For chillers with the variable-speed compressor option (the NQV Series) there is an initial startup routine that will run the compressor at a fixed speed for 2 minutes. After this routine the chiller will actively manage the system to maintain desired set point.

Operate the system for approximately 30 minutes. Check the liquid line sight glass. The refrigerant flow past the sight glass should be clear. Bubbles in the refrigerant indicate either low refrigerant charge or excessive pressure drop in the liquid line. Indications of a shortage of refrigerant are low operating pressures are subcooling. Normal subcooling ranges are from 10°F to 20°F. If it is not, check the superheat and adjust if required. The superheat should be approximately 10°F. Since the unit is factory charged, adding or removing refrigerant charge should not be necessary. If the operating pressures, sight glass, superheat, and subcooling readings indicate a refrigerant shortage, charge refrigerant as required. With the unit running, add refrigerant vapor by connecting the charging line to the suction service valve and charging through the backseat port until operating conditions become normal.

CAUTION: A clear sight glass alone does not mean that the system is properly charged. Also, check system superheat, sub-cooling, and unit operating pressures. If both suction and discharge pressures are low but sub-cooling is normal, a problem other than refrigerant shortage exists. Do not add refrigerant, as this may result in overcharging the circuit.

After achieving proper flows and temperatures, press the Stop button. The unit is now ready for service.

Preventive Maintenance

Once your portable chiller is in service, follow the maintenance procedures shown below as closely as possible. The importance of a properly established preventive maintenance program cannot be overemphasized. Taking the time to follow these simple procedures will result in substantially reduced downtime, reduced repair costs, and an extended useful lifetime for the chiller. Any monetary costs of implementing these procedures will normally more than pay for it. The preventative maintenance checklist in this manual is a great way to log and keep track of maintenance.

Once a Week

1. (Air-Cooled Units Only) Check the surface of the air-cooled condenser coil for dirt and debris. To clean, rinse thoroughly with water and use a mild detergent to remove smoke and or grease stains.

2. Check to make sure that the To Process temperature is reasonably close to the Set Point temperature. If the temperature stays more than 5°F away from the set point, there may be a problem with the chiller. If this is the case, refer to the Troubleshooting Chart or contact the Customer Service Department.

3. Check the pump discharge pressure on the gauge on the back panel of the chiller. Investigate further if the pressure starts to stray away from the normal operating pressure.

4. Check the coolant level in the reservoir. Replenish if necessary making sure to take proper precautions to maintain the appropriate glycol concentration.

5. Check coolant circulation pump for leaks in the seal area. Replace pump seal if necessary.

6. Check refrigerant sight glass for air bubbles or moisture indication. If the sight glass indicates that there is a refrigeration problem, have the unit serviced as soon as possible.

Once a Month

7. With the main disconnect shut off and locked out, check the condition of electrical connections at all contactors, starters and controls. Check for loose or frayed wires.

8. Check the incoming voltage to make sure it is within 10% of the design voltage for the chiller.

9. Check the amp draws to each leg of the compressor (fans or blowers on air-cooled units) and pump to confirm that they are drawing the proper current.

Every Three Months

10. Units are equipped with a Y-strainer between the return connection and the evaporator inlet. Remove and clean the strainer basket if necessary. This may be required more often if contaminants can easily get into the coolant.

11. Have a qualified refrigeration technician inspect the operation of the entire unit to ensure that everything is operating properly. Have condenser cleaned out if necessary.

12. Ensure the variable speed drive remains dust-free and check the heat sink of the drive and make sure it and the ventilation fan of the drive are not gathering duct. Gently clean as necessary.

Preventive Maintenance Checklist

Maintenance Activity	Week Number												
	1	2	3	4	5	6	7	8	9	10	11	12	13
Date													
Clean Air Coils and Inlet Filters													
Temperature Control													
Pump Discharge Pressure													
Coolant Level													
Glycol Concentration													
Pump Seal													
Refrigerant Sight Glass													
Electrical Connections													
Incoming Voltage													
Compressor #1 L1 Amps													
Compressor #1 L2 Amps													
Compressor #1 L3 Amps													
Compressor #2 L1 Amps													
Compressor #2 L2 Amps													
Compressor #2 L3 Amps													
Pump L1 Amps													
Pump L2 Amps													
Pump L3 Amps													
Fan #1 L1 Amps													
Fan #1 L1 Amps													
Fan #1 L3 Amps													
Fan #2 L1 Amps													
Fan #2 L2 Amps													
Fan #2 L3 Amps													
Fan #3 L1 Amps													
Fan #3 L2 Amps													
Fan #3 L3 Amps													
Clean Y-Strainer													
Refrigerant Circuit Check													
Refrigerant Suction Pressure													
Refrigerant Discharge Pressure													
Refrigerant Superheat													

General Troubleshooting

Problem	Possible Cause	Remedy
Compressor will not start	Compressor overload	Check supply voltage, amperage of each leg, contactor and wiring, and overload set point
	Compressor contactor	Replace if faulty
	Compressor failure	Contact Customer Service for assistance
Pump will not start	Pump overload	Check supply voltage, amperage of each leg, contactor and wiring, and overload set point
	Pump contactor	Replace if faulty
	Pump failure	Replace if faulty
Low refrigerant pressure	Low refrigerant charge	Contact refrigeration service technician
	Refrigerant leak	Contact refrigeration service technician
	Low refrigeration pressure sensor	Check for proper range, replace if faulty
High refrigerant pressure	Dirty air filters (air-cooled units only)	Clean filters
	Air flow obstruction (air-cooled units only)	Make sure chiller is installed in accordance with recommendations in this manual
	High ambient air temperature (air-cooled units only)	Ambient temperature must be reduced below 110°F
	Condenser fan motor (air-cooled units only)	Replace if faulty
	Condenser fan cycling control (air-cooled units only)	Confirm proper operation, replace if faulty
	Plugged condenser (water-cooled units only)	Clean out tubes
	Insufficient condenser water flow (water-cooled units only)	Make sure chiller is installed in accordance with the recommendations of this manual
	High condenser water temperature (water-cooled units only)	Condenser water temperature must be reduced below 100°F
	Condenser water regulating valve	Check setting, replace if faulty
	Refrigerant circuit overcharged	Contact a refrigeration service technician
	High refrigerant pressure sensor	Replace if faulty
Freezestat	Low flow through evaporator	Adjust flow to proper level
	Freezestat control module	Check for proper setting (Protected Setting)
	Freezestat sensor	Replace if faulty
Low pump discharge pressure	Pump running backwards	Switch 2 legs of the incoming power
	Pump pressure gauge	Replace if faulty
	Pump failure	Replace if faulty
	Excessive flow	Reduce flow
High pump discharge pressure	Closed valves in process piping	Open valves
	Obstruction in piping or process	Remove obstruction
	Clogged Y-strainer	Clean strainer
	Pressure gauge	Replace if faulty
Erratic temperature control	Low coolant flow through evaporator	Adjust flow to proper level
	Intermittent overloading of chiller capacity	Check to make sure chiller is properly sized for process load
	Hot gas bypass valve	Contact refrigeration service technician
	Temperature sensor	Replace if faulty
Insufficient cooling (temperature continues to rise above set point)	Process load too high	Check to make sure chiller is properly sized for process load
	Coolant flow through evaporator too high or low	Adjust flow to proper level
	Insufficient condenser cooling	See “High Refrigerant Pressure”
	Hot gas bypass valve stuck open	Contact refrigeration service technician
	Refrigeration circuit problem	Contact refrigeration service technician
	Temperature sensor	Replace if faulty

Drawings

We have prepared a custom set of drawings for your unit and placed them inside the control panel prior to shipment. Please refer to these drawings when troubleshooting, servicing, and installing the unit. If you cannot find these drawings or wish to have additional copies, please contact our Customer Service Department and reference the serial number of your unit.

Warranty

Thermal Care warrants its equipment to be free from defects in material and workmanship when used under recommended operating conditions.

Thermal Care's obligation is limited to repair (i.e. rewind a motor) or replacement (not adjustment or maintenance), F.O.B. the factory of any parts supplied by Thermal Care within a period as shown below from the date of shipment to the original purchaser.

Model	**Parts**	**Labor**[1]
SQ, LQ, NQ	18 months	12 months
EQ	12 months	12 months
EQR, LQR, SQR, NQR(remote condensers)	12 months	12 months[2]
TCW, TSW, MXW,	12 months	12 months
TCR, TSR, MXR (remote condensers)	12 months	12 months[2]
Optional Compressor Warranty	5 years	
Chilled Water Systems	See note[3]	12 months[4]
FT or FC Tower Systems	See note[3]	12 months[4]
FT Cooling Tower	12 months (10 years - shell)	
FC Cooling Tower	5 years (10 years - shell)	
RA, RB, RQ	(See Warranty Sheet - Form 1-415.7 or 1-416.2)	
All other products	12 months	

[1]Continental U.S.A., Canada, and Puerto Rico only.
[2]Refrigerant and any labor associated with its evacuation or replacement are not covered for remote condenser systems.
[3]See individual product listing for parts warranty coverage.
[4]The labor warranty covers all equipment purchased at the same time consisting of a minimum of at least one pumping system and one cooling tower and/or chiller.

This warranty does not cover the cost of labor during overtime hours (after normal working hours or during weekends and holidays). Any cost differential for overtime labor will be the responsibility of the customer. Thermal Care is not responsible for any sales, use, excise or other applicable taxes associated with the replacement of parts under this warranty. This warranty will be voided when, in Thermal Care's opinion, the equipment and/or system has been subject to misuse, negligence or operation in excess of recommended limits, including freezing, or has been altered, and/or repaired without express factory authorization. If equipment is installed in hostile environments, unless such conditions were specified at the time of purchase; or the serial number has been removed or defaced, this warranty shall not apply. All labor warranty coverage provided by the Seller is based on normal ground mounted equipment with proper clearance and equipment access. The Buyer is responsible for any additional costs associated with special rigging or access platforms required to perform the warranty work and/or any additional labor cost associated with delays caused by the Buyer which prevent the Seller's service technician from performing their repair work in a proper timely manner. This warranty is not transferable.

Under no circumstances shall Thermal Care be liable for loss of prospective or speculative profits, or special, indirect, incidental or consequential damages.

Thermal Care must authorize all warranty service prior to work being performed and have a Thermal Care purchase order issued. All defective parts become the property of Thermal Care and must be returned as advised by Thermal Care.

Thermal Care neither assumes, nor authorizes any person to assume for it, any liability not expressed in this warranty. There is an implied warranty of merchantability and of fitness for that particular purpose; all other implied warranties, and any liability not based upon contract are hereby disclaimed and excluded by this warranty. This warranty is part of the standard conditions and terms of sale of Thermal Care.

THERMAL CARE
5680 W. Jarvis Ave
Niles, Illinois 60714
Phone: (847) 966-2260
(888) 828-7387
Fax: (847) 966-9358

Email: info@thermalcare.com
www.thermalcare.com
Customer Service
Phone: (847) 966-2636
Fax: (847) 966-2906

Form 1-410.13
Effective 9/15/11

Extended 5 Year Compressor Warranty – (Optional)

Thermal Care, Inc. warrants its equipment to be free from defects in material and workmanship when used under recommended operating conditions.

Thermal Care's obligation is limited to repair or replacement (not adjustment or maintenance), F.O.B. the factory of the compressor supplied by Thermal Care within a period five (5) years from the date of shipment to the original purchaser. This warranty applies to the cost of parts. Labor to replace the compressor is limited to twelve (12) months from the date of shipment. Refrigerant and any labor associated with its evacuation or replacement is not covered by this warranty.

The extended warranty shall be subject to the same inclusions, limitations, and exclusions as the standard warranty policy.

Thermal Care reserves the right to at its sole discretion to repair or replace the defective compressor during the extended warranty period:

Repair: Thermal Care will try to repair the defective compressor as its first option;
Replace: In case the extended warranty compressor cannot be repaired by Thermal Care, a replacement compressor will be sent to you. The remaining time of the extended warranty period will be transferred to the replacement compressor.

This warranty does not cover the cost of labor during overtime hours (after normal working hours or during weekends and holidays). Any cost differential for overtime labor will be the responsibility of the customer. Thermal Care is not responsible for any sales, use, excise or other applicable taxes associated with the replacement of parts under this warranty. This warranty will be voided when, in Thermal Care's opinion, the equipment and/or system has been subject to misuse, negligence or operation in excess of recommended limits, including freezing, or has been altered, and/or repaired without express factory authorization. This warranty shall not apply to equipment installed in hostile environments, unless such conditions were specified at the time of purchase. This warranty shall not cover equipment on which the serial number has been removed or defaced. This warranty is not transferable.

Under no circumstances shall Thermal Care be liable for loss of prospective or speculative profits, or special, indirect, incidental or consequential damages.

Thermal Care must authorize all Warranty service prior to work being performed and have a Thermal Care purchase order issued. All defective parts become the property of Thermal Care and must be returned as advised by Thermal Care.

Thermal Care neither assumes, nor authorizes any person to assume for it, any liability not expressed in this warranty. There is an implied warranty of merchantability and of fitness for that particular purpose; all other implied warranties, and any liability not based upon contract are hereby disclaimed and excluded by this warranty. This warranty is part of the standard conditions and terms of sale of Thermal Care.

THERMAL CARE

5680 W. Jarvis Ave
Niles, Illinois 60714
Phone: (847) 966-2260
(888) 828-7387
Fax: (847) 966-9358

Email: info@thermalcare.com
www.thermalcare.com
Customer Service
Phone: (847) 966-2636
Fax: (847) 966-2906

Form 1-417.1
Effective 12/01/12

Thermal Care, Inc.
5680 W. Jarvis Ave
Niles, IL 60714
www.thermalcare.com

New Equipment Sales
Phone (847) 966-2260
Fax (847) 966-9358
info@thermalcare.com

Customer Service
Phone (847) 966-2636
Fax (847) 966-2906
service@thermalcare.com

Parts
Phone (847) 966-8560
Fax (847) 966-6065
tcparts@thermalcare.com

NQ Series IOM 2-332.24
April 2016

C Series C10/C20/C30 *Operation Manual*

Serial No: C16070050
C16070051

NOTE - Notes contain helpful suggestions or references.

CAUTION - Indicates a potentially hazardous situation, which, if not avoided, may result in minor or moderate injury. It may also be used to alert against unsafe practices. This could result in equipment damage or loss of data.

WARNING - Indicates a potentially hazardous situation, which, if not avoided, could result in death or serious injury. The reader is in a situation that could cause bodily injury.

WARNING **DO NOT USE THIS EQUIPMENT IN A MANNER NOT SPECIFIED BY PROTON.**

PROTON offers a full range of installation and training services. Contact PROTON Customer Service at **(203) 949-8697** or your local service provider/supplier for more information.

CAUTION **If freezing conditions exist at your site, you must take measures to prevent condensation from freezing and obstructing the H_2 vent line, O_2 vent line, and freezing the water supply and drain lines.**

WARNING **After performing any service or maintenance work, make sure the doors to the enclosures are completely closed prior to the startup operation of your C Series Hydrogen Generator.**

NOTE It is the customer's responsibility to organize a backup hydrogen supply to bridge critical times during maintenance and service.

WARNING **CONTACT WITH HIGH VOLTAGE/CURRENT MAY RESULT IN DEATH OR SERIOUS INJURY. ALL ENCLOSURE DOORS MUST BE CLOSED DURING OPERATION.**

1 SAFETY

The safety guidelines below may not cover all situations. Please address concerns or questions to Proton or check with local authorities.

NOTE Hydrogen gas is lighter than air and diffuses quickly.

WARNING **FIRE OR EXPLOSION DANGER! KEEP ALL SOURCES OF IGNITION AWAY FROM HYDROGEN.**

WARNING **DO NOT BYPASS THE C SERIES SAFETY SYSTEM - UNCONTROLLED OPERATION CAN RESULT IN DEATH, SERIOUS INJURY AND/OR DAMAGE TO THE C SERIES HYDROGEN GENERATOR.**

1.1 References

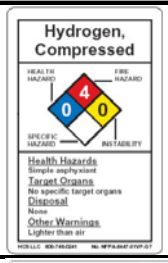
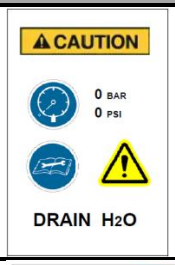
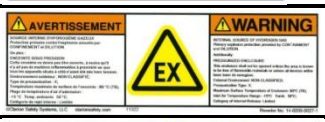
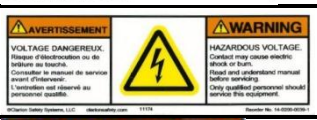
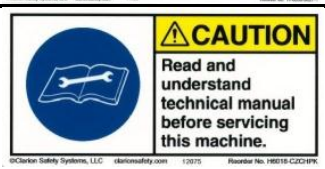
Product Specification: PD-0600-0068
Electrical Schematic: XPE2730
P&ID: XPE2739
Installation Manual: PD-0100-0067
Maintenance Manual: PD-0200-0018
Software Parameters: PD-9900-0017

NOTE Specifications are subject to change. Consult factory for latest specifications and tolerances on figures specified without ranges.

1.2 Wire Colors

AC wires are black. 24VDC wires are blue and blue/white. Control/instrumentation wires are various colors. All earth ground wires are green/yellow. Any exceptions are listed in XPE2730.

1.3 Warning Labels

Label	Description	Label	Description
	The electrolyzer contains and produces compressed hydrogen. Hydrogen is an asphyxiant and is lighter than air.		Caution should be taken due to risk of burning from drain water. Temperatures could reach in excess of 60°C.
	Hazardous AC or DC voltages could be present inside. Do not remove guards.		Do not work within the enclosures with energized parts due to a risk of arc flash and shock hazard. Appropriate PPE is required.
	Warning that there is an internal source of hydrogen.		There is a hazardous voltage present.
	It is important to read and understand the manuals before performing service on the electrolyzer.		Oxygen is odorless, tasteless, colorless and heavier than air. Materials that do not burn in air including fire resistant material, can burn vigorously in an oxygen enriched atmosphere. Oxygen levels must be kept below a volume fraction of 23.5% in air.

2 OPERATION

The C Series Hydrogen Generator is a fully automated system and is configured for operation in either Tank Filling or Load Following operations.

2.1 Applying Power

Procedure for applying power (refer to Figure 1):

1. Confirm the Service Bypass Switch Key is removed (Figure 2).
2. Verify the doors for both enclosures are closed and secured.
3. Verify the air inlet and exhaust openings are clear (free from blockage) and the air filters and screens are installed.
4. Verify the water supply is on.
5. Verify the Main Power Disconnect switch for the Thermal Control Unit (TCU) (*when configured*) is ON, (*else assure all customer supplied cooling is on and available*).
6. Turn the Main Disconnect Switch (DS1) on the Power Supply enclosure from OFF to ON. See Figure 1
7. Turn the Electrolyzer Circuit Breaker (CB1) on the Electrolyzer enclosure from OFF to ON. See Figure 1

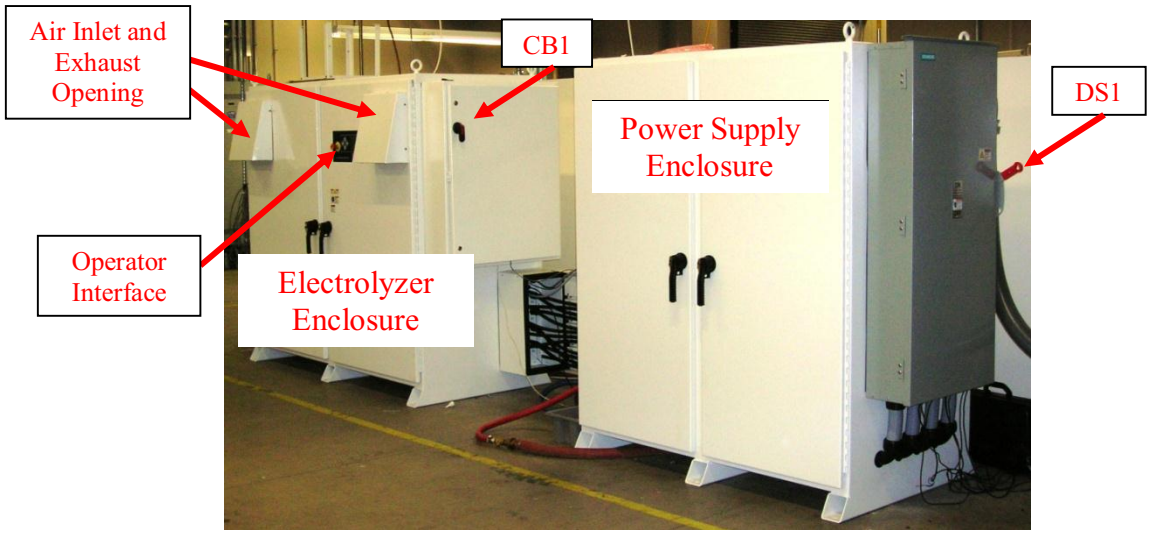


Figure 1 C Series System

AC POWER IS PRESENT IN THE ELECTROLYZER UNTIL THE MAIN POWER DISCONNECT IS SWITCHED OFF. FOR MAINTENANCE, LOCK OUT/TAG OUT AT THE MAIN POWER DISCONNECT.

DC VOLTAGE AND CURRENT CAN PERSIST AT CELL STACK TERMINALS - CONSULT MAINTENANCE MANUAL (PD-0200-0018) BEFORE OPENING ENCLOSURES.

DO NOT REMOVE POWER UNTIL "*READY TO START*" IS DISPLAYED. SHUTTING OFF PREMATURELY CAN DAMAGE THE ELECTROLYZER.

2.2 Operator Interface

The operator interface shown in Figure 2 is located on the front right door panel of the C Series Hydrogen Generator Electrolyzer enclosure. The "Stop/Reset" button stops operation and is used to reset certain errors. An Emergency Stop (E-Stop) switch is provided on the operator interface.

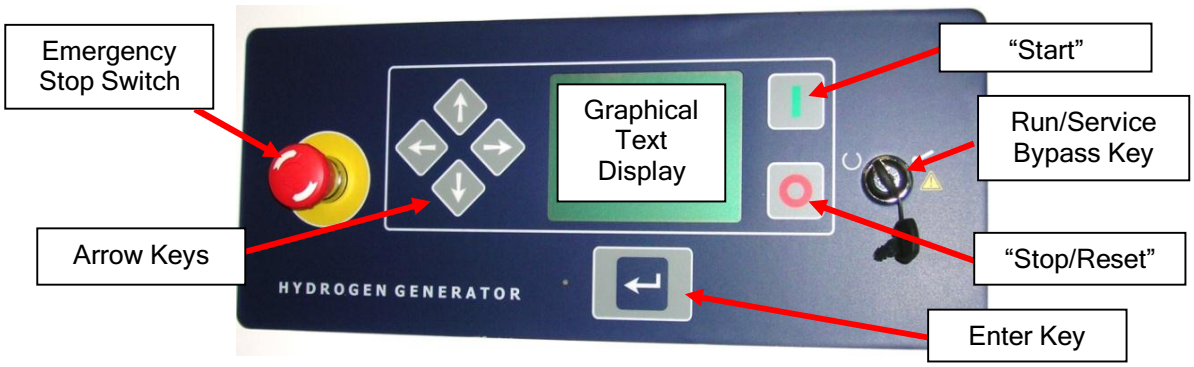


Figure 2 – Operator Interface Control Panel

2.3 Display Screens

Table 1 - Display Titles

Title	Description
Ready to Start	The system is ready to accept a start pushbutton command
Setting Up System	The system is initializing, filling the A200 and the A500
Standby	The Standby menu displays the values: Product Pressure, Refill Pressure Setpoint, Full Pressure Setpoint, Total Hydrogen Produced, H_2 Production Time, Standby Time
Generating	The default menu displays the values: Product Pressure, Full Pressure Setpoint, Hydrogen Purity, Hydrogen Production Rate, Total Hydrogen Produced, H_2 Production Time, Standby Time
Menu	The Menu screen is selectable when a system mode is displayed. The system mode is displayed on the left-hand side of the status bar and has the form "M##." (See Table 2)
Warning Screen	The Warning Screen displays all system warnings since the last power cycle. The screen utilizes a circular buffer and retains the last 15 (fifteen) warnings.
Error Screen	The Error Screen displays all system errors since the last power cycle. This screen resets system errors.

2.4 Operation

Apply power per Section 2.1. The operator interface Graphical Display shows several initialization screens

To operate the C Series from "Ready to Start"

- Press the green "Start" button to begin generating hydrogen in the factory configured operational modes as described in the next section.
- Press the red "Stop" button to stop hydrogen generation, returning the C Series to the "Ready to Start" state with no hydrogen generation.

2.5 Generating Hydrogen

During operation, the C Series Hydrogen Generator system provides hydrogen through the product hydrogen port. The unit is factory configured to run in Tank Filling (tank topping) or Load Following modes of operation. These states and modes are described below.

Table 2 - Operating Modes

Mode	Description	Mode	Description
M01	Hydrogen Generation – Load Following Mode	M12	Degraded Mode due to Stack Water Flow Issue
M03	Hydrogen Generation – Tank Filling Mode	M13	Combustible Gas Sensor Calibration Mode
M04	Standby / Idle	M14	Firmware Upgrade
M05	Degraded Mode due to Power Supply Failure	M15	Generate to Vent
M09	Degraded Mode due to Low Current	M16	Error Condition - Unit Shutdown Mode
M11	Degraded Mode due to High Temperature		

2.5.1 Tank Filling Operation

This mode fills an external tank to a customer-specified set point. After reaching the set point, the system stops generating hydrogen and enters the "Standby" state. When the product pressure reaches a customer-specified tank refill set point, the system again initiates hydrogen generation and begins to fill the tank.

2.5.2 Tank Filling – Standby Operation

Once the tank pressure is greater than the fill pressure set point, the system stops hydrogen generation and begins the shutdown process; enters the "Standby" mode.

2.5.3 Load Following Operation

This mode follows a customer's process hydrogen demand by responding to sensed H_2 product pressure drop or rise. The system is capable of generating hydrogen between 0 and 100% of full production rate as long as the demand for hydrogen does not exceed the rated capacity of the product.

2.6 Manual Shutdown – Tank Filling and Load Following Operation

Manual shutdown of the C Series hydrogen generator occurs by pressing the red "Stop/Reset" button.

NOTE The E-Stop and power disconnect switch cause an immediate stop and does not allow the unit to go through the normal shutdown process. Repeated use of the E-Stop button can degrade the C Series Hydrogen Generator's performance. The preferred method of shutdown is to press the red "Stop" button on the keypad.

NOTE For Tank Filling configurations, pressing the red "Stop" button will stop the unit, but it **will not** automatically start when the external tank pressure is below the reset start value.

NOTE When engaging the E-Stop the unit will not be able to make hydrogen when the safety circuit is triggered, the safety circuit does not shutdown the system entirely. Fans and other areas of the safety circuit will remain engaged. The C Series Hydrogen Generator safely depressurizes when the E-Stop is engaged.

2.7 System Warnings and Errors

In the event the control system detects a measured value outside of Proton's normal anticipated ranges, the graphical display will output any one of the following warnings (See Table 3). Failure to resolve system warnings in a timely manner may result in lower system performance.

NOTE Warnings do not shut down the unit. Warnings alert that an undesirable condition exists and may result in an error. A corrective action should be taken to eliminate the warning before an error code results.

Table 3 - Warning Codes

Code	Abbreviated Description	Code	Abbreviated Description
W06	Low Temp – TE601 Coolant	W18	High Temp – TE159 P/S Enclosure
W07	High Temp – TE601 Coolant	W21	Due – CG calibrations
W08	High Temp – TE219 System	W22	CG in O_2 Low Reading
W09	High Concentration – CG220		

Table 4 - Error Codes

Code	Abbreviated Description	Code	Abbreviated Description
E01_A,B,C	Low Voltage – Stack A, B or C	E32	High Temperature – Controller Board
E02_A,B,C	High Voltage – Stack A, B or C	E33	Invalid State – A200 Level Switch
E03_A,B,C	Low Current – Stack A, B or C	E34	Invalid State – A300 Level Switch
E04_A,B,C	High Current – Stack A, B or C	E35	LS301-Empty Drain Time Too Long
E05_A,B,C	Stack Disabled/Power Supply Fault – Stack A, B or C	E36_A,B,C	Low Water Flow – Stack A, B or C
E06	Comm. Error (Startup) – Power Supply	E38	No Stacks Present
E07	Comm. Error (Generating) – Power Sup.	E40	Calibration Due – CG220
E09	High Pressure – PT307 System	E41	High Temperature – TE159 P/S Enclosure
E10	Low Pressure – PT307 System	E42	Out of Range – TE601 Coolant Temperature
E12	High Temperature – TE219 System	E43	Out of Range-PT312 Product Pressure
E13	Low Temperature – TE219 System	E45	Out of Range – DPS340 H_2 Purity (dewpoint)
E14	Empty – A200	E46	Out of Range – TE219 System Temperature
E15	Flooded – A200	E47	Out of Range – PT307 System Pressure
E16_A,B	Bad Water Quality (RS209, RS507)	E49	Low Hydrogen Purity – DPS340 Water Vapor
E17	A200 Pre-Start Timeout	E50	Low Product Pressure – PT312
E18	A300 Empty	E51	Out of Range – TE128 Electrolyzer Encl. Temp
E19	A300 Flooded	E52	High Pressure – PT312 Product
E20_A,B	Bad Resistivity Sensor (RS209, RS507)	E53	Time Out – Cold Start Temperature
E21	Fault – Safety Relay 1 Status (SR1)	E54	Alarm – TCU
E23	Fault – Safety Relay 2 Status (SR2)	E55	Time Out – A500
E24	High Concentration – CG220 %LFL	E56	Empty – A500
E26	Out of Range – CG220 %LFL	E57	Flooded – A500
E28	Unexpected FSW250 Flow	E58	Invalid State – LS501
E29	Checksum Error – Controller	E59	Out of Range – PT207 Oxygen
E30	Out of Range – 24V, 5V, 3.3V Supply	E60	High Pressure – PT207 Oxygen
E31	Fault – I/O Board Fuses	E61	High Pressure – PT307 Gen to Vent

For detailed error and warning codes refer to Maintenance Manual: PD-0200-0018

Contact the Customer Service department at **(203) 949-8697** for field service technical support or email **customerservice@protononsite.com**.

2.8 Remote Monitoring Software

Monitoring of the hydrogen generation is performed using the C Series Monitoring software. The software comes pre-loaded on the laptop provided with the electrolyzer (Figure 3). During power up, the laptop will automatically login and load the monitoring software.

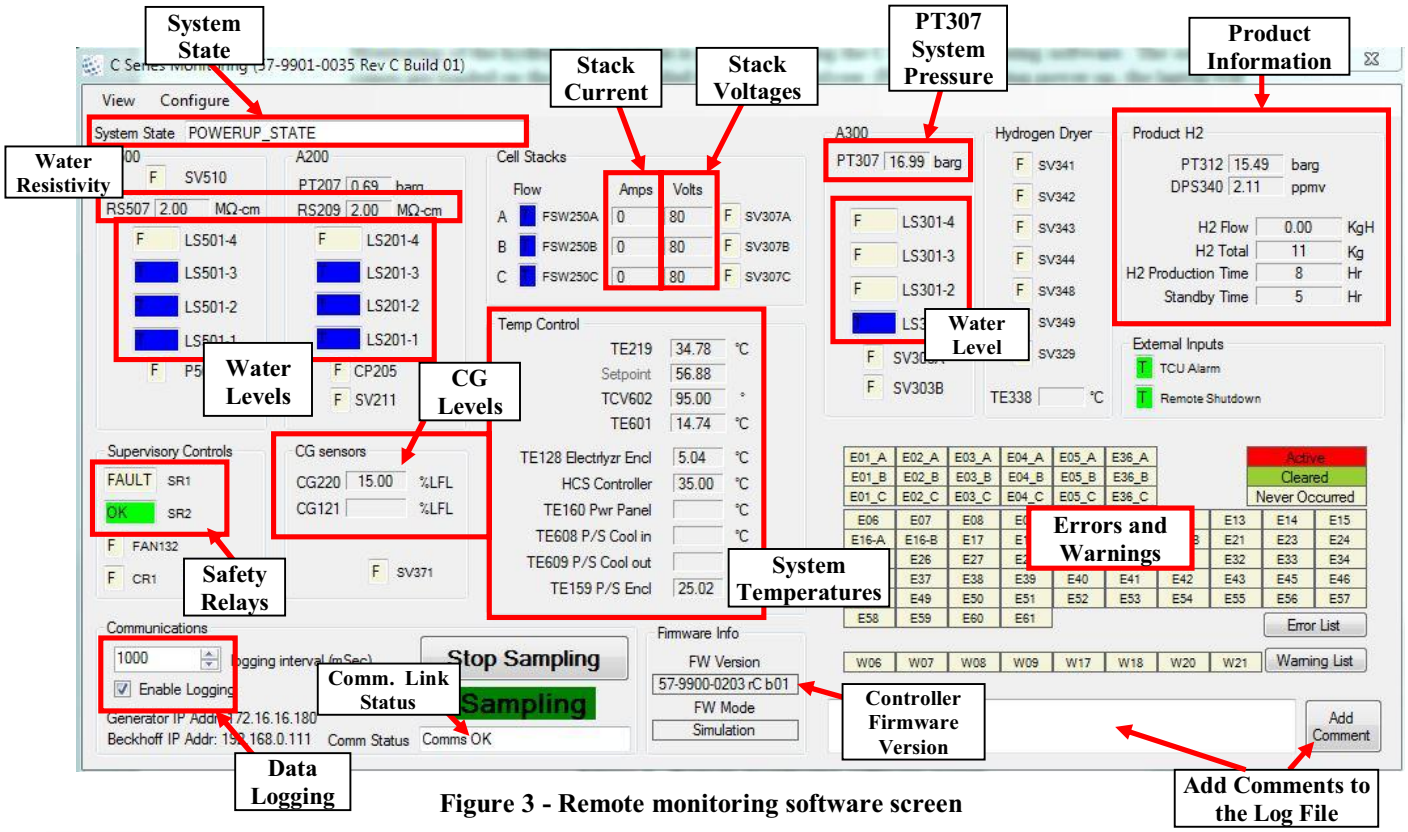


Figure 3 - Remote monitoring software screen

NOTE If the valves or power supplies are energized, then the node is turned green.

NOTE In the Errors/Warnings list, active errors/warnings are turned red. When the error is cleared at the control panel (Figure 3), the error/warning turns green. When the power is cycled at the unit, all errors/warnings are cleared.

2.9 Data Logging and Data File Retrieval

To Log Data:

1. Establish communication with the C Series. See Installation Manual, PD-0100-0067.
2. Ensure that the "Enable Logging" box is selected on the C Series monitoring software and that the green "Sampling" text is shown.

Figure 4 Monitoring Software - Enable Logging & Sampling

Figure 5 C Series Data Shortcut

Retrieve Data Files:
Data files are written to *C:\Users\Public\C-Series Data* on the laptop provided with the system. There is a shortcut to the data folder on the laptop's desktop (See Figure 5). The files can be copied to a USB drive and emailed to Proton's customer service department for troubleshooting.

Proton OnSite
10 Technology Drive
Wallingford, CT 06492
Phone 203.949.8697 • Fax 203.949.8016

C Series C10/C20/C30

HYDROGEN GAS GENERATORS

Maintenance Manual

C Series Hydrogen Gas Generator
Maintenance Manual

Model Numbers:
C10, C20, C30
(10, 20, 30 Nm^3/h @ 30 bar)

C Series Serial Number: _____

C Series Model Number: _____

SIC 3569-901 Gas Generating Equipment
NAICS 333-999-8556 Gas Generating Equipment

November 2016

Proton OnSite
10 Technology Drive
Wallingford, CT 06492
Phone 203.949.8697 • Fax 203.949.8016
www.protononsite.com
customerservice@protononsite.com
techsupport@protononsite.com

C Series Hydrogen Generator
MAINTENANCE MANUAL

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Key Definitions, Acronyms, and Abbreviations Used in this Document

µS/cm – MicroSiemen per centimeter, a measure of water conductivity
Bar – 14.5 PSI or 100 KPa (KiloPascals or Newton/cm), a unit of system pressure. All pressures are at gauge pressure unless otherwise specified.
cc – Cubic centimeter
CPI – Chemical Process Instrumentation
FPT – Female Pipe Thread
FuelGen® - Registered TM of Proton Energy Systems, Inc. for hydrogen systems, comprised of a hydrogen generator, hydrogen storage container, hydrogen dispensers and parts and accessories
HCS – H Series Control System
HGMS – Hydrogen Gas Management Subsystem
HOGEN® - Registered TM of Proton Energy Systems Inc. for packaged water electrolysis based hydrogen generators
kVA – Kilovolt - Ampere
kW – Kilowatt
L/m – Liters per minute flow (for hydrogen, calculated at a standardized temperature & pressure)
LAN – Local Area Network
LFL – Lower Flammability Limit
Mohm-cm – Mega ohm – cm, a measure of water resistivity
NEC – National Electric Code, NFPA 70
NFPA – National Fire Protection Association, a Standards Organization
Nm^3/h – Normal cubic meter per hour (International Normal conditions are 1.01325 bar and 0 Celsius)
NPT – National Pipe Thread
NRTL – Nationally Recognized Testing Laboratory
P&ID – Piping and Instrumentation Diagram (Fluid Schematic)
PEM - Proton Exchange Membrane
PPE – Personal Protective Equipment
PPM – Parts per Million
PSI – Pounds force per square inch (lb_f/in^2=6894.7 Pa)**,** a unit of pressure. All pressures are at gauge pressure unless otherwise specified.
SCFH – Standard cubic foot per hour (US Standard conditions for air are 1 atmosphere and 70°F)
Standard atmosphere = 1.01325 bara = 14.696 psia
TCU – Thermal Control Unit
TVSS – Transient Voltage Surge Suppressor
VAC – Volts Alternating Current
VDC – Volts Direct Current
WOMS – Water/Oxygen Management Subsystem

- Notes contain helpful suggestions or references.

- Indicates a potentially hazardous situation, which, if not avoided, may result in minor or moderate injury. It may also be used to alert against unsafe practices. This could result in equipment damage or loss of data.

- Indicates a potentially hazardous situation, which, if not avoided, could result in death or serious injury. The reader is in a situation that could cause bodily injury.

1 INTRODUCTION

Our Proton OnSite C Series Hydrogen Generator (Figure 1) is a Proton Exchange Membrane (PEM) water electrolysis system packaged for easy onsite installation and automatic operation. Configured with one, two, or three PEM stacks, the C Series Hydrogen Generator delivers 10, 20, or 30Nm^3/hr H_2 (21.6, 43.3, or 65 kg/day H_2) [380, 761 or 1141 SCF/hr H_2]. The C Series Hydrogen Generator is configured at the factory per customer requirements to operate in 'Tank Filling' or 'Load Following'. In Tank Filling configuration, the generator monitors an external hydrogen storage tank. When the pressure in the storage tank declines below a configurable threshold, the C Series unit produces H_2 until the pressure is above a second configurable threshold. In Load Following configuration, the generator monitors customer H_2 demand and automatically adjusts hydrogen generation rate to match the customer's process. In this configuration, the generator can deliver H_2 between 0 and 100% of rated flow rate.

The C Series Hydrogen Generator is designed to operate in a non-classified area. The generator can be configured at the factory according to customer environmental needs to operate in an indoor or outdoor environment.

Proton provides these instructions to guide the maintenance of a C Series Hydrogen Generators. Important safety information is also included in this manual. Please take the time to familiarize yourself with the system and this manual.

WARNING

DO NOT USE THE C SERIES HYDROGEN GENERATOR IN A MANNER NOT SPECIFIED BY PROTON.

Figure 1 - C Series Hydrogen Generator

This manual attempts to answer most of the frequently asked questions with regards to the operation of the unit. PROTON technical staff is also available to answer questions and support the successful deployment of this equipment. Please call **(203) 949-8697** and ask for technical service support or email **customerservice@protononsite.com**. Please have the serial number of your unit available.

After performing any service or maintenance work, make sure the doors to the enclosures are completely closed prior to the startup operation of your C Series Hydrogen Generator.

If the C Series is not operational, check for DI water content in the cell stack hoses every 30 days. If DI water is not present in the cell stack hoses, re-hydrate the cell stack hoses as needed. A cell stack hydration kit is available through PROTON.

PROTON can offer a full range of maintenance services. Contact PROTON Customer Service at (**203) 949-8697** or your local service provider/supplier for more information.

1.1 General Procedures

Prior to performing scheduled maintenance, the following measures should be taken:

- Make sure the work area is clean before beginning any maintenance work.
- Personal Protective Equipment (e.g. safety glasses, gloves, etc…) should be worn prior to beginning service of the system.

When hydrogen lines have been altered in any way, a system leak check is to be performed using a liquid gas detection method, handheld combustible gas sensor (supplied with unit) or equivalent.

Take special care to avoid introducing dust or metal particles into the water system. This may cause damage to the system.

Take special care to avoid damaging the doors and seals of the hydrogen generator. Visually inspect for dents, cracks, broken plastic, and other signs of damage on a regular basis. Contact PROTON or your local service provider/supplier to determine if damaged parts need to be replaced.

THE CELL STACK RETAINS A SIGNIFICANT CAPACITIVE CHARGE EVEN WHEN THE SYSTEM IS DISCONNECTED FROM POWER. CARE SHOULD BE TAKEN WHEN WORKING NEAR THE CELL STACK TO AVOID SHORT CIRCUITING THE TERMINALS.

IT IS ESSENTIAL THAT THE SAFETY SYSTEM IS NOT BYPASSED. CONTINUED OPERATION COULD RESULT IN SERIOUS INJURY AND/OR DAMAGE TO THE GENERATOR.

FAILURE TO CHECK FOR LEAKS IN THE SYSTEM AFTER MAINTENANCE TO HYDROGEN COMPONENTS MAY RESULT IN A SYSTEM SHUTDOWN AND MAY LEAD TO A DANGEROUS SITUATION.

1.2 Draining the System

1. Turn on the Electrolyzer circuit breaker handle (CB1) while depressing the *Up* and *Down* Arrow Keys on the user interface at the same time until the system momentarily displays 'Booting System in Service Mode' as shown in Figure 2.

Figure 2 - Flash Screen for Boot in Service Mode

2. Using the *Down* Arrow Key, scroll down to the 'Service Mode' menu item as shown in Figure 3 and depress the Enter button.

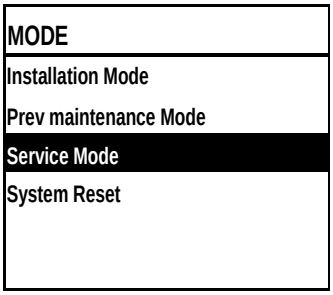

Figure 3 - 'Service Mode' Selection Screen

3. The C Series prompts the user for a password. Press the *Right* Arrow Key eight (8) times to access the required menu.
4. Once in 'Service Mode' menu, scroll down to the 'Adjust digital output' menu item and depress *Enter* (Figure 4).

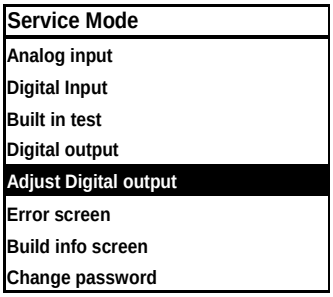

Figure 4 - 'Adjust Digital Output' Selection Screen

5. Within the 'Adjust digital output' sub-menu, scroll down to the 'SV211 A200 Drain Valve' as presented in Figure 5. Depress the *Enter* key to toggle between CLOSE and OPEN. The A200 can be drained with the valve in the OPEN position.

Adjust Digital output		
SV307-A	Stack A valve	CLOSE
SV307-B	Stack B valve	CLOSE
SV307-C	Stack C valve	CLOSE
SV329	Vent valve	CLOSE
CP205	Pump control	OFF
SV801	Calibration gas valve	CLOSE
SV211	A200 Drain valve	CLOSE
SV510	A500 Inlet valve	CLOSE

Figure 5 - 'A200 Drain Valve' Selection Screen

1.3 Lockout/Tagout Procedure

The Lockout/Tagout procedure is intended to prevent injuries during machine or equipment service and maintenance operations. Lockout/Tagout prevents injuries that can be caused by the unexpected energizing or start-up of machines or equipment, or the release of stored energy during maintenance and service jobs. This procedure should be applied any time maintenance or service work is done on the C Series hydrogen generator or TCU.

NOTE

Follow the Lockout/Tagout policy for the facility where the C Series hydrogen generator is installed.

WARNING

CONFIRM THE SYSTEM IS DE-ENERGIZED WITH A VOLTMETER.

WARNING

WEAR PROPER PPE PER NFPA 70E FOR VOLTAGE TESTING.

WARNING

DO NOT PERFORM SERVICE WITHIN THE DISCONNECT PANEL WITHOUT REMOVING POWER TO THE DISCONNECT PANEL AND LOCKING OUT THE POWER SOURCE.

The following steps outline an example of a Lockout/Tagout Procedure:

1. Prepare for shutdown.
   Before the authorized employee removes power on the C Series hydrogen generator and/or TCU, the authorized employee must know the type and magnitude of the energy and its hazards and must know how to control the energy. Before Lockout/Tagout devices can be applied, either the employer or the authorized employee must notify the affected employees.
2. Shutdown.

The C Series hydrogen generator or TCU must be turned off (not generating hydrogen or in stand-by mode) according to the established procedures. Shutting down the machine must not create any increased hazards from equipment stoppage.

3. Isolate the equipment.
   The authorized employee, who is performing the servicing or maintenance work, must isolate the C Series hydrogen generator or TCU from its energy sources. The energy-isolating device must be physically located and operated by the authorized employee.
4. Apply Lockout/Tagout devices.
   The authorized employee is to apply Lockout/Tagout devices to the energy-isolating device. Lockout devices must hold the switch in the "OFF" position. If a Tagout system is used, the tags must clearly show that moving the energy-isolating device from the "OFF" position is not allowed.
5. Release stored energy.
   Any potentially hazardous stored or residual energy from all sources and components must be released, relieved, disconnected, or restrained to make sure they are safe.
6. Verification.
   The authorized employee must verify that the Lockout/Tagout procedure successfully isolated the C Series hydrogen generator or TCU from its energy sources before electrical work begins. To verify that power is disconnected from the power source, use an approved voltage meter, rated to Category II or higher to check for no AC voltage.

To release the C Series hydrogen generator or TCU from Lockout/Tagout, use the following steps:

1. Check the C Series hydrogen generator and/or TCU.
   Before any Lockout/Tagout devices are removed, the authorized employee must replace all machine guards and remove all tools and nonessential items from the area. Remove any blocking devices that were inserted. Make sure the C Series hydrogen generator or TCU is intact and ready to operate.
2. Check for employees.
   The authorized employee must check the work area to make sure all employees are in a safe place away from the C Series hydrogen generator or TCU before any Lockout/Tagout devices are removed.
3. Remove Lockout/Tagout devices.
   The authorized employee who applied the Lockout/Tagout device is the only person authorized to remove it. After the Lockout/Tagout devices are removed and before the generator is started, the affected employees must be notified that the Lockout/Tagout devices have been removed.

The C Series hydrogen generator may be locked/tagged out using the built in disconnect, which disconnects T1, T2 and T3 (Figure 6).

WARNING

SUPPLY CONDUCTOR TO INPUTS OF T1, T2 and T3 WILL STILL BE ENERGIZED UNLESS THE FACILITY DISCONNECTS FOR THE HYDROGEN GENERATOR HAS ALSO BEEN LOCKED AND TAGGED OUT.

Figure 6 - C Series main disconnect switch, DS1

1.3.1 Discharging the Cell Stack

WARNING

THE CELL STACK RETAINS A SIGNIFICANT CAPACITIVE CHARGE EVEN WHEN THE SYSTEM IS DISCONNECTED FROM POWER. CARE SHOULD BE TAKEN WHEN WORKING NEAR THE CELL STACK TO AVOID SHORT CIRCUITING THE TERMINALS.

The cell stack holds a capacitive charge for an extended period of time. The charge may be as high as 90 volts DC immediately after the C Series is shutdown. This DC potential is exposed at the positive terminal of the cell stack and the positive DC terminals on the Power Supply module. It is important to prevent electric shock use the Cell Stack Voltage Dissipating Tool which is supplied with each system.

To use the Cell Stack Voltage Dissipating Tool, first remove the front cover to access the cell stack and then attach the alligator clips to the positive and negative terminals on the cell stack or the power supply DC buss bars. Perform this procedure to one cell stack or power supply set at a time. DC voltage below 5 volts DC is considered safe.

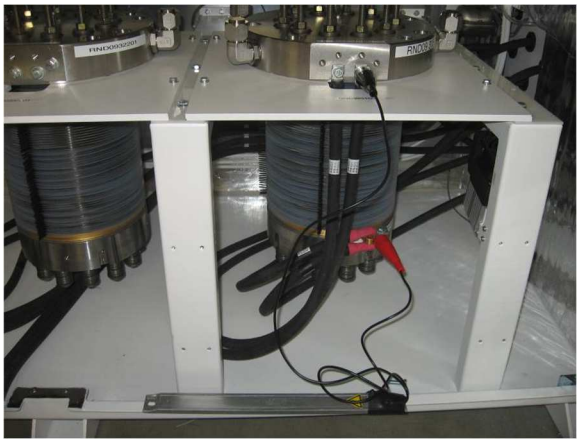

Figure 7 – Cell Stack Voltage Dissipating Tool in Use

CAUTION

Personnel with pacemakers, defibrillators or other electrical medical equipment should not perform any cell stack or power supply maintenance.

1.4 Tools Required

Most service procedures require basic hand tools: SAE wrenches, screwdrivers, pliers, etc. Some specialized tools are required and are listed in Table 1.
A detailed description on how to use the tool in its application can be found in the section where the tool is used. Before beginning any maintenance procedure, it is good practice to review the appropriate section of the manual to ensure the proper tools are assembled before beginning a maintenance procedure.

Table 1 - Specialized Tools Required for Scheduled Maintenance

Tools Required	Function	Provider
Basic Hand Tools: SAE Wrenches, Screwdrivers, Pliers, etc.	General Maintenance	Customer supplied
60 ohm, 1000 Watt Resistor and Spring Clips	Cell Stack Discharge	Included in Loose Parts
Hand Held Combustible Gas Detector and charger	Fault Analysis	Included in Loose Parts
Wrench, Spanner, Solenoid	Solenoid Replacement	Included in Loose Parts
Key, Enclosure, 7mm triangle	Open or lock door compartments	Included in Loose Parts
Wrench, Spanner 15, 20, 30, 50, 80	Orifice Replacement	Included in Loose Parts
Wrench, Spanner 70	Orifice Replacement	Included in Loose Parts
Liquid Leak Detector (TRAX)	General Maintenance	Sold separately
Calibration Gas: 2 Percent Hydrogen in Air Regulated to 50 psig	Combustible Gas Detector Calibration	Sold separately
Multimeter / DC Amp Clamp	Fault Analysis	Sold separately
Krytox® synthetic lubricant	O-ring Replacement	Sold separately

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NOTE

A standard set of tools is available from Proton. Contact PROTON Customer Service at **(203) 949-8697** for more information.

1.5 Compression Tube Fitting Information

The C Series Hydrogen Generator is designed to produce hydrogen that contains no more than 5 PPM of water and 1 PPM of other contaminants. Hydrogen can be delivered at pressures ranging from 0 to 30 barg (435 psig) and up to the unit's rated flow rate. The product hydrogen port uses a compression tube fitting for ¼" OD tubing 0.035" wall stainless steel. These fittings are reusable when used properly, according to the procedures included in this section.

To ensure proper connections, use the following procedure and See Figure 8 and Table 2.

1. Mark the fitting and nut for assembly reference.
2. Use the appropriate SAE wrench to loosen the nut.
3. Completely unthread the nut from the fitting before pulling off the nut.
4. When reassembling the fitting, make sure the assembly has been inserted into the fitting until the ferrule sits in the fitting.
5. Re-tighten the nut by hand.
6. Using an appropriately sized SAE wrench, tighten the nut until the reference marks are aligned (A noticeable increase in mechanical resistance should be felt.).
7. Tighten the nut an additional 1/12th of a turn (equal to ½ a flat surface on the nut).

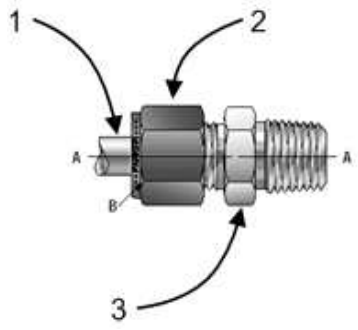


Figure 8 - Compression Tube Fitting Assembly

Table 2 - Tube Fitting Assembly Details

Reference	Detail
A	Reference Marks Made
B	1/12th Extra Turn of Nut
1	Tubing
2	Nut
3	Fitting

2 SERVICE BYPASS MODE, REMOTE BYPASS AND ERROR CODES

2.1 Service Bypass Mode

WARNING

ONLY AUTHORIZED SERVICE PERSONNEL SHOULD USE THE BYPASS KEY. EXTREME CARE SHOULD BE TAKEN WHEN WORKING IN THE VICINITY OF ENERGIZED COMPONENTS. NEVER OPERATE THE SYSTEM IN A POORLY VENTILATED AREA.

The service bypass mode can be used for the purpose of service, to allow the hydrogen generator to operate with the electrolyzer doors open without losing power, for one hour. If the doors remain open for longer than one hour the unit will shut down on an E-Stop error. The key is designed so that it is unable to be removed while in the bypass position facilitating detection of a bypassed condition.

In order to activate the service bypass mode on the C Series hydrogen generator during hydrogen generation, turn the key in the control panel area to the right after the dilution fan is rotating at full speed (Figure 9).

In order to exit the service bypass function while the hydrogen generation:

- Close all doors and covers securely.
- Wait for one minute for the system to ensure proper dilution air pressure.
- Return the key-switch to the left (RUN) position and remove the key.

CAUTION

REMOVE AND STORE THE SERVICE BYPASS KEY AWAY FROM THE C SERIES HYDROGEN GENERATOR WHEN SERVICE IS COMPLETE.

Figure 9 - Key in Service Bypass Mode

WARNING

AUTHORIZED SERVICE PERSONNEL SHOULD ONLY CARRY OUT THIS PROCEDURE. EXTREME CARE SHOULD BE TAKEN IN WORKING IN THE VICINITY OF ELECTRICAL COMPONENTS. NEVER OPERATE THE SYSTEM IN A POORLY VENTILATED AREA. IF A HYDROGEN LEAK IS SUSPECTED, DO NOT USE THIS FEATURE AS AN OVERRIDE.

2.2 Remote Start/Stop Bypass

The remote start/stop bypass key (SW2) is used to disable the remote start (TB16-25/26) and stop (TB16-11/12) commands. The key switch is located on the side of the controller panel inside the electrolyzer enclosure. The key uses two normally open contacts to open the signals from the customer to the control board when the key is in the "Local" mode. While in the Local mode the key can be removed from the switch and held by the service technician while performing maintenance or troubleshooting. To allow the remote start and stop commands to pass through to the controller the key should be placed in the switch and turned to "Remote". The key can remain in the key switch and in the Remote position during normal operation.

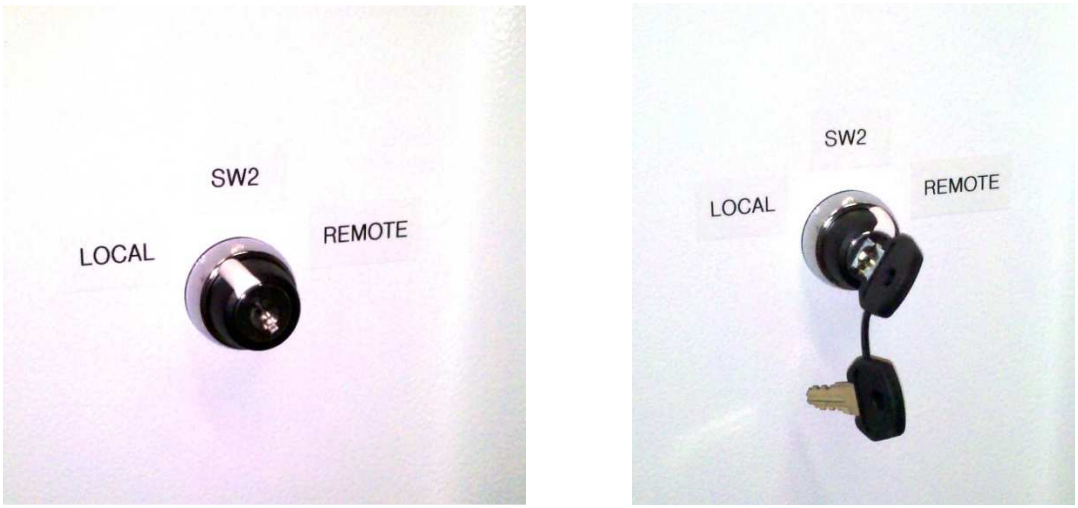


Figure 10 - Key switch in Local mode and Key switch in Remote Mode

2.3 Warning Codes

In the event the control system detects an abnormal condition, the system will output any of the following warning codes (Table 3). Please contact the Customer Service department at **(203) 949-8697** and ask for field service technical support, email customerservice@protononsite.com, or call your local service provider/supplier for more information.

Table 3 - Warning Codes

Code	Abbreviated Description	Detailed Description
W01-W05		RESERVED
W06	Low Temp – TE601 Coolant	TE601: Coolant temperature is low (< 3°C, 37.4°F).
W07	High Temp – TE601 Coolant	TE601: Coolant temperature is high (> 47°C, 116.6°F).
W08	High Temp – TE219 System	TE219: DI system temperature in A200 is high (> 63°C, 145.4°F). The hydrogen output will start to degrade.
W09	High Concentration – CG220	CG220: CG gas concentration in A200 is high (> 45% LFL).
W10-W17		RESERVED
W18	High Temp – TE159 P/S Enclosure	TE159: Air temperature in Power Supply enclosure is high (> 50°C, 122°F).
W19-W20		RESERVED
W21	Due – CG calibrations	CG220, CG121 & CG131 calibration is due within 2 weeks.
W22	CG in O_2 Low Reading	Hydrogen Concentration in A200 is reading <5% LFL

NOTE

Warnings do not shut down the C Series. Warnings alert that an undesirable condition exists and may result in an error. A corrective action should be taken to eliminate the warning before an error code results.

2.4 Error Codes

In the event the control system detects a fault that may require the C Series to cease operation, the unit will automatically shutdown. The graphical display will output any one of the following error codes (Table 4). Please contact the Customer Service department immediately at **(203) 949-8697** and ask for field service technical support or email customerservice@protononsite.com.

Table 4 - Error Codes

Code	Abbreviated Description	Detailed Description
E01_A	Low Voltage – Stack A	Cell Stack A voltage is low (< 0.8 Volts/cell).
E01_B	Low Voltage – Stack B	Cell Stack B voltage is low (< 0.8 Volts/cell).
E01_C	Low Voltage – Stack C	Cell Stack C voltage is low (< 0.8 Volts/cell).
E02_A	High Voltage – Stack A	Cell Stack A voltage is high (> 2.7 Volts/cell).
E02_B	High Voltage – Stack B	Cell Stack B voltage is high (> 2.7 Volts/cell).
E02_C	High Voltage – Stack C	Cell Stack C voltage is high (> 2.7 Volts/cell).
E03_A	Low Current – Stack A	Cell Stack A current is low (< 1 Amp).
E03_B	Low Current – Stack B	Cell Stack B current is low (< 1 Amp).
E03_C	Low Current – Stack C	Cell Stack C current is low (< 1 Amp).
E04_A	High Current – Stack A	Cell Stack A current is high (> 451 Amps).
E04_B	High Current – Stack B	Cell Stack B current is high (> 451 Amps).
E04_C	High Current – Stack C	Cell Stack C current is high (> 451 Amps).
E05_A	Stack Disabled – Stack A	Stack A disabled because of power supply fault or communication loss

Code	Abbreviated Description	Detailed Description
E05_B	Stack Disabled – Stack B	Stack B disabled because of power supply fault or communication loss
E05_C	Stack Disabled – Stack C	Stack C disabled because of power supply fault or communication loss
E06	Comm. Error (Startup) – Power Supply	Communications error between system controller and power supply modules during startup.
E07	Comm. Error (Generating) – Power Supply	Communications error between system controller and power supply modules during hydrogen generation.
E08	RESERVED	
E09	High Pressure – PT307 System	PT307 system pressure is high (> 33barg, 478.6psig).
E10	Low Pressure – PT307 System	PT307 system pressure is low (< 26.2barg, 380psig) for more than 50 seconds.
E11	RESERVED	
E12	High Temperature – TE219 System	TE219 system temperature is high in A200 (>65°C, 149°F).
E13	Low Temperature – TE219 System	TE219 system temperature is low in A200 (< 2°C, 35.6°F). *** MUST ENTER SERVICE MODE TO RESET ***
E14	Empty –A200	LS201 level sensor is at empty position in A200.
E15	Flooded – A200	LS201 level sensor is at flooded position in A200.
E16_A	Bad Water Quality – RS209	RS209 water quality sensor has detected poor water quality (<1Mohm-cm, >1µS/cm) for greater than 30 seconds.
E16_B	Bad Water Quality – RS507	RS507 water quality sensor has detected poor water quality (<1Mohm-cm, >1µS/cm) for greater than 45 seconds when SV510 is on.
E17	A200 Pre-Start Timeout	Time for LS201 level sensor in the A200 takes more than 30 minutes to reach high level during Start-up.
E18	A300 Empty	LS301 level sensor is at empty condition in A300.
E19	A300 Flooded	LS301 level sensor is at flood condition in A300.
E20_A	Bad Sensor – RS209	RS209 water quality sensor value is out of range.
E20_B	Bad Sensor – RS507	RS507 water quality sensor value is out of range.
E21	Fault – Safety Relay 1 Status	Safety relay SR1 is de-energized or SR1 is energized before the dilution fan (FAN132) is powered
E22	RESERVED	
E23	Fault – Safety Relay 2 Status	Safety circuit SR2 is de-energized
E24	High Concentration – CG220	CG220 hydrogen concentration in A200 exceeds 50 % LFL.
E25	RESERVED	
E26	Out of Range – CG220	Calibration values for CG sensor are out of range (CG220).
E27	RESERVED	
E28	Unexpected FSW250 Flow	Cell stack flow switch(es) are detecting flow prior to pump Start-up.
E29	Checksum Error – Controller	System controller has memory storage error
E30	Out of Range – 24V, 5V, 3.3V Supply	Input power source values to system controller are out of range.
E31	Fault – I/O Board Fuses	A digital output fuse is failed.
E32	High Temperature – Controller Board	The air temperature on the system controller board exceeds 65°C (149°F).
E33	Invalid State – A200 Level Switch	LS201 level sensor in the A200 is in a contradicting / illogical state.
E34	Invalid State – A300 Level Switch	LS301 level sensor in the A300 is in a contradicting / illogical state.

Code	Abbreviated Description	Detailed Description
E35	LS301 – Empty Drain Time Too Long	LS301 level sensor in the A300 does not go to empty state during 10 minutes of Gen-to-Vent state.
E36_A	Low Water Flow – Stack A	Flow switch is not detecting required flow condition for Cell Stack A.
E36_B	Low Water Flow – Stack B	Flow switch is not detected required flow condition for Cell Stack B.
E36_C	Low Water Flow – Stack C	Flow switch is not detected required flow condition for Cell Stack C.
E37	RESERVED	
E38	No Stacks Present	No Cell Stacks have been enabled.
E39	RESERVED	
E40	Calibration Due – CG220	Validity of CG sensor has elapsed (>104 days) and needs to be recalibrated.
E41	High Temperature – TE159 P/S Enclosure Air	Power supply enclosure air temperature is high (>55°C, 131°F).
E42	Out of Range – TE601 Customer Stack Coolant Supply Temperature	Coolant water temperature sensor value is out of range.
E43	Out of Range-PT312 Product Pressure	PT312 pressure sensor value is out of range.
E44	RESERVED	
E45	Out of Range – DPS340 Hydrogen Purity	DPS340 hydrogen purity sensor value is out of range.
E46	Out of Range – TE219 System Temperature	TE219 system temperature sensor value is out of range.
E47	Out of Range – PT307 System Pressure	PT307 system pressure sensor value is out of range.
E48	RESERVED	
E49	Low Purity – DPS340 Water Vapor	DPS340 product dew point sensor is low (< configurable parameter P48).
E50	Low Product Pressure – PT312	PT312 product pressure is low (<configurable parameter P50) for more than 10 seconds.
E51	Out of Range – TE128 Electrolyzer enclosure Temperature	TE128 electrolyzer enclosure air temperature sensor is out of range.
E52	High Pressure – PT312 Product	PT312 product pressure is high (> 35barg, 507.6psig).
E53	Time Out – Cold Start Temperature	TE219 system water temperature is low (< 22°C, 71.6°F) for more than 300 minutes after generation.
E54	Alarm – TCU	Thermal Control Unit is either faulted or is not on-line during hydrogen generation.
E55	Time Out – A500	Time for LS501 level sensor in the A500 takes more than 90 minutes to reach low level during Start-up.
E56	Empty – A500	LS501 level sensor is at empty condition in A500.
E57	Flooded – A500	LS501 level sensor is at flooded condition in A500.
E58	Invalid State – LS501	LS501 level sensor in the A500 is in a contradicting / illogical state.
E59	Out of Range – PT207 Oxygen	PT207 oxygen pressure sensor value is out of range.
E60	High Pressure – PT207 Oxygen	PT207 Oxygen pressure is high (> 2.76barg, 40psig)
E61	High Pressure – PT307 Gen to Vent Hydrogen	PT307 system pressure value is too high during Gen-to-Vent state (>10 minutes).

NOTE

Errors E03, E05 and E36 shut down the individual stack(s), but the C Series still operates at partial capacity (degraded mode operation) (Table 5).

2.5 Operating Modes

The C Series will display the following operating modes:

Table 5 - Operating Modes

Mode	Description
M01	Hydrogen Generation – Load Following Mode
M02	RESERVED
M03	Hydrogen Generation – Tank Filling Mode
M04	Standby / Idle
M05	Degraded Mode due to Power Supply Failure
M06-M08	RESERVED
M09	Degraded Mode due to Low Current
M10	RESERVED
M11	Degraded Mode due to High Temperature
M12	Degraded Mode due to Stack Water Flow Issue
M13	Combustible Gas Sensor Calibration Mode
M14	Firmware Upgrade
M15	Generate to Vent Mode
M16	Error Condition - Unit Shutdown Mode

3 GENERAL INSPECTIONS

3.1 General Area Inspection

It is important that the area surrounding the C Series is kept clear of combustible materials as well as any excess materials that might obstruct any intake or exhaust openings. This inspection should be done routinely as determined by the customer on a case by case basis. Factors like the likelihood of the area being used as a storage area and whether walls or fencing might trap combustible materials should be taken into consideration.
During this time the area surrounding the C Series should be inspected for signs of physical deterioration which might undermine any structural support for the hydrogen generator.

3.2 Vent Stack Inspection

The C Series has a hydrogen vent and oxygen vent that can be configured to either be integrated into existing hydrogen and oxygen vent systems or both to be stand-alone vent stacks. The oxygen vent releases oxygen continuously during operation and the hydrogen vent releases small amounts of hydrogen during operation and to depressurize the system upon shutdown. It is important that these two vent systems always be clear of obstructions to ensure proper operation of the C Series. Provide routine inspection to

ensure the vent lines are clear from obstruction and it provides a free vent path to the atmosphere. This inspection is to include any customer supplied components.

4 QUARTERLY MAINTENANCE

Tools Required: Combustible Gas Detector; Calibration Gas (2 Percent Hydrogen in Air) and regulator
Estimated Time to Complete: <1 Hour Total

4.1 Quarterly Maintenance Checklist

Complete Table 8 located in Section 6 (Page 55) and file a copy in the Unit Log Book.

4.2 Plumbing Inspection and Maintenance

Both the C Series Power Supply Enclosure and Electrolyzer Enclosure have configured plumbing with liquid flowing through them. In case of a major leak, each enclosure is equipped with two flood switches attached to the floor (see Section 5.3.3 on page 34) to immediately stop hydrogen production and remove electrical energy from potentially dangerous equipment. The Electrolyzer Enclosure requires DI water and coolant and the Power Supply Enclosure requires just coolant.

The Electrolyzer Enclosure has three separate drain traps to collect condensate from the hydrogen dryer, oxygen and hydrogen vent lines. It is common to see a small amount of water accumulate from these traps on the inside floor of the Electrolyzer Enclosure. The forced air flow through the Electrolyzer Enclosure causes evaporation, which will keep any water accumulation to a minimum.

The Power Supply Enclosure is a sealed enclosure with an active dehumidifier that drains to the outside. It is not common to see any liquid or condensate accumulate inside.

For both enclosures, use the following instructions:

1. Immediately after operation, open the doors on the Electrolyzer Enclosure and visually check for excessive DI water or coolant leaks at all plumbing connections.

If leaks occur in the Electrolyzer Enclosure, evaluate the size of the leak and components that are exposed to the leak to determine if an immediate repair is required or to monitor the leak and repair it at a later date.

2. Check the condensate drain of the Power Supply Enclosure to monitor if any large amount of water is dispelled. Open the doors of the enclosure and visually check for any coolant leaks or condensation on any components. Repair as required.

3. Check coolant level in TCU. If coolant level is low add an appropriate mix of distilled water (or de-ionized water) and propylene glycol. Use a mixture of propylene glycol and water appropriate for local ambient temperatures. Water/Propylene Glycol Specifications: pH 7.0 to 9.0, chloride <20ppm, nitrate <10ppm, sulfate <100ppm, total solids <250ppm, calcium carbonate <250ppm

4.3 Combustible Gas Sensor Calibration

The combustible gas sensors output a signal that is proportional to the percentage of combustible gas present at the catalytic bead up to 100 percent Lower Flammability Limit (LFL).

THE COMBUSTIBLE GAS DETECTORS NEED TO BE CALIBRATED EVERY THREE (3) MONTHS WITH 2% HYDROGEN IN AIR MIX AND REGULATED TO 50 PSIG (3.5 BARG) FOR PROPER OPERATION OF GAS DETECTING EQUIPMENT WITHIN THE HOGEN GENERATOR.

The controller issues a W21 CG calibration warning, which indicates that calibration needs to be completed within a 2-week period or the C Series shuts down on an E40 error, CG Calibration Expired + 2 Weeks.

4.3.1 Combustible Gas Sensor Calibration Instructions (P&ID Tag CG220)

Every three months, a Cal gas warning, W21, is displayed for expired calibration, which prompts the user to initiate calibration through the user interface.

During calibration, in the event of an error, an appropriate error code is displayed.

1. Cycle power to the control board by turning off power using CB1, waiting 10 seconds, and then turning CB1 back on. While applying power hold the up and down arrows on the front panel to put the unit into the Mode menu. Scroll down to Preventative Maintenance and press enter. The password is 8 down arrows.
    a. Remove the electrical connector, unscrew and remove CG220 from the A200 manifold. Re-install the electrical connector (Figure 11).
    b. Press the Down Arrow Key and scroll down to the ‘Calibrate CG sensor’ menu option and press Enter.
    c. Step C02 will automatically set the zero of CG220 (“Wait for Offset”).
    d. At step C03, apply the calibration gas (“Apply Cal Gas”). Immediately apply the calibration gas (Figure 11).

Figure 11 - Calibration Gas for CG220

e. At step C04 (“Remove Gas”), remove the calibration gas and the hood.
f. At the conclusion of C04, ‘SUCCESS’ should be displayed in the lower left information bar represented in Figure 12.

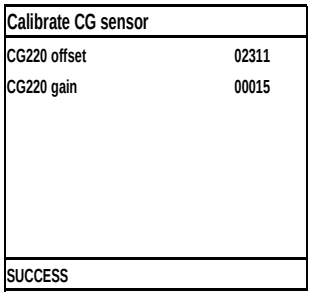


Figure 12 - CG Calibration Success Screen

g. Remove the electrical connector, screw CG220 back into the A200 manifold and re-install the electrical connector.
h. Press the Left Arrow Key two times, scroll down to ‘System reset’ and press Enter.

CAUTION

If calibration fails, the C Series aborts Cal values, reverts to the previous calibration values, including calibration due date, and issues a warning, W20.

4.3.2 Combustible Gas Sensor Calibration (P&ID Tag CG121)

The following steps shall be performed every three months at the same time CG220 is calibrated. For full calibration details and instructions see PD-0110-0004, *MSA Ultima/Ultima X Series Controller and Calibrator Instruction Manual* that is additionally supplied with your unit.

1. Attach the calibration bottle hose to the calibration port on CG121. Do not apply gas at this point. See Figure 13.
2. Hold the black button (SW1) until the CG121 screen displays a small heart ♥.
3. Release the button.
4. Press and hold the button within 3 seconds of the button being released.
5. Release the button when the CG121 screen displays CAL SPAN (approximately 10 second hold time).
6. The sensor will start the zero air calibration. The CG121 screen will display APPLY ZERO GAS. Do not apply calibration gas at this point. Wait for the 30 second countdown to expire.
7. When the CG121 screen displays APPLY SPAN GAS, open the regulator on the calibration bottle and apply the span gas to the sensor. **NOTE:** This can take several minutes for the measurement to stabilize.
8. When the CG121 screen displays END the calibration was successful.
9. Turn off the calibration gas. Wait for the CG121 screen to display 0% LFL.
10. Turn on the calibration gas and verify that the CG121 screen displays 50% LFL with the calibration gas applied.
11. Once 50% LFL has been verified, close the regulator and remove the calibration gas from the calibration port.
12. Return the system to normal operation.

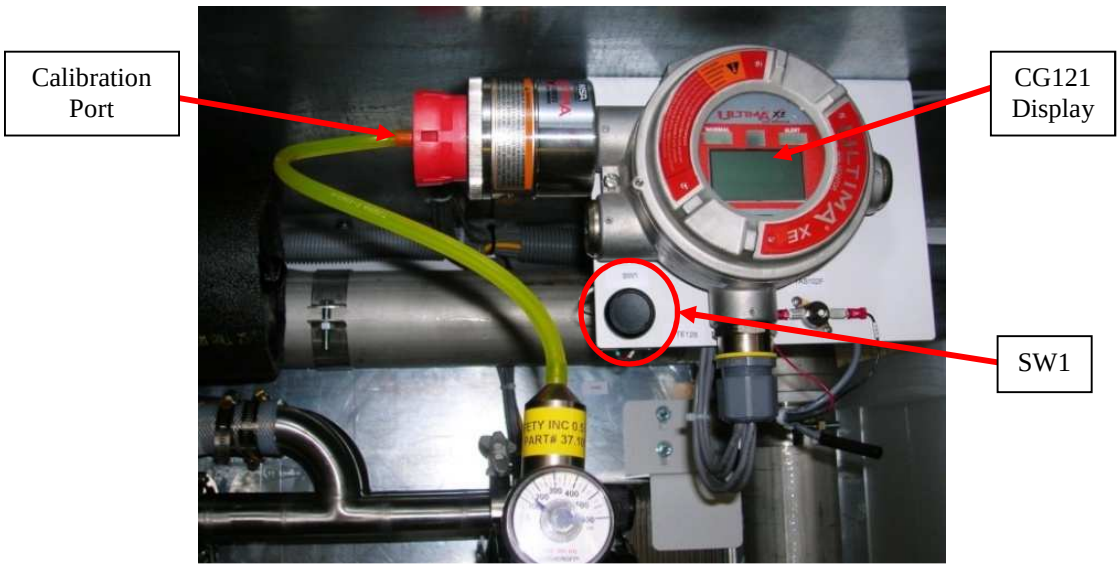


Figure 13 - Calibration gas for CG121

4.4 High Power Electrical Connection Check

To perform the electrical supply connection check, use the following instructions:

1. Place the C Series in 'Ready to Start' state by depressing the "0" Stop button.
2. Turn off the electrolyzer circuit breaker (CB1)
3. Remove the electrical power by turning the Main Disconnect Switch (DS1) to off position (Figure 6).
4. Perform all necessary Lockout/Tagout procedures (Section 1.3)

Open the electrical enclosure door and check the wire locations listed in Table 6 (see Table 7 for SN's before 50) for visual signs of thermal damage due to a loose connection, pinched insulation, etc. If required, check fastener torque and tighten to values listed in Table 6 (see Table 7 for SN's before 50).

C Series After Serial Number 49

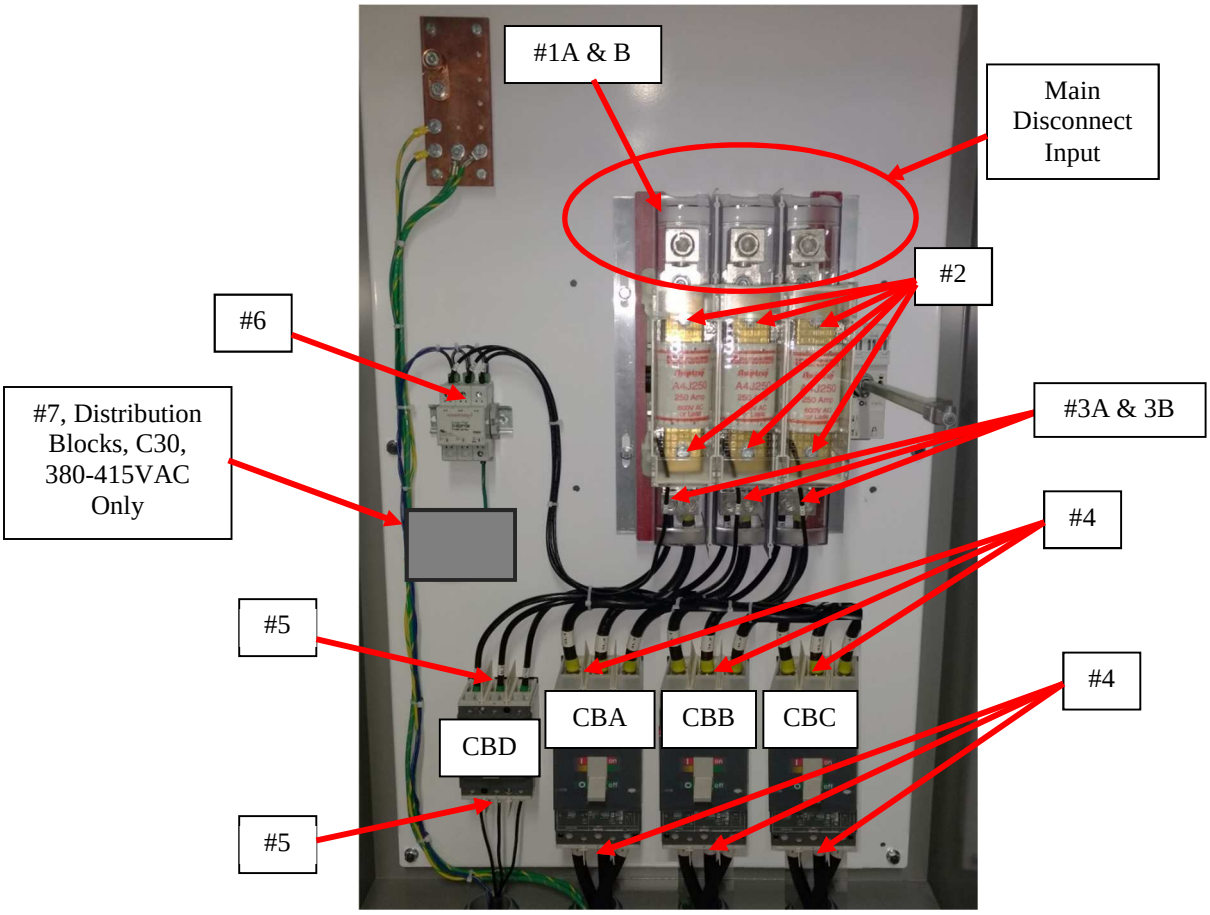


Figure 14 - High Power Electrical Connections (After SN49)

Table 6 - Recommended Torque for Disconnect Enclosure Connections (After SN50)

Location	Description	Recommended Torque	Tool Required
Figure 14, #1A	AC service (line) – Pressure Screw	375 lb-in (42.4 N-m) for all configurations	3/8” or 1/2” hex key
Figure 14, #1B	AC service (line) – Bolt	310 lb-in (35 N-m) for C30, 380-415VAC 398 lb-in (45 N-m) for All Other C Series	17mm wrench 17mm wrench
Figure 14, #2	Visual inspect Main fuses (line & load)	372 lb-in (42 N-m) for C30, 380-415VAC 106 lb-in (12 N-m) for All Other C Series	3/4” (19mm) wrench 1/2” (13mm) wrench
Figure 14, #3A	Visual inspect Distribution (load) – Pressure Screw	275 lb-in (31 N-m)	5/16” hex key
Figure 14, #3B	Visual inspect Distribution (load) - Bolt	310 lb-in (35 N-m) for C30, 380-415VAC 398 lb-in (45 N-m) for All Other C Series	17mm wrench 17mm wrench
Figure 14, #4	Visual inspect CBA, CBB & CBC, (line & load)	120 lb-in (13.6 N-m)	5/16 hex key
Figure 14, #5	Visual inspect CBD (line & load)	32 lb-in (3.6 N-m)	Flathead screwdriver
Figure 14, #6	Visual inspect Surge Protector (line)	15 lb-in (1.7 N-m)	Flathead screwdriver
Figure 14, #7	Visual inspect terminal blocks (line & load), C30, 380-415VAC Only	Line: 120 lb-in (13.6 N-m) Load: 20 lb-in (2.3 N-m)	3/16” hex key 1/8” hex key

C Series Before Serial Number 50

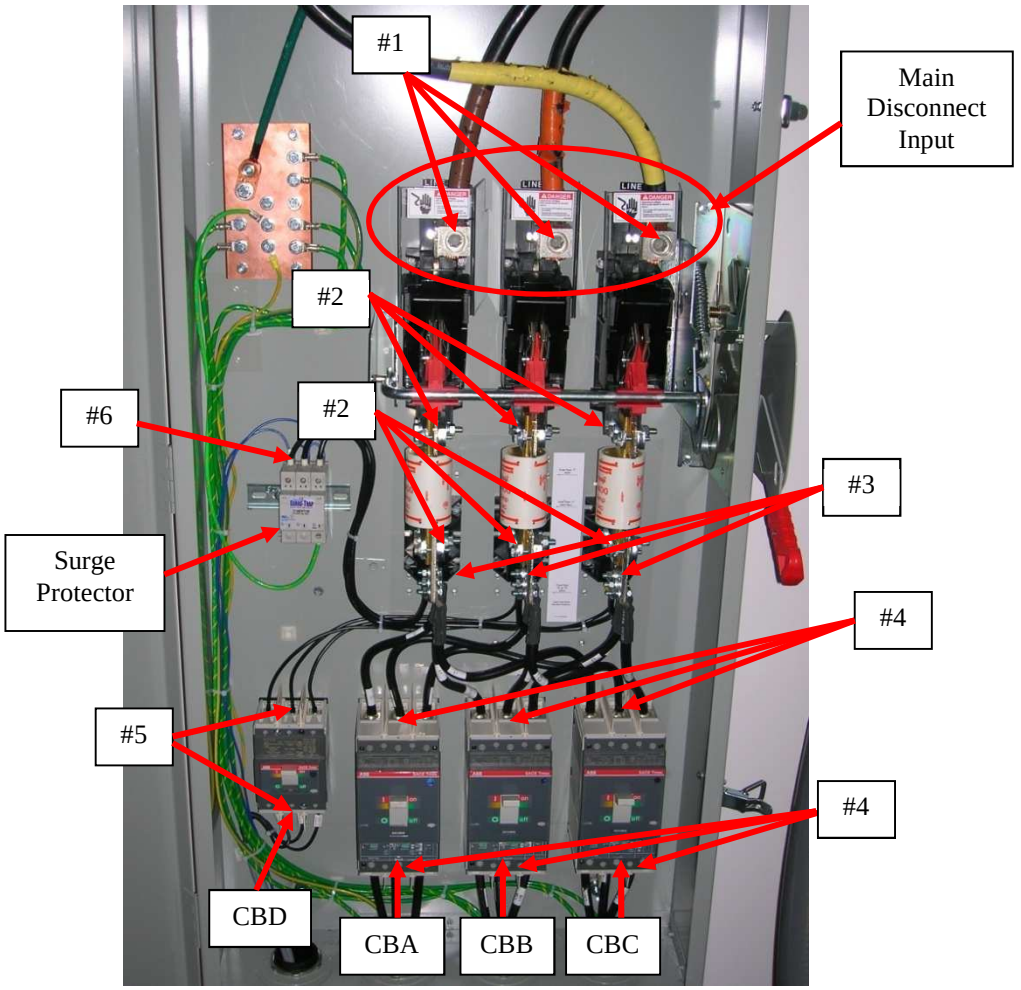


Figure 15 - High Power Electrical Connections (Before SN50)

Table 7 – Recommended Torque for Power Panel Connections

Location	Description	Recommended Torque	Tool Required
Figure 15, #1	AC service (line)	500 in-lb (56.5 N-m)	½" hex key
Figure 15, #2	Visual inspect Main fuses (line & load)	50 in-lb (5.6 N-m)	7/16" wrench
Figure 15, #3	Visual inspect Distribution (load)	50 in-lb (5.6 N-m)	7/16" wrench
Figure 15, #4	Visual inspect CBA, CBB & CBC, (line & load)	275 in-lb (31.1 N-m)	6mm hex key
Figure 15, #5	Visual inspect CBD (line & load)	35 in-lb (4.0 N-m)	3/6" hex key
Figure 15, #6	Visual inspect Surge Protector (line)	15 in-lb (1.7 N-m)	Flathead screwdriver

4.5 Surge Protection Inspection

To perform a surge protection check, use the following instructions:

1 Visually inspect the indicator tab locations of each surge protector (SUP1 is located next to fuse T1). See Figure 15, Item #6.
2 If an indicator tab protrudes out of any tab location, the surge protector must be replaced.

NOTE

Perform the surge protection check if there is any interruption of power that is abnormal, i.e. a power outage due to inclement weather.

4.6 Air Filter Inspection and Maintenance

The C Series Hydrogen Generator uses air filters on the Electrolyzer Enclosure to protect the internal components from contamination from the outside environment (ingress protection). The unit uses one disposable air filter on the inlet to remove contaminants from the dilution air entering the system and another on the exhaust to prevent contaminates from entering the C Series when the unit is in standby state. The maintenance interval for the filters is dependent upon the local ambient conditions where the C Series Hydrogen Generator is located. Very dusty and/or windy locations may require more frequent filter service. The maximum service interval for air filters is 12 months.

CAUTION

Do not prevent airflow by blocking either the air inlet or outlet.

For the inlet and outlet air filters, use the following instructions:

1. If the unit is generating hydrogen, place the C Series in 'Ready to Start' state by depressing the "0" Stop button.
2. Using a screwdriver, unscrew the exterior screws of each shroud and remove them from their respective door. Note the inlet shroud on the right door has an additional cover over the screen.
3. Remove both plastic grill covers holding the filters in place.
4. Inspect and replace the air filters as required.
5. Re-install both plastic grill covers.

6. Re-install the front shrouds to their respective doors and secure with original screws.

NOTE

When the inlet filter becomes clogged, the pressure sensor trips the safety circuit. To restart, replace the inlet filter and recycle the C Series power.

NOTE

Installing the front air shrouds to the wrong doors will cause the purge switches, PSW121A&B to not correctly function (Page 33).

4.7 Date and Time Check

Use the following procedure to check or change date and time on HCS display:

1. Place the C Series in 'Ready to Start' state by depressing the "0" Stop button.
2. Remove the electrical power by turning the Electrolyzer circuit breaker handle (CB1) to off position.
3. Wait 5 seconds before turning on the Electrolyzer circuit breaker handle (CB1) while depressing the Up and Down Arrow Keys at the same time until the system momentarily displays 'Booting System in Service Mode' as shown in Figure 2.
    a. Select the 'Installation Mode' menu item and depress the Enter button (Figure 16).

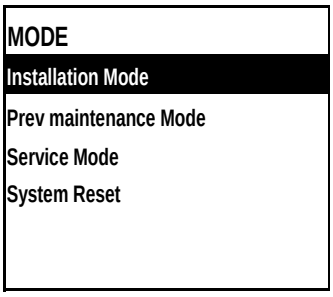


Figure 16 - User Interface Installation Mode Selection Screen

    b. The C Series prompts the user for a password. Press the Up Arrow Key eight (8) times to access the required menu.
4. Set Time and Date
    a. Scroll down to the line identified as 'Set Time' and depress Enter (Figure 17).

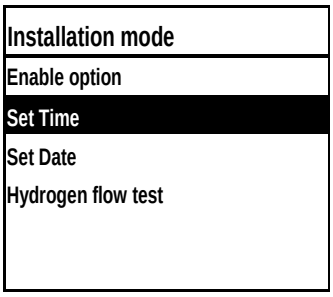


Figure 17 - Installation Mode Set Parameter Selection Screen

b. Using the Up, Down and Right arrows adjust the time to correspond with local time. When complete, depress Enter.
c. Scroll down to the line identified as 'Set Date' and depress Enter (Figure 17).
d. Using the Up, Down and Right arrows adjust the date to correspond with today's date. When complete, depress Enter.

5 ANNUAL MAINTENANCE

Tools Required: A Pair of Pliers; 11/16" Wrench; 9/16" Wrench; 13 mm Wrench; Rubber Mallet; Retainer Ring Seat Tool; 3/16 Allen Wrench; Needle Nose Pliers
Estimated Time to Complete: 4 Hours Total

NOTE

It is estimated that the Dryer Desiccant Replacement, Section 0, will take two (2) hours to complete.

5.1 Annual Maintenance Checklist

Complete Table 9, located in Section 7 and file a copy in the Unit Log Book.

5.2 High Power Electrical Connections

Verify and torque all the connections listed in Section 4.4 based on your serial number.

5.3 Safety Circuit Checks

All components associated with the safety circuit chain shall be checked annually and tested to ensure the safety circuit is functioning properly.
See the following documents:

P&ID
XPE2739 P&ID, HYDROGEN GENERATOR, C SERIES 2

Electrical Schematic
XPE2730 SCHEMATIC, ELECTRICAL, C SERIES 2

5.3.1 PSW121 A&B

The pressure switches measure the pressure in the Electrolyzer Enclosure relative to the ambient atmosphere. There are two pressure switches (PSW121 A&B) located in the ceiling of the Electrolyzer Enclosure. When the fan creates negative pressure on the Electrolyzer Enclosure, the pressure switches close and closes the safety chain circuit.

To check the pressure switches, perform the following tests:

1. With the 240VAC Electrolyzer circuit breaker handle (CB1) on and the door open, turn on the hydrogen generator by depressing the "1" Start button.
2. When the purge fan turns on, watch when the TR1 timer starts flashing (indicating both pressure switches have been satisfied – closed.)
3. On the right door, completely cover the screen of the air inlet shroud to "choke off" the airflow. Visually verify that the TR1 timer quits flashing until the obstruction is removed.

4. On the left door, completely cover the screen of the air outlet shroud to "block" the airflow. Again, visually verify that the TR1 timer quits flashing until the obstruction is removed.

NOTE

The C Series will lose negative pressure if the Electrolyzer doors are open while the C Series is generating hydrogen, if the fan is not operating properly, the air filters are clogged or something is blocking the air flow. Pressure levels out of range will indicate improper air flow and prompt the pressure switches to open the safety circuit.

5.3.2 E-Stop Check

An emergency stop, designed in accordance with ISO 13850, is located on the control panel. Observe all 3 lights on the Safety Circuit SR2 are illuminated and depress the red E-Stop button. This will trip safety relay SR2. Note: only A1/A2 Fuse is illuminated. Release the E-Stop button to verify all lights are again illuminated on SR2.

NOTE

The E-Stop is a NORMALLY CLOSED circuit. Engaging the E-Stop trips the contactor, which stops hydrogen production and removes power to safety-critical components and circuits, but the 24V power supply and controller inside the electrical enclosure remain energized. If generating hydrogen, the generator safely depressurizes and releases all gas through the hydrogen vent when the E-Stop is engaged. Error E23 will be displayed on the front display.

5.3.3 Flood Level Switches

The level sensors detect flooding in the enclosures. There are two level sensors in each enclosure of the C Series Hydrogen Generator. LS101F and LS102F are in the Electrolyzer Enclosure and LS101P and LS102P are in the Power Supply Enclosure.

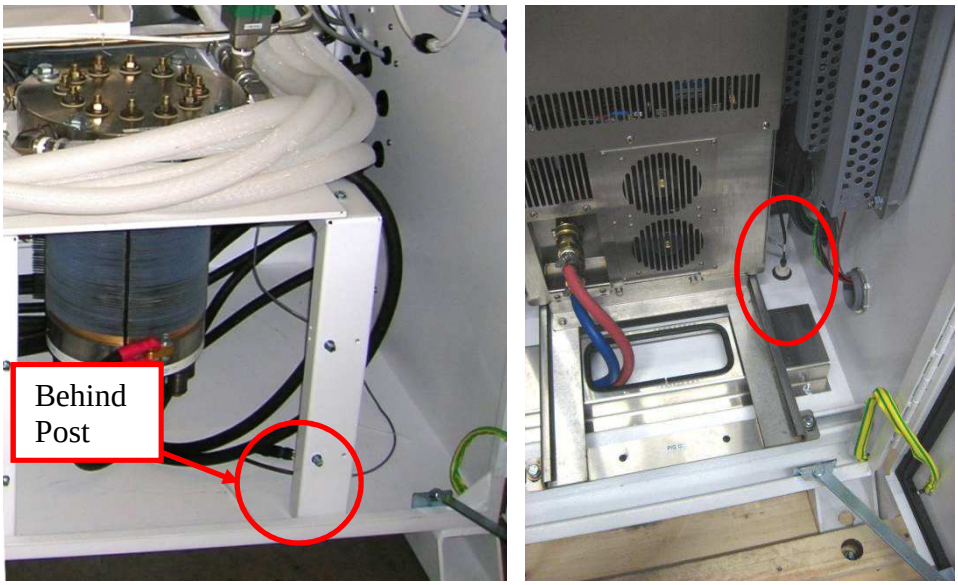


Figure 18 - Flood Level Switches

The level sensors are NORMALLY CLOSED, which means they have electrical continuity through them.

If there is a flood in the enclosure, the level sensors will open and trip the safety circuit to remove DC power to the cell stacks.

To test the level sensors, perform the following tasks:

1 Place the C Series in 'Ready to Start' state by depressing the "0" Stop button.
2 Observe all 3 lights on the Safety Circuit SR2 are illuminated.
3 Lift the float on any level sensor.
4 Observe that the safety circuit is tripped.
5 Release the float and verify associated SR2 input illuminates.
6 Reset safety circuit by depressing the E-Stop on the door and releasing.
7 Perform above steps for the other level sensors.

5.3.4 TAS102 P & F and TAS166 A, B, & C

In the case of an internal high temperature event, the thermal switches will detect the excessive high temperature in the enclosure. There are five thermal switches in the C Series Hydrogen Generator - TAS102P (located in the Power Supply Enclosure), TAS102F and TAS166 A, B, & C located in the Electrolyzer Enclosure (Figure 19).

The contacts are NORMALLY CLOSED and open when the surface or the ambient temperature set point is reached. The circuit remains open until the manual reset button is depressed and also only when the ambient temperature is approximately 70% of the set point temperature.

If there is an excessive temperature increase in the enclosure, the thermal switches open and trip the safety circuit to shut down power. To test the thermal switches (TAS102 E & F and TAS166 A, B, & C), use the following directions:

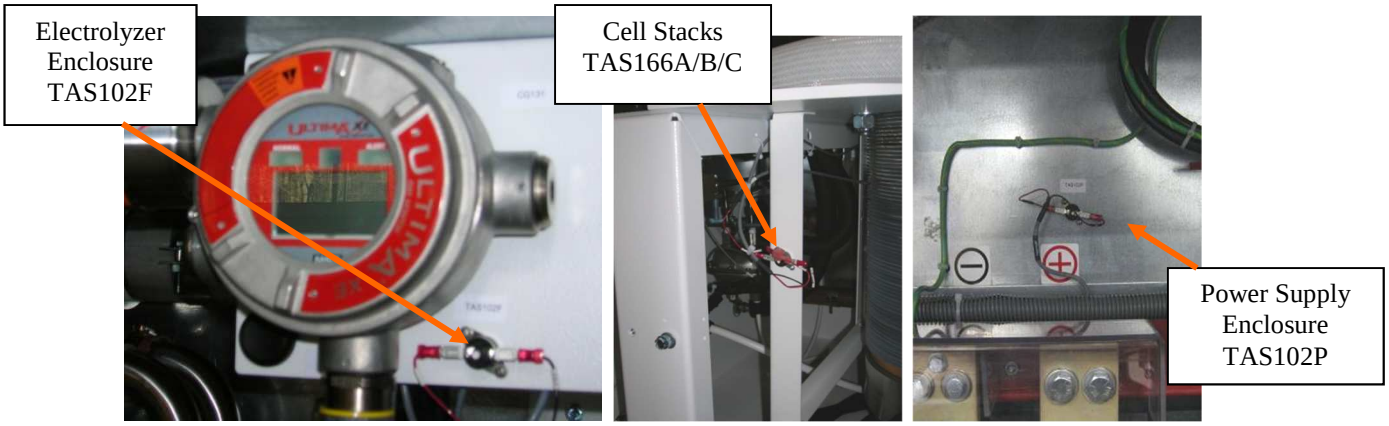


Figure 19- Electrolyzer and Power Supply Enclosure Thermal Switches

1. Place the C Series in 'Ready to Start' state by depressing the "0" Stop button.
2. Remove one Quick Connect terminal from one temperature switch.
3. Observe that the safety circuit is open. (This is a latching fault. The safety circuit does not reset when the Quick Disconnect is replaced.)
4. Replace removed Quick Connect.
5. Reset safety circuit by depressing the E-Stop on the door and releasing.
6. Perform above steps for each of the other sensors.

5.3.5 Remote E-Stop Button

The Electrolyzer's Remote E-Stop will shut down the electrolyzer any time the circuit loses connection between TB16-5 and 6. Error E21 will be displayed on the front display if the remote E-Stop is opened while the system is generating. The customer may connect TB16-5 and 6 to the site's emergency-stop circuit to shut down the electrolyzer remotely. Separately, spare contacts from the electrolyzer's own emergency stop button are made available to TB16-1, 2, 3, and 4. The customer can monitor the status of the electrolyzer's E-Stop button by connecting to TB16-1, 2, 3, and 4 (refer to electrical schematic XPE2730).

5.3.6 Time Delay Relay

The time delay relay, TR1, is a 30-second, factory-set window that allows the C Series dilution fan to turn on and reach normal flow which triggers a negative pressure in the enclosure (Figure 20).

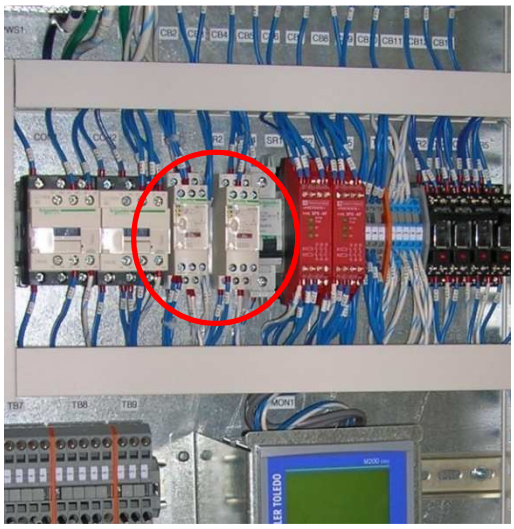


Figure 20 - Time Delay Relay Location

NOTE

The time delay relay is factory-set and should not be adjusted.

5.4 Pump Filter Replacement (P&ID Tag F210)

Maintenance Parts from Annual Maintenance Kit: Item 19

Use the following instructions to replace the pump filter:

1. If the C Series is either in generating or standby state, stop it down by pressing the Stop key.
2. Drain the system by activating the A200 drain on the user interface See Section 1.2.
3. Turn off electrolyzer circuit breaker (CB1)
4. Remove the electrical power by turning the Main Disconnect Switch (DS1) to off position (Figure 6)
5. Perform all necessary Lockout/Tagout procedures (Section 1.3)
6. Shut off the DI water supply.
7. Open the front doors of the C Series Electrolyzer Enclosure.

CAUTION

10 gallons (38L) of water stored in the system need to be drained before the system can be shut down.

1. Unscrew the strainer housing counterclockwise from the Y-strainer (Figure 21).

Figure 21 - Strainer Housing Locations

NOTE

Water will spill out from the strainer housing. Use a catch pan to minimize water spillage.

2. Remove the old filter element from the strainer housing and discard (Figure 22).

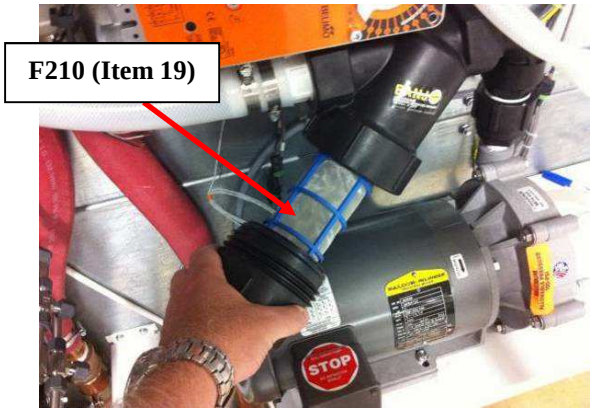


Figure 22 - Removing the Filter

3. Install the new filter element into the strainer housing.
4. Re-install the strainer housing. Hand-tighten.

NOTE

Make sure the O-ring is centered in the fitting.

5.5 A500 Inlet Filter Replacement (P&ID Tag F506)

Maintenance Parts from Annual Maintenance Kit: Item 18

1. Ensure the A500 is drained to below the inlet.

Figure 23 - F506 Filter

2. Note the flow direction arrow on the installed filter.
3. Remove the filter from the water lines (Figure 23). Use a catch pan to minimize water spillage.

4. Retain the fittings from the filter; they need to be reused, as they are not provided with the replacement filter.
5. Discard the old filter
6. The NPT threaded fittings will require new Teflon tape to be added to its threads. Apply a minimum of two wraps of tape in the direction of the threads.
7. Remove all old Teflon tape from removed fittings.
8. Install the new filter into the system with the flow direction arrow facing upwards toward the A500.

5.6 Guard Bed Polishing Bag Replacement (P&ID Tag GB208A & GB208B)

NOTE

A C10 configuration only has one guard bed. A C20 or C30 has two guard beds.

Maintenance Parts from Annual Maintenance Kit: Items 20 and 21

Figure 24 - Guard Bed Housing Assemblies Location

1. Loosen the three top clamp screws on the guard bed housing and swing out of the way (Figure 24).
2. Carefully remove DI bag from the housing. Use a catch pan to help minimize any water spillage.

Figure 25 - DI Bag Removal

3. Replace the consumed DI bag with the new one by carefully forming and inserting into the housing.

Figure 26 - Guard Bed Filter DI Bag

CAUTION

ENSURE care is taken to not damage the DI bag. Damaging the bag will free the resin beads into the water system.

4. Ensure bag is inserted below the top fitting.

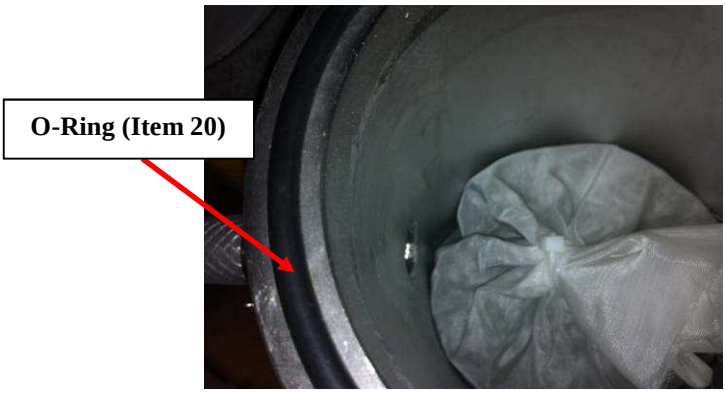


Figure 27 - DI Bag below Upper Fitting

5. Place cover on housing and tighten the three top clamp screws.

5.7 Hydrogen Filter & Orifice Replacement

Tools Required: A pair of pliers.

NOTE

A C10 configuration has only one A300 (F365A). A C20 or C30 has two A300's (F365A and F365B). The replacement instructions are the same for F304, F365A and F365B.

5.7.1 Hydrogen Filter Replacement (P&ID Tag F304, F365A and F365B)

Maintenance Parts from Annual Maintenance Kit: Items 4 and 5

Use the following instructions to replace up to three (3) hydrogen filters and two (2) drain orifices:

1. Unscrew the cap to the hydrogen filter and set aside (Figure 28).

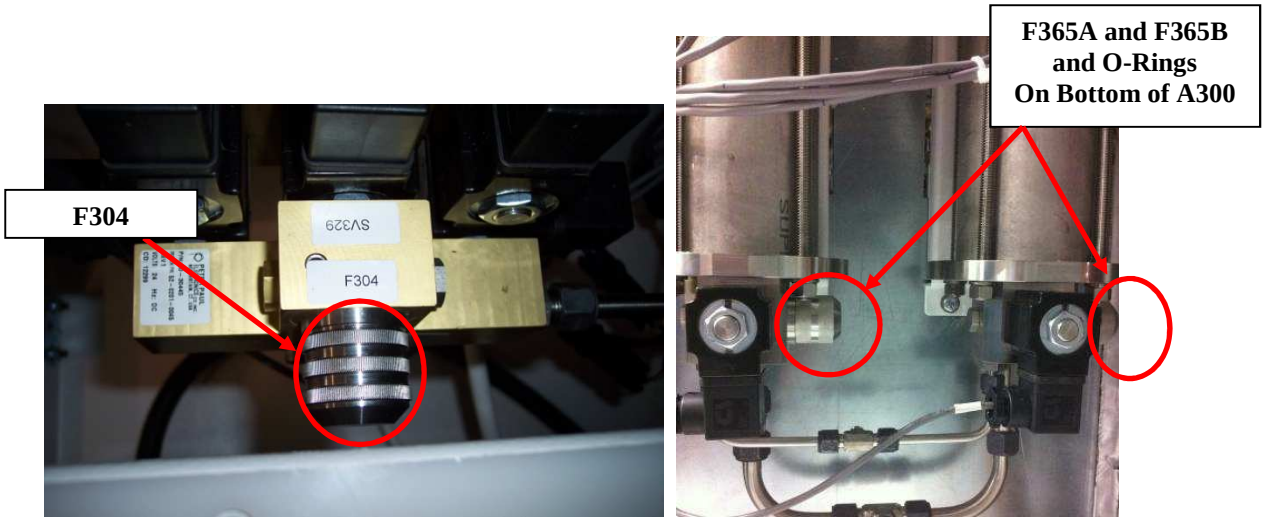


Figure 28 - A300 Hydrogen Filter Locations

NOTE

If the cap is screwed on tightly, use a pair of pliers to loosen it.

2. Remove the old screen element from the filter and discard.
3. Install the new screen element to the filter (Figure 29).
4. Inspect the O-ring on the cap for damage. Replace if necessary.

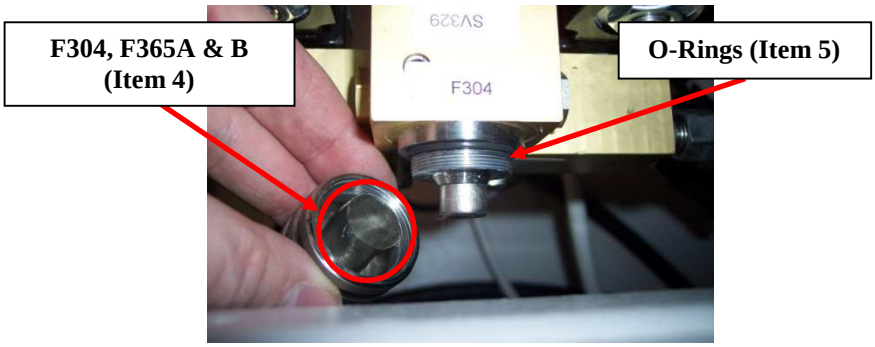


Figure 29 - Hydrogen Filter Screen

CAUTION

Hydrogen may escape during operation if the O-ring is not properly installed. Make sure the O-ring is seated within the grooves.

5. Reinstall the Hydrogen filter cap. Hand-tighten turning clockwise.
6. Repeat Steps #1-5 for the other hydrogen filter(s) (F365A and F365B).

5.7.2 Drain Orifice Replacement (P&ID Tag OR336A and OR336B)

Tools Required: 13/16" wrench, 11/16" wrench, 9/16" wrench, 1/8" Allen wrench, 3/32" Allen wrench.

Maintenance Parts from Annual Maintenance Kit: Items 2 and 3

Use the following instructions to replace up to three (3) hydrogen filters and two (2) drain orifices:

NOTE

A C10 configuration has only one A300 (OR336A). A C20 or C30 has two A300's (OR336A and OR336B). The replacement instructions are the same each.

Use the following instructions to replace up to two (2) drain orifices:

1. Unscrew the plug to the A300 drain orifice using a 9/16" wrench and set aside (Figure 30).
2. Using an Allen wrench, remove the existing drain orifice and discard.
3. Install the new orifice into the manifold block (Figure 31).
4. Check the O-ring on the cap for damage. Replace if necessary.
5. Reinstall the plug and tighten using a 9/16" wrench.
6. If A300B, repeat Steps #1-5 for the other drain orifice.

Figure 30 – Drain Orifice Locations

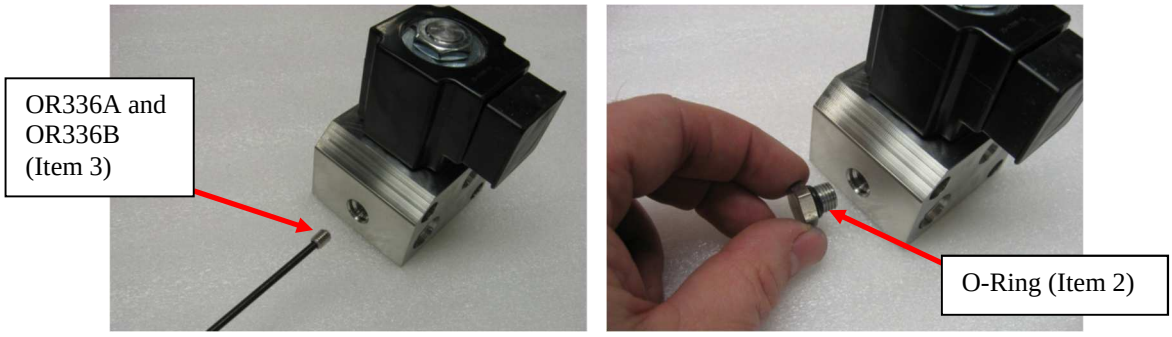


Figure 31 – Drain Orifice Replacement

5.8 Dryer Desiccant Replacement

Tools Required: 11/16” Wrench; 13/16” Wrench; 13 mm Wrench; Rubber Mallet or Ball Peen Hammer; Retainer Ring Seat Tool; Needle Nose Pliers; Flat Blade Screwdriver

Maintenance Parts from Annual Maintenance Kit: Items 6, 7, 8, 9 and 10

1. Bleed any pressure from the dryer by loosening the purge valve. Once pressure has been released tighten the valve to close.

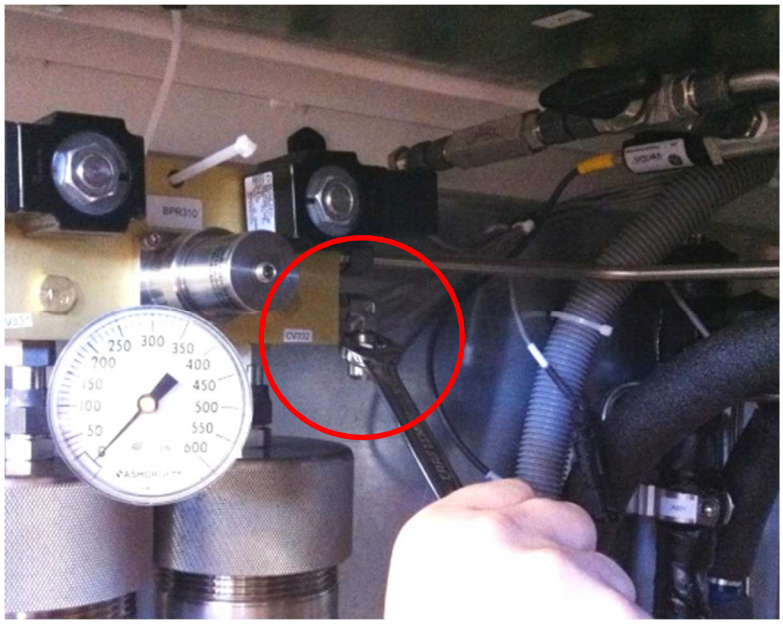


Figure 32 - Purge Valve

2. Loosely put a cable tie through the top dryer manifold block and to the cable tie clip on the ceiling of the Electrolyzer Enclosure.

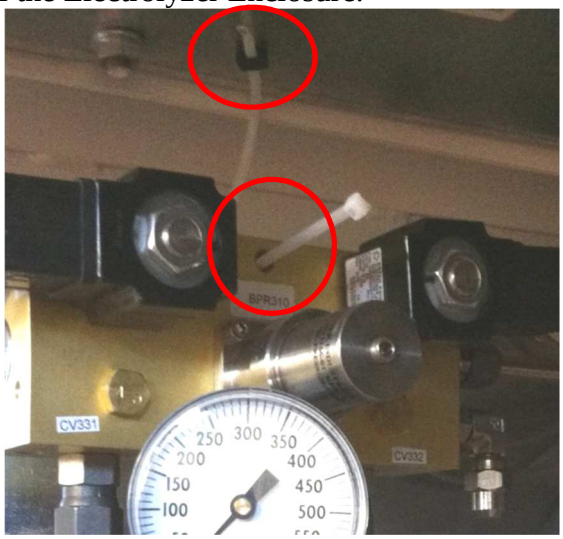


Figure 33 – Cable Tie Connection

3. Loosen the fittings on the top of each dryer column.

Figure 34 – Top Fittings

4. Pull the cable tie tight and lift the manifold block off of the dryer columns.

Figure 35 - Lifting the Top Manifold

5. Loosen the fittings on the bottom of each dryer column.

Figure 36 - Bottom Fittings

6. Loosen the column support clamps and remove the dryer beds. Start with the bottom clamps.

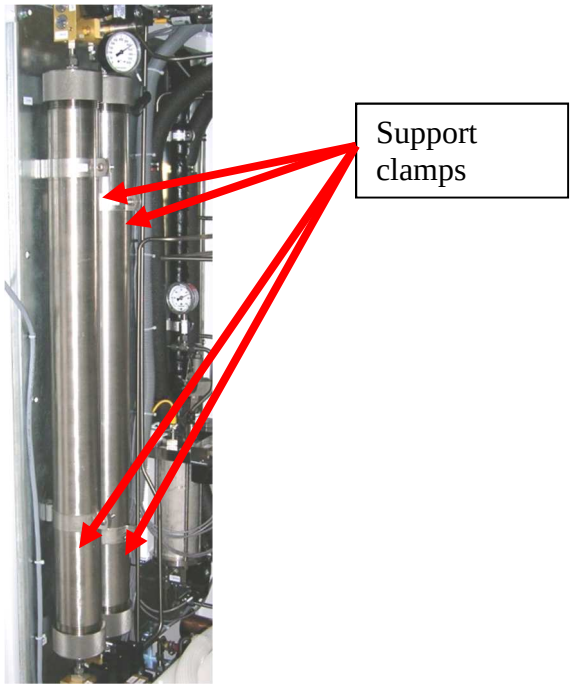


Figure 37 - Dryer Supports

CAUTION

The dryer column weight is approximately 45 pounds.

7. Using strap wrenches, remove the top cap of each column. Remove the old desiccant from the tubes and properly dispose of the desiccant.
8. Remove the bottom cap of each column.

9. Place each cap in a vice and use needle nose pliers to remove the retaining ring, filter screen and support plate. Inspect the cover and clean as required so they are free of any desiccant dust/debris.

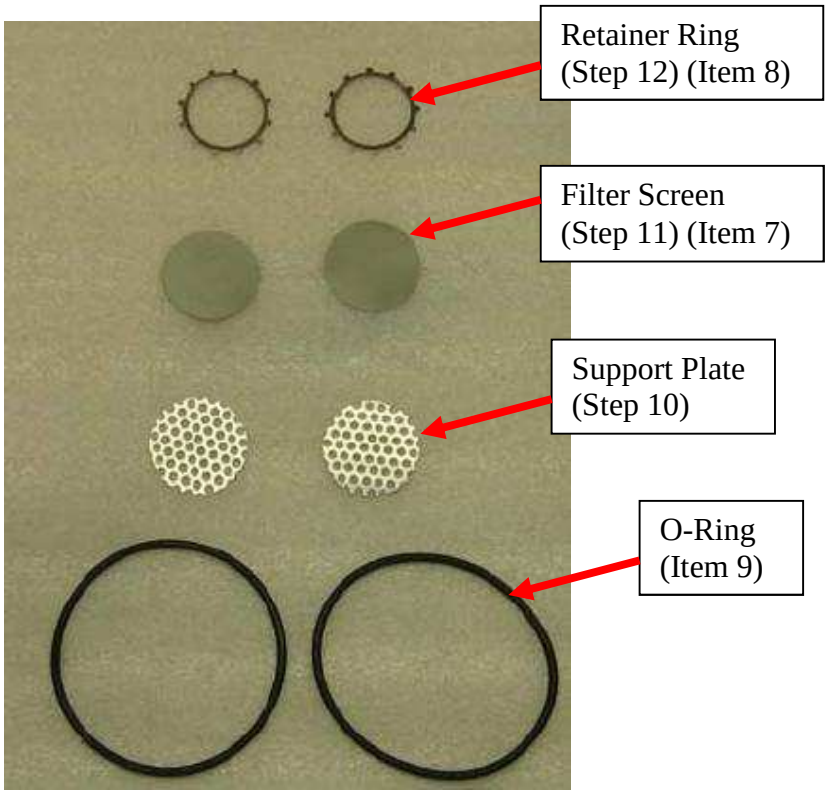


Figure 38 - Retaining Ring, Filter Screen and Screen Support Plate

10. Set the support plate back into the cap.

Figure 39 – Cap with Screen Support

11. Install new filter screen on top of screen support.

Figure 40 – Cap with Filter Screen

12. Install the retainer ring by laying it in the center of the screen. Set the retainer ring using the Retainer Ring Seat Tool and a mallet. NOTE: The seat tool is designed to seat to a specific depth.

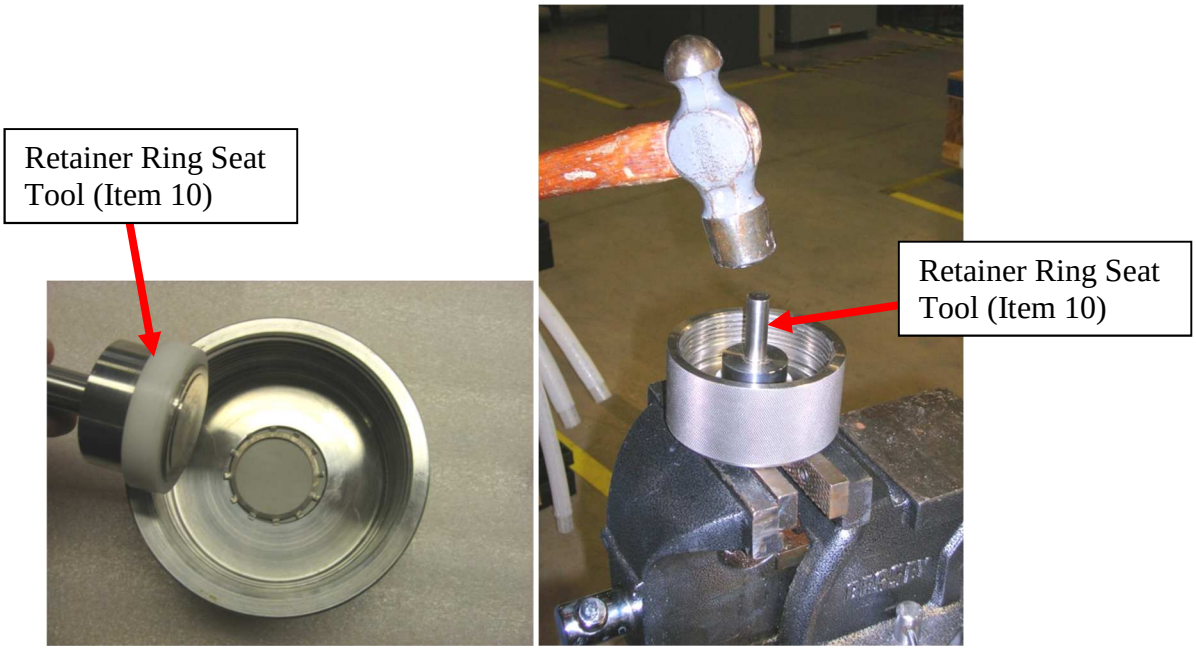


Figure 41 – Setting retainer ring

13. Tap on the tool with a hammer until the screen is locked in place.

Figure 42 - Installed Retainer Ring

14. Inspect the O-ring on the cap for damage and replace if necessary. Before installing new O-ring, apply Krytox to the ring (use sparingly).
15. Repeat Steps #6-10 for the other caps.
16. Using the strap wrench, reinstall the bottom caps on each of the dryer tubes.
17. Turn the dryer cylinder upright and support bottom cap so that the bottom fitting is not contacting the ground. Note: Be careful not to lose the O-ring in the dryer fitting when turning the dryer column upside down. (See Figure 44)

Figure 43 - Supported Dryer Cylinder

Figure 44 - Dryer Fitting with O-Ring

18. Fill each of the tubes with new desiccant.

Figure 45 - Filling Dryer Cylinder and Desiccant

19. When the desiccant nears the top of the tube, lightly tap the sides of the tube with a mallet to help pack the desiccant.

Figure 46 - Desiccant at the Top of the Cylinder and Tapping the Cylinder

20. Fill the desiccant to the top of the dryer bed.

Figure 47 - Topped off Desiccant

21. Using a strap wrench, reinstall the top caps on each column and tighten.

22. Place the right dryer column in first and loosely thread the fitting from the manifold into the dryer column. Put the bolts through the support clamps and loosely tighten nuts to hold the dryer column.

Figure 48 - Right Dryer Column

23. Install the left dryer column as was done for the right dryer column.
24. Cut the cable tie that is holding the upper manifold block and lower the block onto the 2 dryer columns.

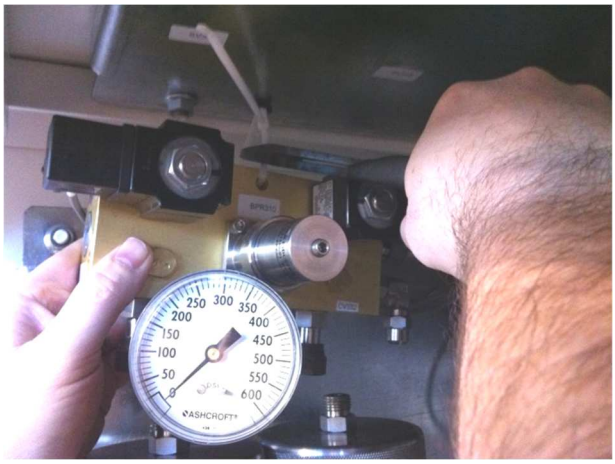


Figure 49 - Upper Manifold Block

25. Tighten the upper and lower fittings.
26. Tighten the support clamps.

5.9 Dryer Orifice Replacement (P&ID Tag OR330)

Tools Needed: ¼" Nut driver; Spanner Wrench

Maintenance Parts from Annual Maintenance Kit: Items 11 (C10), 12 (C20) or 13 (C30) and 14

Use the following procedure to replace the orifice on the internal dryer located on the ceiling of the Electrolyzer enclosure:

Figure 50 – Orifice Cap

1. Using a spanner wrench, remove the orifice cap by turning counterclockwise. Set the cap aside. (Refer to Figure 51.)

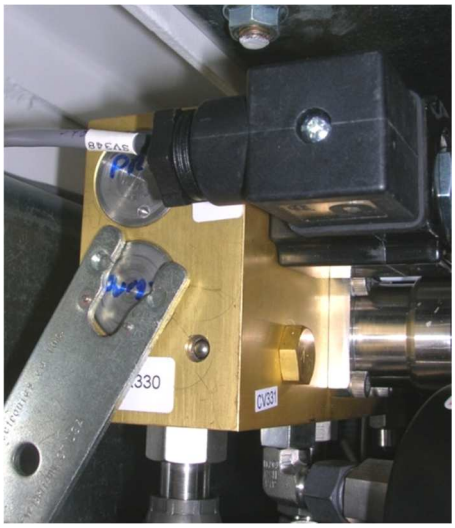


Figure 51 – Removing the Orifice Cap with Spanner Wrench

2. Using a ¼" nut driver, remove the orifice assembly. Discard the old orifice assembly (Figure 52).

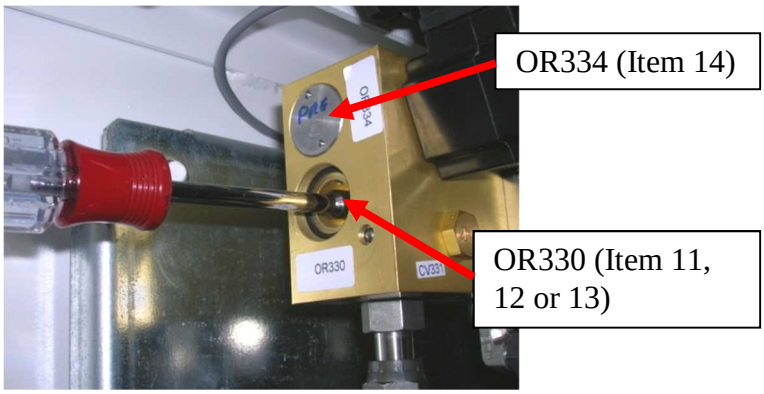


Figure 52 – Removing the Orifice Assembly

3. Install the new orifice assembly with a ¼" nut driver. Tighten clockwise.
4. Inspect the O-ring for damage. Replace if necessary.

NOTE

Make sure the O-ring is fitted in the grooves.

5. Reinstall the orifice cap with the spanner wrench by turning clockwise.
6. Repeat steps 1 through 5 to replace OR334.

NOTE

After initial hydrogen generation, place the unit in Service mode and check all fittings for leaks using the hand-held hydrogen leak detector or non-corrosive leak detection soap solution.

5.10 Dewpoint Sensor Calibration / Replacement (when configured)

A yearly calibration of the dew point sensor is recommended. The spare dew point sensor can be sent out just prior to maintenance for re-calibration at either of the two facilities listed below.

Inside the European Union	Outside the European Union
GE Panametrics	GE Panametrics
Shannon Industrial Estate	221 Crescent St. Suite 1
Shannon, CO. Clare	Waltham, MA 02453-3497
Ireland	USA
Telephone: 353-61-470200	Telephone: 781-899-2719

Use the following instructions to replace the dew point sensor:

1. Shut down the system and remove power to the system (Section 1.1).
2. Open the front doors of the Electrolyzer Enclosure and unscrew the cable harness from the sensor. Using an adjustable wrench, remove the sensor from the sensor housing (Figure 53).
3. Insert the new sensor into the housing and tighten. Use the adjustable wrench as required to fully seat the housing. Connect the sensor cable into the top of the sensor.
4. Close the front door of the Electrolyzer Enclosure and power up the system.

NOTE

Keep the old dew point sensor as the spare and send out for re-calibration just prior to the annual maintenance.

Figure 53 - Dew point sensor replacement

6 QUARTERLY MAINTENANCE CHECKLIST

Table 8 - Quarterly Maintenace Checklist

Qtr: 1, 2, 3 or 4	**Date:**	**Location:**	
Ref.	**Action**	**Completed ?**	**Comments**
Sec 3.1	Perform General Area and Vent Stack Inspection		
Sec 4.2	Inspect hoses and connections for DI water leak		
Sec 4.3.1	Perform Combustible Gas Sensor Calibration (CG220)		
Sec 4.3.2	Perform Combustible Gas Sensor Calibration(CG121)		
Sec 4.4	Inspect High Power Electrical Connections		
Fig 14, #1A&B	Visual check AC service (line)		
Fig 14, #2	Visual check Main fuses (line & load)		
Fig 14, #3A&B	Visual check AC disconnect (load)		
Fig 14, #4	Visual check CBA, CBB, CBC (line & load)		
Fig 14, #5	Visual check CBD (line & load)		
Fig 14, #6	Visual check Surge Protector (line and ground)		
Fig 14, #7	Visual check Distribution Blocks (C30, 380-415VAC Only)		
Sec 4.5	Visual check Surge Protection		
Sec 4.6	Inspect & perform maintenance on air Filters		
Sec 4.7	Inspect / Adjust Date and Time of controller		
Other maintenance performed or issues identified:			
Name:		Signature:	

7 ANNUAL MAINTENANCE CHECKLIST

Table 9 - Annual Maintenace Checklists

Yr: 1, 2, 3 or 4	**Date:**	**Location:**	
Ref	**Action**	**Completed ?**	**Comments**
Sec 4	Perform 1st Quarterly Maintenance		
Sec 5.2	Torque AC Connections		
Sec 5.3	Check Safety Circuit		
Sec 5.4	Replace Pump Filter		
Sec 5.5	Replace A500 Inlet Filter		
Sec 5.6	Replace Guard Bed DI Bags		
Sec 5.7	Replace Hydrogen Filter & Orifice		
Sec 5.8	Dryer Desiccant Replacement		
Sec 5.10	Replace Dew Point Sensor (when configured)		
Advise	If applicable, purchase Proton Recommended Spares Kit at End of Year 1		
Advise	If applicable, purchase Proton Major Spares Kit		
Advise	If applicable, purchase Proton Premium Spares Kit		
Other maintenance performed or issues identified:			
Name:		Signature:	

NOTE

For the highest in equipment reliability and performance, contact PROTON Customer Service at (**203) 949-8697** or your local service provider/supplier to purchase the Recommended Spares Kit, Major Spares Kit or Premium Spares Kit as recommended.

8 MAINTENANCE KITS

C Series Maintenance Matrix						
	AVAILABLE MAINTENANCE KIT					REQUIREMENTS
	MATERIAL CONTENT				KIT NUMBER	✓ = Required
YR	ITEM	System/ P&ID Tag	DESCRIPTION	QTY		x = Optional
ANNUAL MAINTENANCE KIT	1	LS301	Level Sensor, A300	1	KT-0100-0038 (EXTERNAL CUSTOMER DI SYSTEM)	✓ = Required on Annual Basis (Includes Quarterly Maintenance Components)
	2	A300A & B	O-Ring, A300, Plug	2		
	3	OR336A & B	Orifice, A300,10-32,#33 (.033)	2		
	4	F304, F365A & B	Strainer, A300 and Dryer, 43 Micron	3		
	5	F304, F365A & B	O-Ring, A300 and Dryer, Filter Cap	3		
	6	Dryer	Desiccant, Dryer	16		
	7	Dryer	Filter Screen, Dryer	4		
	8	Dryer	Retainer Ring, Dryer	4		
	9	Dryer	O-Ring, Dryer, Column Cap	4		
	10	Dryer	Tool, Retainer Ring Seat	1		
	11	OR330	Orifice, Dryer, C10, 0.0071” (0.18MM) DIA.	1		
	12	OR330	Orifice, Dryer, C20, 0.0059” (0.15MM) DIA.	1		
	13	OR330	Orifice, Dryer, C30, 0.0047” (0.12MM) DIA.	1		
	14	OR334	Orifice, Dryer, Purge, 0.0102” (0.26MM) DIA	1		
	15	O-Rings	Lubricant, O-Rings, 2oz Tube	1		
	16	F124A & B	Filters, Electrolyzer Enclosure Door	8		
	17	Panel Doors	Desiccant Bags, Panel and Enclosure Doors	6		
	18	F506	Filter, 1/4"NPT,40 Micron	1		
	19	F210	Filter, 80 Mesh	1		
	20	GB208A & B	O-Ring, Guard Bed, Top Cover	2		
	21	GB208A & B	Resin Bag, Guard Bed	2		

AVAILABLE SPARES		KIT NUMBER	Requirements
Recommended Spares	Recommended Spares	KT-0300-0019	✓ = Purchased during Year 1
Pipe Fittings	Common Spares for Pipe Fittings	KT-1000-0081	x* = Optional
Electrical Fuses	Common/Commissioning Spares for Electrical Fuses	KT-0800-0015	x* = Optional
Power Supply Spares	Major Spares for Power Supply Modules	KT-0900-0015	x* = Optional
Major Spares	Major Spares for Mechanical and Electrical	KT-0300-0020	x* = Optional
Premium Spares	Premium Spares for Mechanical and Electrical	KT-0300-0021	x* = Optional

* = Proton offers these higher level spares to insure maximum uptime.

9 NOTES

ELGA

PURELAB Option-S 7/15

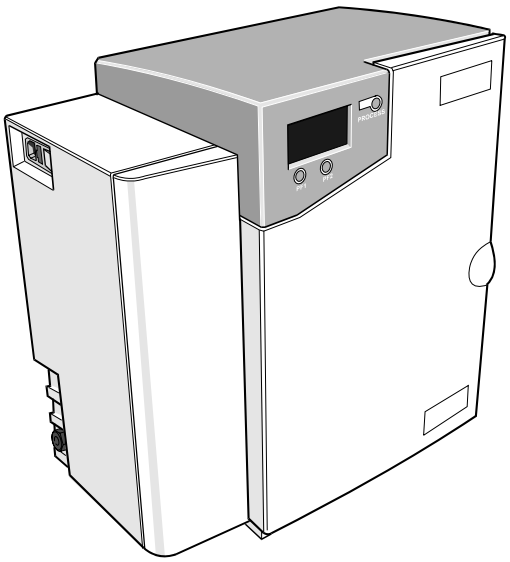
Operator Manual

Publication ref: MANU36812

Version 4 – 08/07

TABLE OF CONTENTS

1. INTRODUCTION



PURELAB Option-S

1.1 Product Range

This Operator Manual has been prepared for the ***PURELAB Option-S*** product models:

PURELAB Option-S7

PURELAB Option-S7 BP *(with boost pump)*

PURELAB Option-S15

PURELAB Option-S15 BP *(with boost pump)*

1.2 Use of this Manual

This manual contains full details on installation, commissioning and operation of the ***PURELAB Option-S*** unit. If this unit is used contrary to the instructions in this handbook, then the safety of the user may be compromised.

1.3 Customer Support

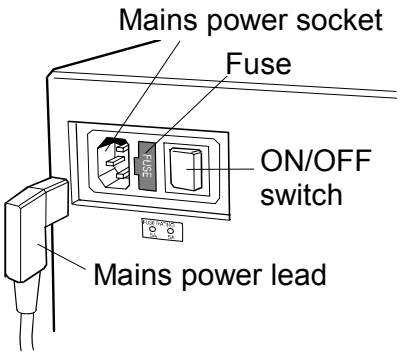
Service support and consumable items are available from your local supplier or distributor. Refer to customer service contact details shown at the end of this publication.

2. HEALTH AND SAFETY NOTES

PURELAB Option-S products have been designed to be safe, however, it is important that personnel working on these units understand any potential dangers. All safety information detailed in this handbook is highlighted as WARNING and CAUTION instructions. These are used as follows:

WARNING! **WARNINGS ARE GIVEN WHERE FAILING TO OBSERVE THE INSTRUCTION COULD RESULT IN INJURY OR DEATH TO PERSONS.**

CAUTION! **Cautions are given where failure to observe the instruction could result in damage to the equipment, associated equipment and processes.**



Mains Power Supply

2.1 Electricity

It is essential that the electrical supply to the ***PURELAB Option-S*** is isolated before any items are changed or maintenance work performed.

The ON/OFF switch is located at the left-hand side of the unit. The mains power lead is located just behind the ON /OFF switch.

WARNING! **THIS APPLIANCE MUST BE EARTHED.**

2.2 Pressure

The main water supply pressure should be isolated and residual pressure released prior to removal of any cartridges or carrying out work on the unit.

2.3 Control of Substances Hazardous to Health (COSHH)

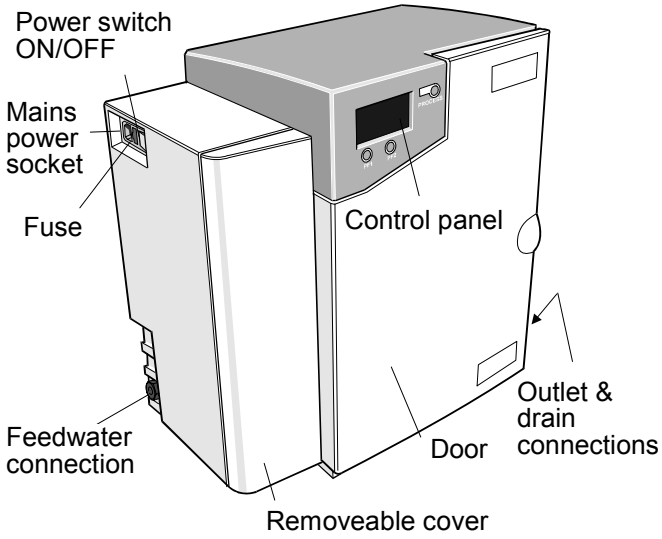
Material safety data sheets covering the various replaceable cartridges are available upon request. Contact your local supplier or distributor.

3. PRODUCT AND PROCESS DESCRIPTION

3.1 Product Description

The ***PURELAB Option-S*** water purification unit has been specifically designed to provide a supply of ***purified water*** equivalent in quality to water prepared by single-distillation, but without the high energy cost associated with distillation.

The ***PURELAB Option-S*** can be bench or wall mounted with an optional wall mounting kit. A range of accessories is available to complement the unit. *(See Section 9 - Consumables and Accessories, for details).*



PURELAB Option-S

3.2 Process Description

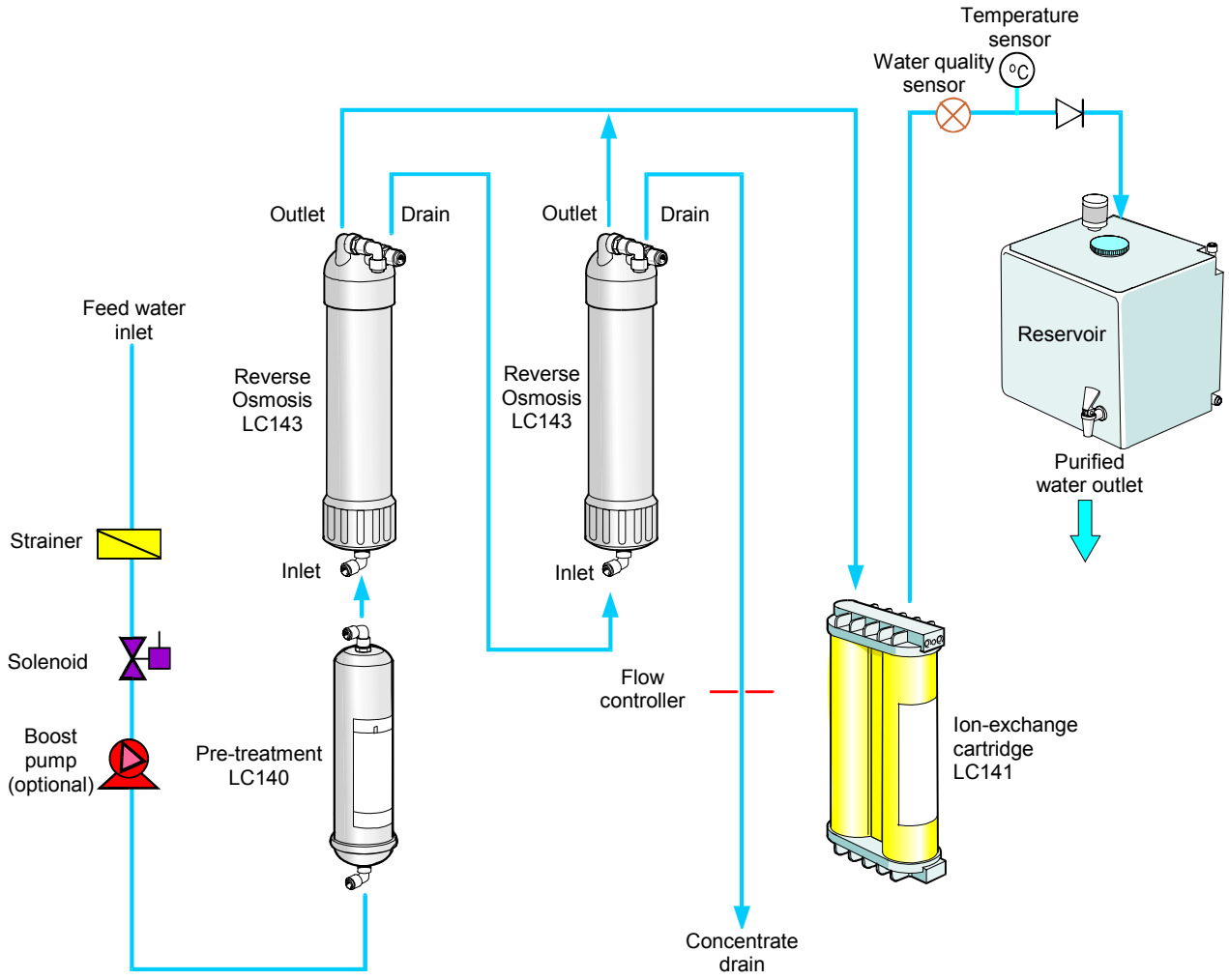
The ***PURELAB Option-S*** process links three purification technologies, reverse osmosis, adsorption and de-ionization and also incorporates an optional RO feed water boost pump.

The unit is designed to operate from a good quality potable water supply, and produces either 7 or 15 liters per hour of purified reverse osmosis grade water which is collected in a treated water reservoir.

A graphics screen displays the system status and provides control by means of three function buttons.

The water is processed and treated by the ***PURELAB Option-S*** unit as follows:

- Potable water enters through a strainer and inlet solenoid valve at either regulated mains water pressure, or is pumped by means of a feed water pump (optional), and passes through the pre-treatment ca rtridge. The pre-treatment cartridge has been designed to protect the reverse osmosis cartridges from particulate/colloidal matter and excessive free chlorine, which may be present in the incoming feedwater.
- The permeate water then passes through one or two reverse osmosis cartridges, set up in series, which split the flow into permeate and concentrate streams. The permeate water is further purified whilst the waste concentrate stream is passed to drain.
- The permeate water then passes through the ion-exchange cartridge which removes dissolved ionic impurities from the permeate water.
- Finally, the water is passed through a:
  - Water quality sensor, which measures the resistivity of the water.
  - Temperature sensor which provides accurate temperature measurement.



Process Flow - ***PURELAB Option-S***

3.3 Technical Specifications

The Technical Specifications for the ***PURELAB Option-S*** are as follows:

Feedwater		
	PURELAB Option-S 7	***PURELAB Option-S 15***
Feedwater		
Source Quality	Potable mains water supply	Potable mains water supply
Fouling Index-maximum	10	10
Total Dissolved Solids-maximum	1400µS/cm 1400	µS/cm
Free Chlorine-maximum	0.5ppm	0.5ppm
Heavy Metals - maximum	0.05ppm	0.05ppm
Silica- maximum	30ppm	30ppm
Temperature	1 - 35°C	1 - 35°C
Flowrate (Maximum requirement)	78 l/hr	85 l/hr
Drain Requirements (gravity fall with air gap). Maximum during Service	70 l/hr	70 l/hr
Feedwater Pressure		
Maximum - without internal boost pump	6.0 bar (90 psi)	6.0 bar (90 psi)
Minimum - without internal boost pump	4.0 bar (60 psi)	4.0 bar (60 psi)
Maximum - with internal boost pump	2.0 bar (30 psi)	2.0 bar (30 psi)
Minimum - with internal boost pump	Flooded Suction	Flooded Suction

Dimensions		
Height	460mm (18.1")	460mm (18.1")
Width	410mm (16.1")	410mm (16.1")
Depth	270mm (10.6")	270mm (10.6")
Weight		
With internal boost pump	16kg (35lb)	16.5kg (36lb)
Without internal boost pump	13.5kg (30lb)	14.5kg (32lb)

Connections		
Inlet-quick connect	8mm (5/16") OD	8mm (5/16") OD
Outlet-quick connect	8mm (5/16") OD	8mm (5/16") OD
Drain RO-quick connect	8mm (5/16") OD	8mm (5/16") OD
Reservoir feed-quick connect	8mm (5/16") OD	8mm (5/16") OD
Positioning	Wall, bench or under bench mounted.	Wall, bench or under bench mounted.
Environment	Clean dry indoor. Temp 5 - 40°C. Humidity max 80% non-condensing.	Clean dry indoor. Temp 5 - 40°C. Humidity max 80% non-condensing.

Electrical Requirements	
Mains input	100-240V ac, 50-60Hz all models
System voltage	24V dc
Power consumption with boost pump	43VA
Power consumption without boost pump	19VA
Fuses	2 x T3.15 Amp
Reservoir level connection	Jack Plug 3.5mm
Noise level	<45 dBA

User Interface 使用者操作介面		
Display	Continuous graphical and numerical reservoir level display Graphical flow schematic on screen with mimic display Intuitive icons	
Adjustable settings	Auto restart after power failure	Selectable
Audible	alarm 停電復電後系統會自動重新啟動。	Selectable
	Water purity units	MicroSiemens/cm or MegaOhms.cm
	Water purity	Alarm Setpoints
Indicators De-ionized	water quality	Temperature compensated resistivity/ conductivity
Temperature		Degrees centigrade
Resrvoir		% Full
	Pre-treatment cartridge	Maximum remaining life indicator
	Ion-exchange cartridge	Maximum remaining life indicator
Alarms-Audiovisual 聲音警示	Purified water purity	Outside set point alarm
	Reservoir	Low level 低水位保護裝置
	Pre-treatment cartridge	Change reminder
	Ion-exchange cartridge	Change reminder
Outputs	RS232 Printer connection RS232 Remote display connection Volt free contact-internal	

Safety Features 安全規範
Power fail safe
Boost pump protection from low pressure 水壓過低啟動幫浦保護, 以防空轉
Low operating voltage 24V
Audio visual alarms
Water leaking detector (optional) 漏水偵測(選配), 偵測到漏水自動停機。

Special Features
Low noise levels – minimum intrusion
Flow rate upgradable
Optional internal boost pump for low pressure feed waters
Optional printer kit for record of operating parameters
Optional remote display

Technologies	
Purification Methods	Adsorption Reverse osmosis Ion-exchange

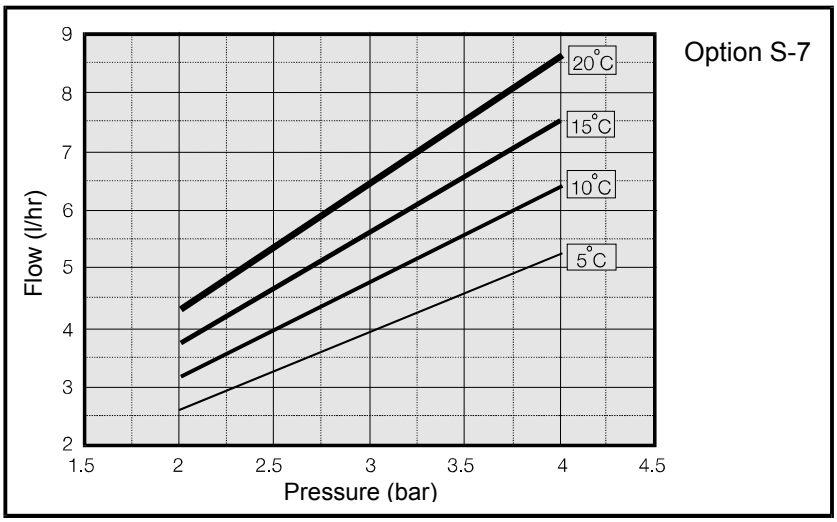
Purified Water Specification		
	PURELAB Option-S7	***PURELAB Option-S15***
*Make Up Rate	7.5 l/hr	15 l/hr
*Daily Output (nominal max)	180 l/24 hour day	360 l/24 hour day
**Output reverse pressure (max)	0.1 bar (1 psi)	0.1 bar (1 psi)
Purity:		
Inorganic-Typical	1 to >10MΩ.cm @ 25°C	
Total Organic Carbon (TOC)	<30ppb	
pH Effectively	neutral	

* Standard conditions are 4 bar inlet pressure, 0 bar back pressure at 15 degrees centigrade, fed with potable water and a clean pre-treatment cartridge. Refer to flow tables outside these conditions.

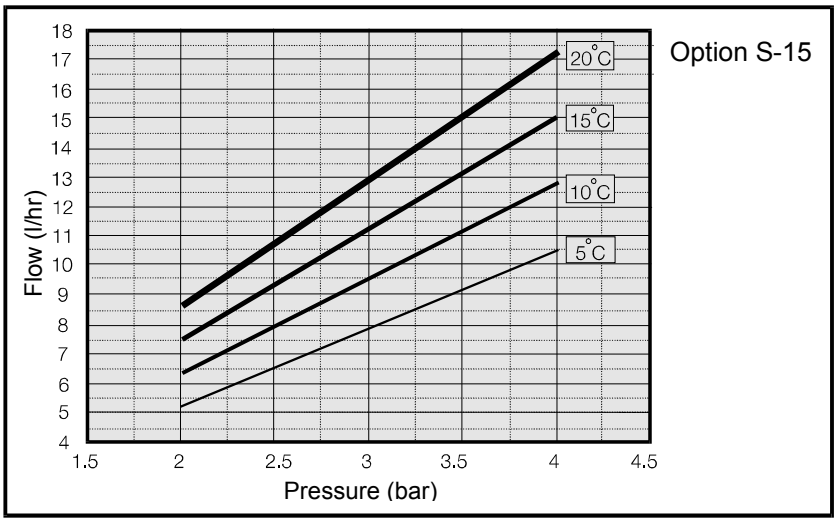
** Purification unit and reservoirs should be at same level.

As part of our policy of continual improvement we reserve the right to alter the specifications given in this document.

PURELAB Option-S Reverse Osmosis Capacity Charts

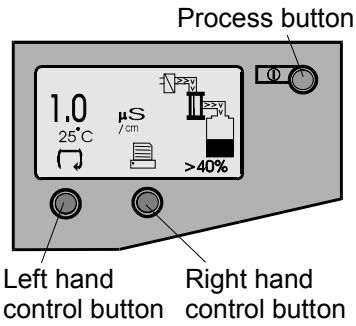


Graph 1 - Nominal Flowrate vs Inlet Pressure for ***PURELAB Option-S7***



Graph 2 - Nominal Flowrate vs Inlet Pressure for ***PURELAB Option-S15***

4. CONTROLS



Control Panel

The ***PURELAB Option-S*** operates with a tactile membrane touch pad control panel which has a graphics display window and three program function control buttons.

Details of how to use the controls will be given in the appropriate sections.

Control Button	Function
PROCESS	Turns the process ON/OFF.

The ***PURELAB Option-S*** control panel has a range of control icons as follows:

Button	Icon	Description
LEFT		Menu
		Scroll
RIGHT		Reset
		Mute Alarm
		Accept
		Printer

5. INSTALLATION INSTRUCTIONS

5.1 Unpacking the *PURELAB Option-S*

The following items should be supplied with your ***PURELAB Option-S***:

1. ***PURELAB Option-S*** unit
2. Cartridge Pack LC141
3. Installation kit (LA513 or LA506)
4. Operator Manual
5. Mains Lead

5.2 Positioning the *PURELAB Option-S*

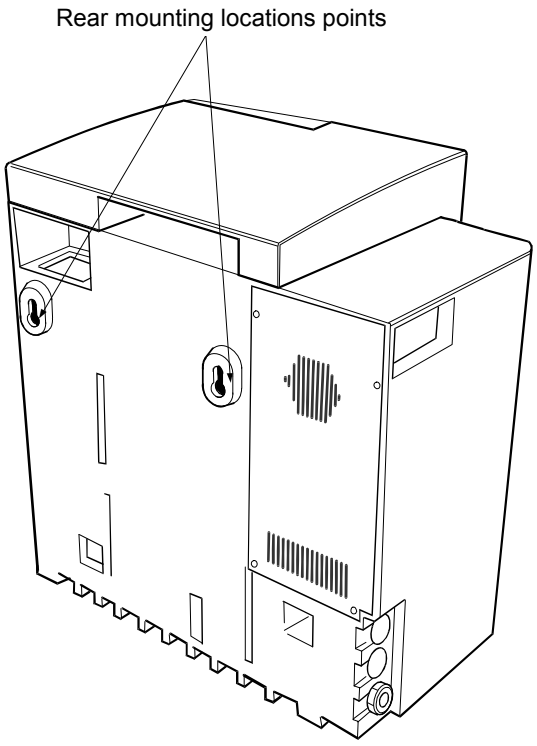
Before commencing with installation and operation of the ***PURELAB Option-S*** unit, please read and observe the following points.

Environment

The unit should be installed on a flat, level surface, in a clean, dry environment. The unit can also be wall mounted against a vertical wall capable of supporting the weight (for this we recommend the use of the wall mounting kit Part No LA610).

CAUTION! **If unit is to be wall mounted, ensure it is mounted on a substantial brick or concrete solid wall capable of supporting the operating weight of the system. If mounting the unit on the wall, use the wall mounting kit and follow the instructions included in the kit.**

Note: *Refer to specifications for unit weights.*

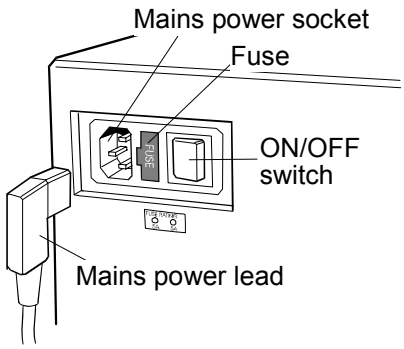


Unit Rear Mounting Points

The unit is designed to operate safely under the following conditions:

- Indoor Use
- Altitude up to 2000m
- Temperature Range 5 - 40°C
- Maximum Relative Humidity 80% @ 31°C decreasing linearly to 50% @ 40°C, non-condensating

The unit is in Installation Categor y II, Pollution Degree 2, as per IEC1010-1.



Electrical Connections

Electrical

The unit can be connected universally to any electrical supply in the range of 100 - 240V and 50 - 60Hz. The mains lead is supplied with a molded plug on one end and a molded connector to the unit on the other. The unit should be connected to an earth.

Drain

A semi rigid flexible connection to a sink or suitable drain capable of handling at least 1.5 l/min is required. The drain point should have a gravity fall below the level of the unit and any connections direct to drain should have an air-break device fitted.

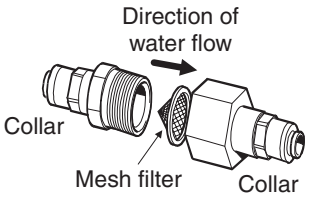
Feed Water

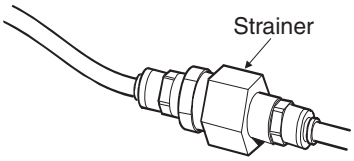
The feed water should be of good quality and comply with specifications provided. This should enter the unit via an 8mm (5/16") O/D semi rigid tube, and should be in the temperature range 1 to 35°C.

CAUTION! Operating with feedwater temperatures outside the range 1 to 35°C will cause damage to the *PURELAB Option-S* unit.

For pressurized feeds, the minimum direct inlet pressure is 4.0 bar (60 psi) and maximum inlet pressure is 6 bar (90 psi). Higher feedwater pressures must be reduced using a pressure regulator valve (Part No. LA512).

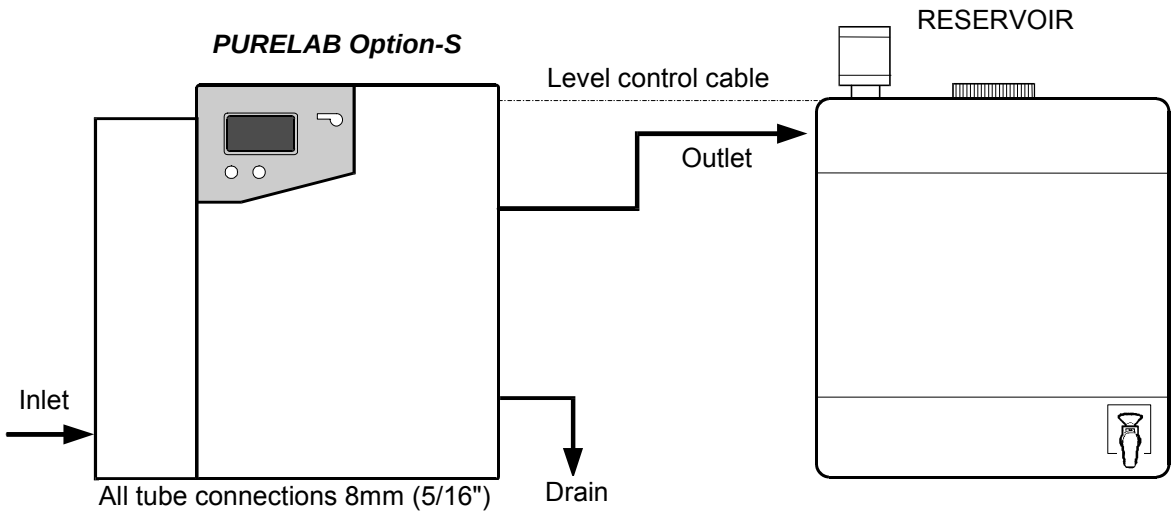
Reservoir feeds to the ***PURELAB Option-S*** unit should be positioned at the same height, or above the unit, to provide a positive flooded inlet pressure.



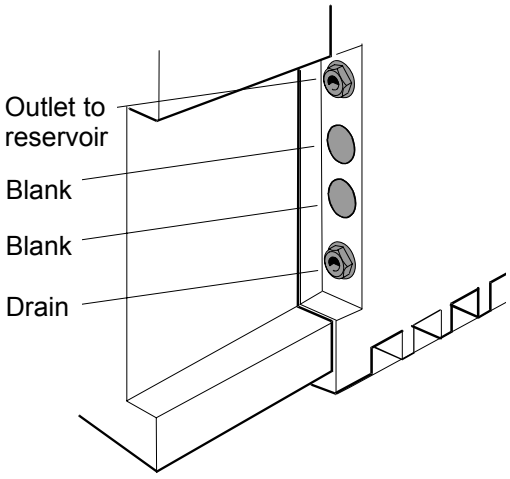


Feed Water Strainer

Option-S進水濾網保護, 以防細微顆粒膠體堵塞電導度計



PURELAB Option-S *unit installed with storage reservoir*



Outlet and Drain Connections

5.3 Connecting up the *PURELAB Option-S*

Once the ***PURELAB Option-S*** unit has been positioned either on a wall or on a bench, it should be connected as follows:

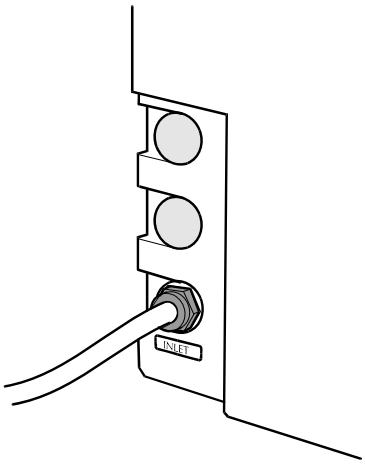
- Mains water inlet tube
- Drain
- Outlet to reservoir

Step 1 - Fitting Tubes

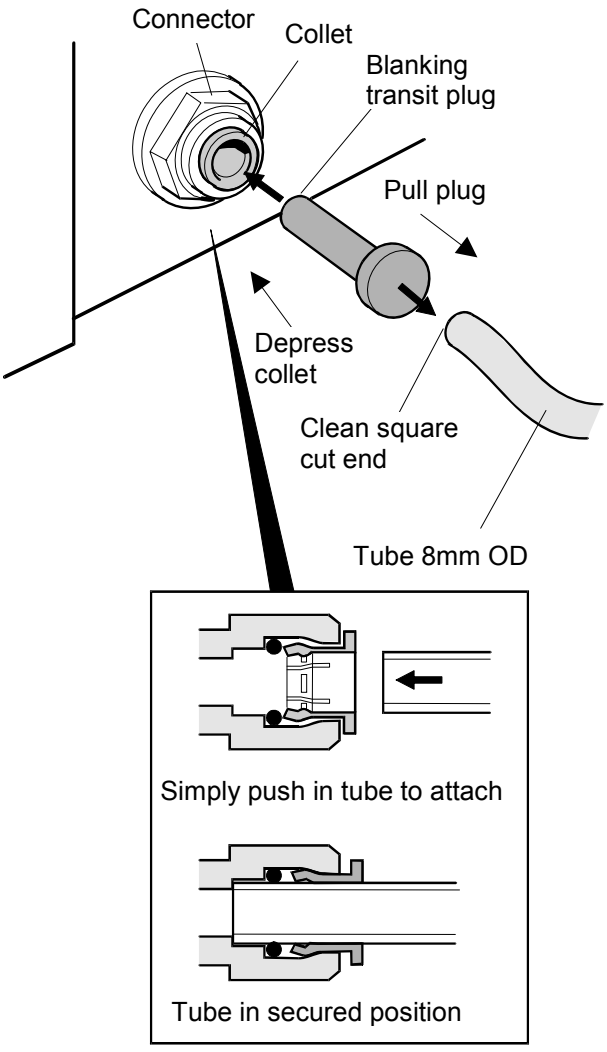
1. PUSH in collet on connector.
2. PULL out transit plug.
3. CUT a clean square end on an 8mm OD semi rigid drain tube.
4. PUSH tube into connector.

CAUTION! **Do not restrict drain line.**

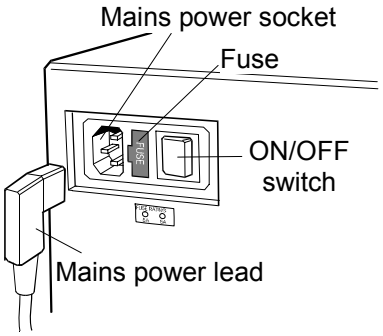
CAUTION! **If the water supply is at a pressure greater than 6 bar (90 psi) fit a pressure regulator (LA512).**



Feed Water Inlet Connection



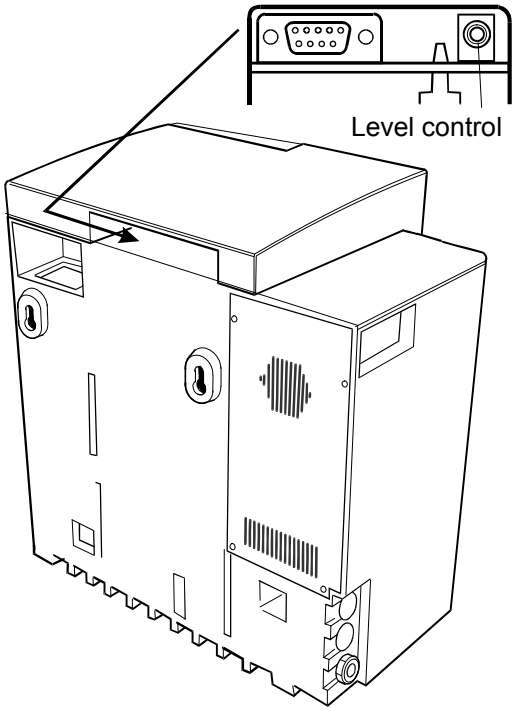
Fitting Tubes



Electrical Connections

Step 2 - Connect Electrical Supply

1. PLUG mains lead into the socket on the left hand side of the ***PURELAB Option-S*** unit.
2. PLUG mains lead into mains socket.



Reservoir Level Connections

Step 3 - Connect High/Low Level Switch to Reservoir

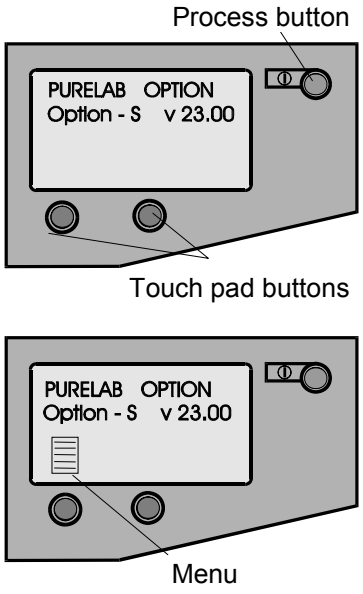
1. INSERT jack plug into the level control socket located at rear of unit and reservoir.

5.4 Initial Controller Set-Up

The ***PURELAB Option-S*** control panel is fitted with three control buttons. These are:

1. The PROCESS button, which switches the purification process ON and OFF.
2. Two software controlled touch pad buttons which are used to control set-up and process control functions.

When the ***PURELAB Option-S*** unit is started for the first time after installation the following steps should be carried out to set up system preferences:



Start Up Screens

Step 1 - Setting Up Menu Options

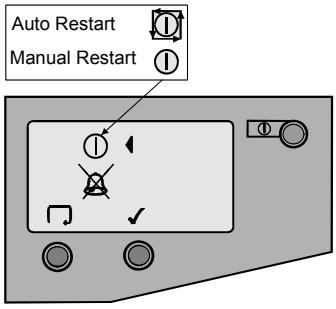
SWITCH the mains power on to initialize the controller hardware set-up sequence.

Note: Always allow the initialization process to complete. This is indicated by the appearance of the MENU icon on the control screen.

PRESS the MENU button to go to the next screen to activate the set-up menu sequence.

A series of set-up screens will now be displayed. Various control icons are used to allow you to step through the set up instruction process. These icons include:

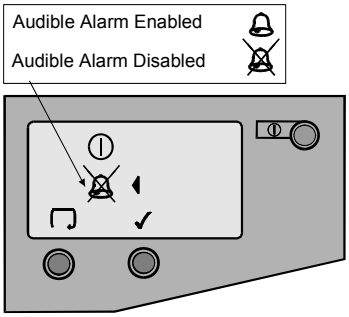
- A "scroll" icon indicated by an arrow ↻
- An "accept" button indicated by a tick ✓
- A "selection" icon indicated by a ◂



Auto/Manual Restart

Step 2 - Auto / Manual Restart

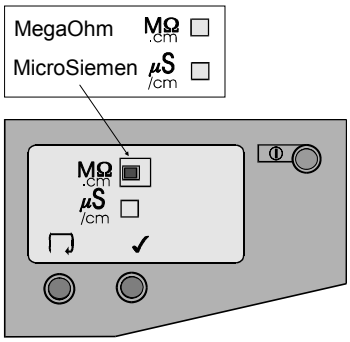
This allows the selection of the AUTO/MANUAL restart option. If auto restart is selected the unit will automatically restart after a power failure. In manual mode the unit will remain in standby. Select the option required using the ↻ button and accept with the ✓ button.



Audible Alarm Enable/Disable

Step 3 - Audible Alarm Enabled / Disabled

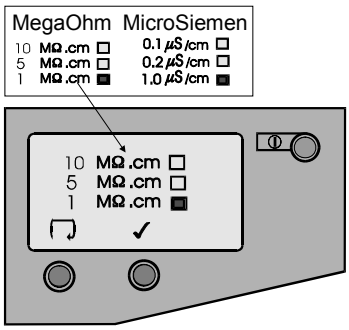
This display provides the option of either enabling the audible alarm causing it to sound or disabling the audible alarm causing it to remain muted whilst it flashes the alarm. Select the option required using the ↻ button and accept with the ✓ button.



Water Purity Settings

Step 4 - Water Purity Unit Setting

This screen enables the preferred water purity unit of measure to be set, to either, **MΩ.cm** or **µS/cm**. Once selected, all future water purity measurements will be displayed with your unit of choice. Select the option required using the ↻ button and accept with the ✓ button.



Purity Alarm Setting

Step 5 - Purity Alarm Setting

This screen is used for setting the value at which the water purity alarm will activate.

If the **MΩ.cm** water purity alarm unit setting was chosen, then the following water purity alarm choices will be displayed.

10 MΩ.cm ☐
5 MΩ.cm ☐
1 MΩ.cm ☐

If the **µS/cm** water purity alarm unit setting was chosen, then the following water purity alarm choices will be displayed.

0.1 µS/cm ☐
0.2 µS/cm ☐
1.0 µS/cm ☐

Select the alarm setting required using the ↻ button and accept with the ✓ button.

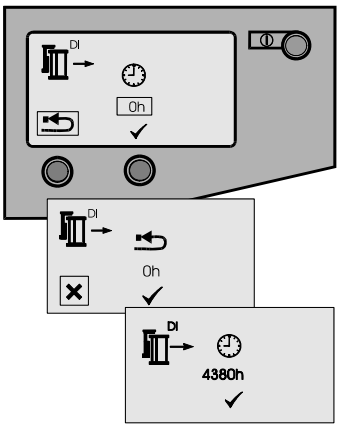
Note: To reset any of the setup parameters, restart from the set-up menu and follow instructions from Step 1.

Setting Up Display and Replacement Timers

Turn the unit off at the power inlet module. To enter the replacement timer set up, press the left hand touch pad button and at the same time turn the power on.

A graphic of the ion-exchange cartridge, UV lamp, pre-treatment cartridge and clock graphics are displayed with hourly timer status.

CAUTION! **Before re-setting any of the cartridge timers, ensure that the appropriate new cartridges have been installed and securely located correctly in the *PURELAB Option-S.***



Ion-exchange Cartridge Timer

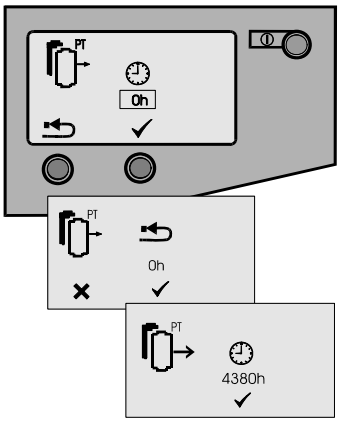
Step 1 - Ion-exchange Cartridge Replacement Timer

Setting this screen will cause the Ion-exchange cartridge timer to reset to the preset value of 4380 hours (6 months).

Press ✓ to jump to the next consumable or ↩ to initiate reset.

Press ✓ to reset timer or press ✗ to abort reset.

Press ✓ to jump to the next consumable.



Pre-treatment Cartridge Timer

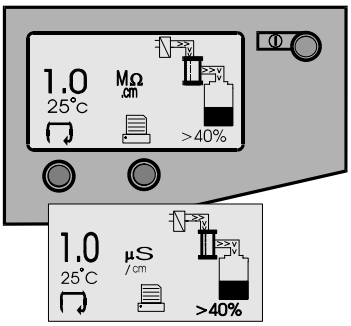
Step 2 - Pre-treatment Cartridge Replacement Timer

Setting this screen will cause the pre-treatment cartridge timer to reset to the preset value of 4380 hours (6 months).

Press ✓ to jump to the next consumable or ⮌ to initiate reset.

Press ✓ to reset timer or press ✖ to abort reset.

Press ✓ to jump to the next consumable.



Process On and Alternate Screen

Step 3 - Accessing the Process On Display Screens

The normal process screen will display newly installed SETUP preferences showing the following process information:

- Output water purity
- Water temperature
- Process mimic
- Reservoir level
- Scroll ↻ and Print 🖶 icons

You can scroll through the following display screens:

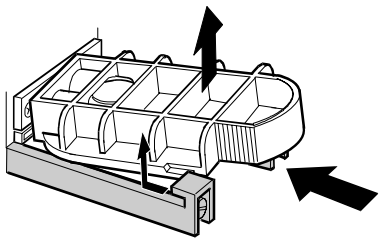
- Ion-exchange cartridge replacement timer (hours remaining).
- Pre-treatment cartridge replacement (hours remaining).

Step 4 - Report Printing *(Only if connected to LA618)*

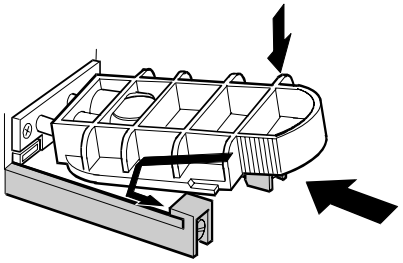
To print a report press the 🖶 icon.

5.5 Initial Start Up

1. THE ***PURELAB Option-S*** should be installed correctly as described in Section 5.
2. TURN on the feedwater supply to the unit and adjust the inlet pressure. The ***PURELAB Option-S*** will operate on a feedwater pressure between 4.0 bar (60 psi) and 6.0 bar (90 psi). Where feedwater pressures are inadequate an internal optional boost pump should be fitted.
3. CHECK all hose connections are water-tight and that there are no leaks.
4. THE ***PURELAB Option-S*** units are supplied containing traces of bacteriostatic solution which have to be rinsed out from the pipework and fittings. The solution is rinsed through both the 'DRAIN' and 'OUTLET' tubes, which therefore initially both need to be directed to a drain or sink.
5. DISCONNECT the outle t tube at the reservoir inlet and direct to a drain or sink.
6. THE unit is supplied without the LC141 Ion-exchange cartridge pack fitted but has the by-pass block in place.
7. ENSURE the cartridge by-pass block is left in place until the unit has been rinsed free of bacteriostatic solution.
8. TURN ON the electrical supply to the unit and switch the mains switch at the power inlet module on the left-hand side of the unit to the ON position.
9. HAVING checked that the water supply has been turned on, press the PROCESS button and the unit will start.
10. LEAVE the unit running for 2 hours to drain. During this period, the bacteriostatic solution will be rinsed from the unit. For critical applications the unit should be left to rinse overnight.
11. AFTER 2 hours, press the PROCESS button to stop the unit. The outlet tube can now be reconnected to the reservoir.
12. THE unit has now been rinsed.
13. REMOVE the by-pass blo ck. (Store in the front door).
14. INSERT Ion-exchange cartridge LC141. *(See Section 7.2).*
15. PRESS the PROCESS button and the water purification process will begin, gradually filling the reservoir with purified water.

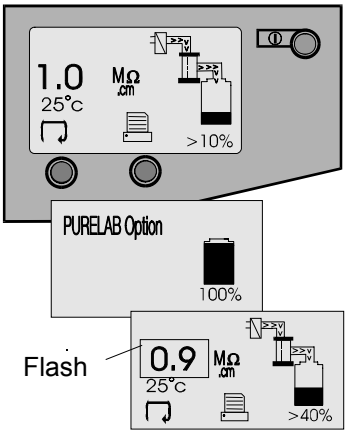


Removing

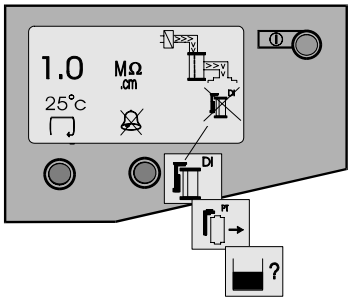


Inserting

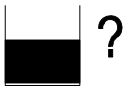
Removing & Inserting By-pass Block



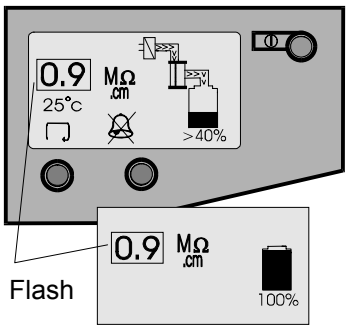
Normal Process Screens



Alarm Conditions



Reservoir Level Disconnect Fault



Water Purity Alarm / Standby

6. OPERATION

The ***PURELAB Option-S*** will run automatically and will signal alarm conditions to ensure prompt efficient system management and corrective action.

Note: To ensure that water purity remains at a high level it is important to leave the unit in process mode.

6.1 Alarm Conditions

Alarms will signal at the following conditions:

Replace Ion-exchange Cartridge

The Ion-exchange cartridge replac ement alarm is signalled by an audible alarm and flashing icon at the default setting of 4380 hours (6 months) of use. Press the button to mute the audible alarm. Follow the instru ctions to replace the Ion-exchange cartridge. *(See Section 7.2)*.

Replace Pre-treatment Cartridge

The pre-treatment cartridge repl acement alarm is signalled by an audible alarm and flashing icon at the default setting of 4380 hours (6 months) of use. Press the button to mute the audible alarm. Follow the instructions to replace the pre-treatment cartridge. *(See Section 7.1)*.

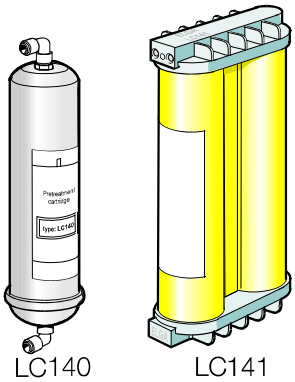
Reservoir Level Disconnect Fault Alarm

The reservoir level disconnect fault alarm condition will signal with an audible alarm and flashing icon. Press the button to mute the alarm. This alarm c ondition will cause the process to turn off. Connect the reservoir level and press the process key to clear the alarm.

Water Purity Alarm

This alarm will signal if the water purity deviates from the preset parameters and will cause the water purity value to flash and an alarm to sound, until water purity improves to within acceptable purity limits. Press the button to mute the alarm. If water purity stays outside acceptable purity limits replace the ion-exchange pack following the instructions in section 7.2.

7. MAINTENANCE



LC140 Pre-treatment cartridge

LC141 Ion-exchange cartridge

PURELAB Option-S
Replacement Consumables

Any maintenance work not detailed in this handbook should be carried out by an approved supplier or distri butor. If further information is required on any aspect of maint enance please contact Customer Service.

Identification of Consumables

There are two types of unique replacement consumables designed for use in the ***PURELAB Option-S*** units and these are illustrated with the following part numbers:

LC140 Pre-treatment cartridge

LC141 Ion-exchange cartridge

All consumables are accessible after opening the front door cover.

To protect the inlet solenoid valve, RO boost pump (when fitted) and re-circulation pump from debris in the water, the unit incorporates two strainers.

WARNING! **ALWAYS CHECK THAT THE MAINS ELECTRICAL POWER AND FEED WATER SUPPLIES ARE SWITCHED OFF BEFORE ATTEMPTING TO CHANGE THE *PURELAB OPTION-S* CONSUMABLES.**

Frequency of Consumable Replacement

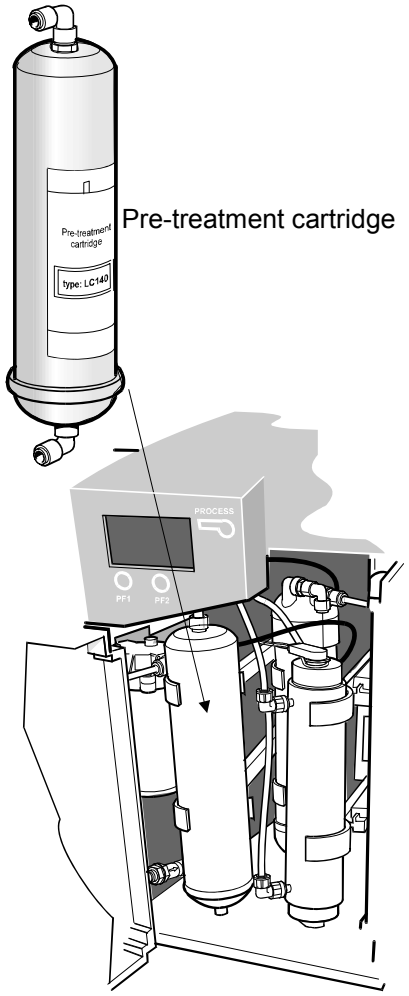
The following frequency of consumable replacement is recommended as a guide assuming typical usage:*

Pre-treatment	-	LC140	maximum 6 months
Ion-exchange	-	LC141	maximum 6 months**
Reverse Osmosis	-	LC143	every 2 - 3 years (not an operator replacement item)

* These frequencies are only estimates and replacement will depend on the application and feed water quality.

** Standard conditions are 4 bar (60 psi) inlet pressure at 15°C, potable water with clean pre-filter.

CAUTION! **Ensure that the display and replacement timer settings are reset after replacing consumables. (Refer to section 5.4).**



Location of Pre-treatment Cartridge

7.1 Replacing the LC140 Pre-treatment Cartridge

The pre-treatment cartridge should be replaced when indicated by the change reminder.

Step 1 - Switch Unit Off

1. SWITCH the ***PURELAB Option-S*** off at the power switch at the top left hand side of the unit.
2. ENSURE pressure has dissipated from the unit by waiting a few minutes after switching off.

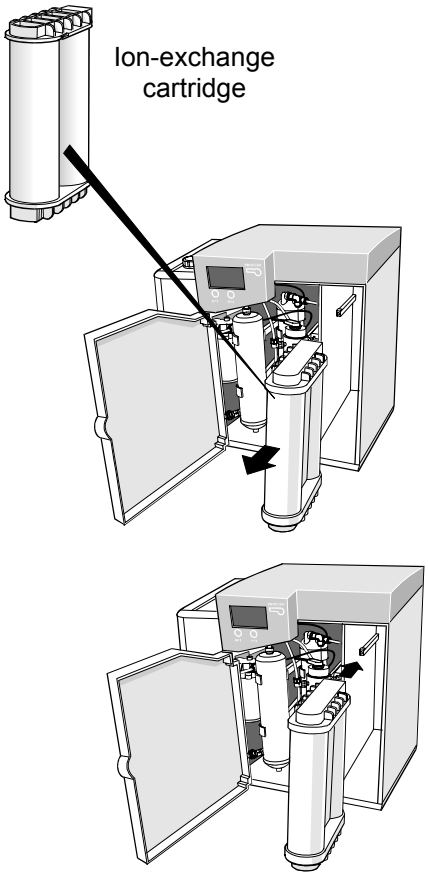
Step 2 - Remove Pre-treatment Cartridge

1. OPEN front door.
2. IDENTIFY the pre-treatment cartridge (LC140).
3. REMOVE the reducing fitting from the elbow at the bottom of the cartri dge, by pushing back the retaining collet on the push fit connector and withdrawing the reducer.
4. REMOVE the reducing fitting from the elbow at the top of the cartridge.
5. REMOVE exhausted cartridge from retaining clips and discard.

   Note: The consumable is non-hazardous. Dispose of as ordinary waste, observing all local and national regulations.

Step 3 - Replacing the Pre-treatment Cartridge

1. UNPACK new cartridge and remove the two protective transit plugs sealing the inlet and outlet connection.
2. SECURE the new cartridge into its retaining clips ensuring the cartridge is the correct way up.
3. REFIT the inlet tubing into the bottom of the cartridge by pushing the reducer into the elbow connector until locked and held by the retaining collet.
4. REFIT the outlet tubing at the top of the cartridge.
5. RESET pre-treatment cartridge timer. *(See Section 5.4 - Setting Up Display and Replacement Timers).*
6. PRESS the PROCESS button to start the unit.
7. CHECK the unit for leaks and close front door.



Removal and Fitting of Ion-exchange Cartridge

7.2 Replacing the LC141 Ion-exchange Cartridge Pack

The ion-exchange cartridge pack should be replaced in the following circumstances:

- The water purity alarm indicates that the water quality has fallen below the preset value and that the pack probably requires changing.
- If the system is being re-commissioned or rinsed through after an extended period in which it was not used.
- When indicated by the change reminder.

Step 1 - Switch Unit Off

1. SWITCH the ***PURELAB Option-S*** off at the power switch at the top left hand side of the unit.
2. WAIT several minutes after turning off the unit to ensure any residual pressure in the system has dissipated.

WARNING! ENSURE THE UNIT IS ISOLATED BEFORE REMOVING THE ION-EXCHANGE CARTRIDGE.

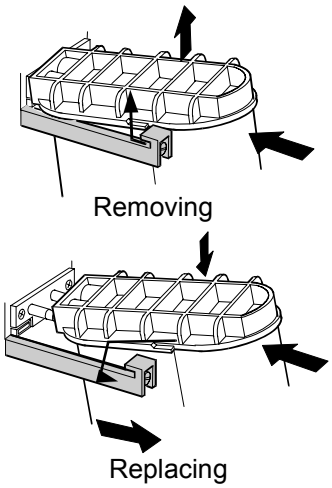
Step 2 - Remove Ion-exchange Cartridge

1. OPEN the front door.
2. PUSH on cartridge top cap.
3. LIFT up cartridge.
4. SLIDE out cartridge.
5. DISCARD used ion-exchange cartridge.

Note: The consumable is non-hazardous. Dispose of as ordinary waste, observing all local and national regulations.

Step 3 - Replace Ion-exchange Cartridge

1. REMOVE a new cartridge pack from its packaging.
2. REMOVE the sealing plugs from the inlet and outlet ports.
3. WET 'O' rings and SLIDE new cartridge into position.
4. POSITION cartridge onto spigots, PUSH into unit.
5. ENSURE guide has dropped down past retainer.
6. CLOSE front door.
7. RESET ion-exchange pack timer. *(See section 5.4 - Setting Up Display and Replacement Timers)*.
8. PRESS the process button to start the unit.
9. Check the unit for leaks.



Ion-exchange Cartridge

7.3 Cleaning the Inlet Strainer

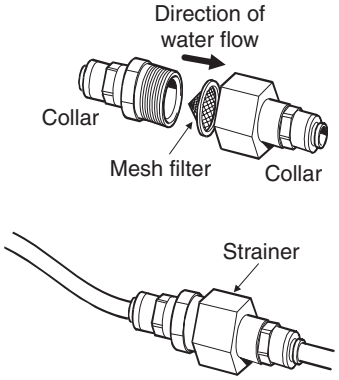
The Inlet Strainer should be checked and cleaned every six months to ensure that the strainer does not become clogged.

Step 1 - Remove the Inlet Strainer

1. SWITCH OFF electrical supply.
2. OPEN front door.
3. ISOLATE inlet water supply.
4. REMOVE the pre-treatment cartridge from its clips and set aside to gain access to the inlet strainer.
5. DEPRESS collars on both sides of strainer and disconnect tubing.
6. REMOVE the inlet strainer from its position.

Step 2 - Dismantle the Inlet Strainer

1. HOLD inlet strainer over a sink or receptacle.
2. UNSCREW inlet strainer.
3. REMOVE mesh filter.
4. CHECK mesh filter for signs of wear or damage, replace or clean as necessary.



Inlet Strainer

Step 3 - Reassemble the Inlet Strainer

1. INSERT mesh filter into strainer, ENSURE it is facing the correct direction.
2. SCREW up the inlet strainer.

Step 4 - Replace the Inlet Strainer

1. REPOSITION the inlet strainer.
2. REFIT tubes to inlet strainer, ENSURE it is facing the correct direction.
3. REPOSITION the pre-treatment cartridge into its support clips.
4. RE-ESTABLISH inlet water supply.
5. TURN on power.

7.4 Replacement of LC143 Reverse Osmosis Cartridge(s)

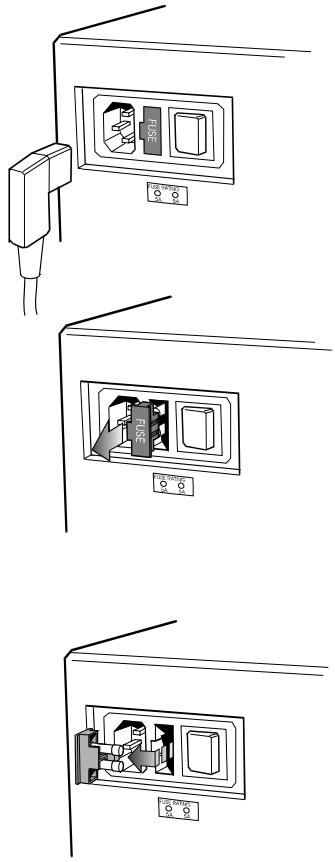
The reverse osmosis cartridge should be replaced if the permeate water purity or flowrate is not adequate and does not meet predicted or previous performance.

For information regarding the r eplacement of the LC143 Reverse Osmosis Cartridge contact Customer Service.

WARNING! ALL NEW RO CARTRIDGES ARE FILLED WITH A BACTERIOSTATIC SOLUTION TO PREVENT BACTERIAL CONTAMINATION DURING STORAGE. THE RO CARTRIDGES WILL THEREFORE REQUIRE RINSING PRIOR TO USE.

8. TROUBLE SHOOTING

This section highlights the problems that could occur with the ***PURELAB Option-S*** unit and how to rectify them. The unit will normally sound an alarm and the respective icons will flash. The alarm sound can be silenced by pressing the mute button. If the unit cannot be repaired using this manual please call either your supplier or local distributor. *(See Section 12 - Useful Addresses).*



Fuse Removal

Problems	Action
No display message	Check mains supply and lead. Check that the mains power is switched on. Check fuse in power inlet module and replace if blown.
Reservoir low level audible alarm sounds	Press the crossed bell button to mute alarm. The reservoir will automatically refill. Check that process mimic is showing reservoir filling. Check feedwater supply. Check connections to Reservoir.
Ion-exchange cartridge replacement alarm	Replace Ion-exchange cartridge pack. *(See Section 7.2. - Replacing the LC141 Ion-exchange cartridge).*
Pre-treatment cartridge replacement alarm	Replace pre-treatment cartridge. *(See Section 7.1 - Replacing the LC140 pre-treatment cartridge).*
Water purity alarm	Check alarm set value is correct. *(See Section 5.4, Step 5 - Purity Alarm Setting).* Allow unit to rinse. If alarm persists replace Ion-exchange cartridge. *(See Section 7.2 - Replacing the LC141 Ion-exchange cartridge).* If problem persists beyond that expected from normal operating conditions, contact your local distributor.
Reservoir level disconnect fault alarm	Check that the level controls are correct. *(See Section 5.3 Step 3 - Connect High/Low Level Switch to Reservoir).* If problem persists contact your local distributor.
Output flow below specification	Check supply pressure. *(See Section 5.2 - Positioning the **PURELAB Option-S**).* Check RO flow-rate for the unit against the graphs shown in Section 3.3, which details treated water output vs temperature and feedwater pressure. Check the inlet strainer. *(See Section 7.3 - Cleaning Inlet Strainer).* Contact service technician to fit or replace optional booster pump.
Unit noisy	Open front door and secure pipework to stop vibration.

9. CONSUMABLES AND ACCESSORIES

Consumable	Maximum Service Life*	Maximum Shelf Life
LC140 (Pre-treatment cartridge)	6 months	2 years
LC143 (Reverse Osmosis cartridge module)	Typical life 2-3 years	2 years
LC141 (Ion-exchange cartridge Pack)	6 months	2 years
LC136** (Composite Vent Filter)	6 months	2 years
LC123*** (Pre-treatment Filter)	6 months	2 years

* *Service Life is an estimate only, and will depend on the application and feed water quality. Care should be taken to order the correct consumable items.*

** *Required for reservoirs (LA611, LA612, LA613).*

*** *Required for optional pre-treatment filter housing (LA518).*

Accessory	Cat No
Installation kit	LA513
Installation kit (with saddle valve)	LA506
Pressure regulator valve (inlet)	LA512
Pre-treatment filter housing	LA518
Wall mounting kit (***PURELAB Option*** Unit)	LA610
25 liter reservoir	LA611
40 liter reservoir	LA612
75 liter reservoir	LA613
Wall mounting kit (25 & 40 liter reservoirs)	LA591
Wall mounting kit (75 liter reservoir)	LA592
Flow upgrade kit (7-15 l/hr)	LA604
RS232 Printer kit	LA618
RS232 Remote display kit	LA619
Docking Vessel - DV35	LA620
Pre-filter (if boost pump fitted)	LA582

10. KEY TO CONTROL PANEL

10.1 Icons

Icon	Description
	Mute Alarm
	Accept
	Scroll
	Auto Restart
	Manual Restart
	Set Up Menu
	Cursor Option Choice
	Cursor Selection Choice
	Cancel
	Reset
	Printer

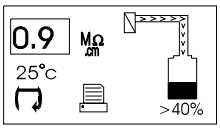
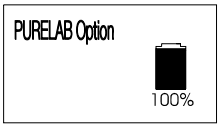
10.2 Alarm Conditions

Icon	Alarm Conditions
	Replace Conditioning Cartridge
	Replace Pre-treatment Cartridge
	Reservoir Level – Disconnect Fault

10.3 Replacement Timers

Replacement Timer	Icon	Preset
Ion-exchange Cartridge		4380 hours (= 6 months)
Pre-treatment Cartridge		4380 hours (= 6 months)

10.4 Quality and Standby Alarms

Screen	Description
	Process on and water purity alarm
	Standby and purity alarm
	Standby

11. WARRANTY/CONDITIONS OF SALE

ELGA LabWater is a trading name of VWS (UK) Ltd.

General Limited Warranty

VWS (UK) Ltd. warrants the products manufactured by it against defects in materials and workmanship when used in accordance with applicable instructions for a period of one year from the date of shipment for the products. VWS (UK) LTD. MAKES NO OTHER WARRANTY, EXPRESSED OR IMPLIED. THERE IS NO WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. The warranty provided herein and the data, specifications and descriptions of the VWS (UK) Ltd. products appearing in VWS (UK) Ltd.'s published catalogues and product literature may not be altered except by express written agreement signed by an officer of VWS (UK) Ltd. Representations, oral or written, which are inconsistent with this warranty or such publications are not authorized and, if given, should not be relied upon.

In the event of a breach of the foregoing warranty, VWS (UK) Ltd. sole obligation shall be to repair or replace, at its option, any product or part thereof that proves to be defective in materials or workmanship within the warranty period, provided the customer notifies VWS (UK) Ltd. promptly of any such defect. The exclusive remedy provided herein shall not be deemed to have failed of its essential purpose so long as VWS (UK) Ltd. is willing and able to repair or replace any nonconforming VWS (UK) Ltd. product or part. VWS (UK) Ltd. shall not be liable for consequential, incidental, special or any other indirect damages resulting from economic loss or property damage sustained by any customer from the use of its products.

Water Systems Limited Warranty

VWS (UK) Ltd. warrants the water systems manufactured by it, BUT EXCLUDING MEMBRANES AND CARTRIDGES, against defects in materials and workmanship when used in accordance with the applicable instructions and within the operating conditions specified for the systems for a period of one year from the earlier of:

a) the date of installation, or
b) the 120th day following the date of shipment.

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12. USEFUL CONTACT DETAILS

ELGA LabWater - Global Operations Centre

Lane End Industrial Park
High Wycombe
Bucks
HP14 3BY
UK

Tel: +44 (0) 1494 887 500
Fax: +44 (0) 1494 887 505
E-mail: techsupport@elgalabwater.com

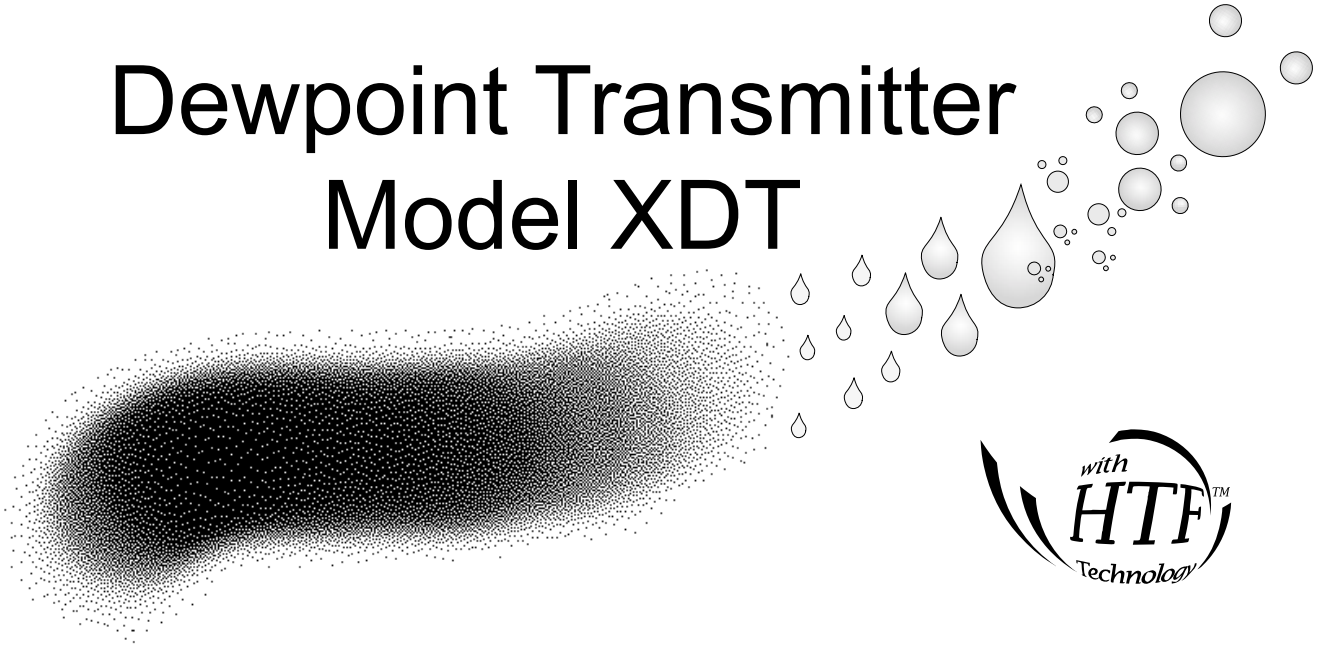
For the address of your nearest ELGA LabWater Sales and Service office visit the country list on our website

http://www.elgalabwater.com

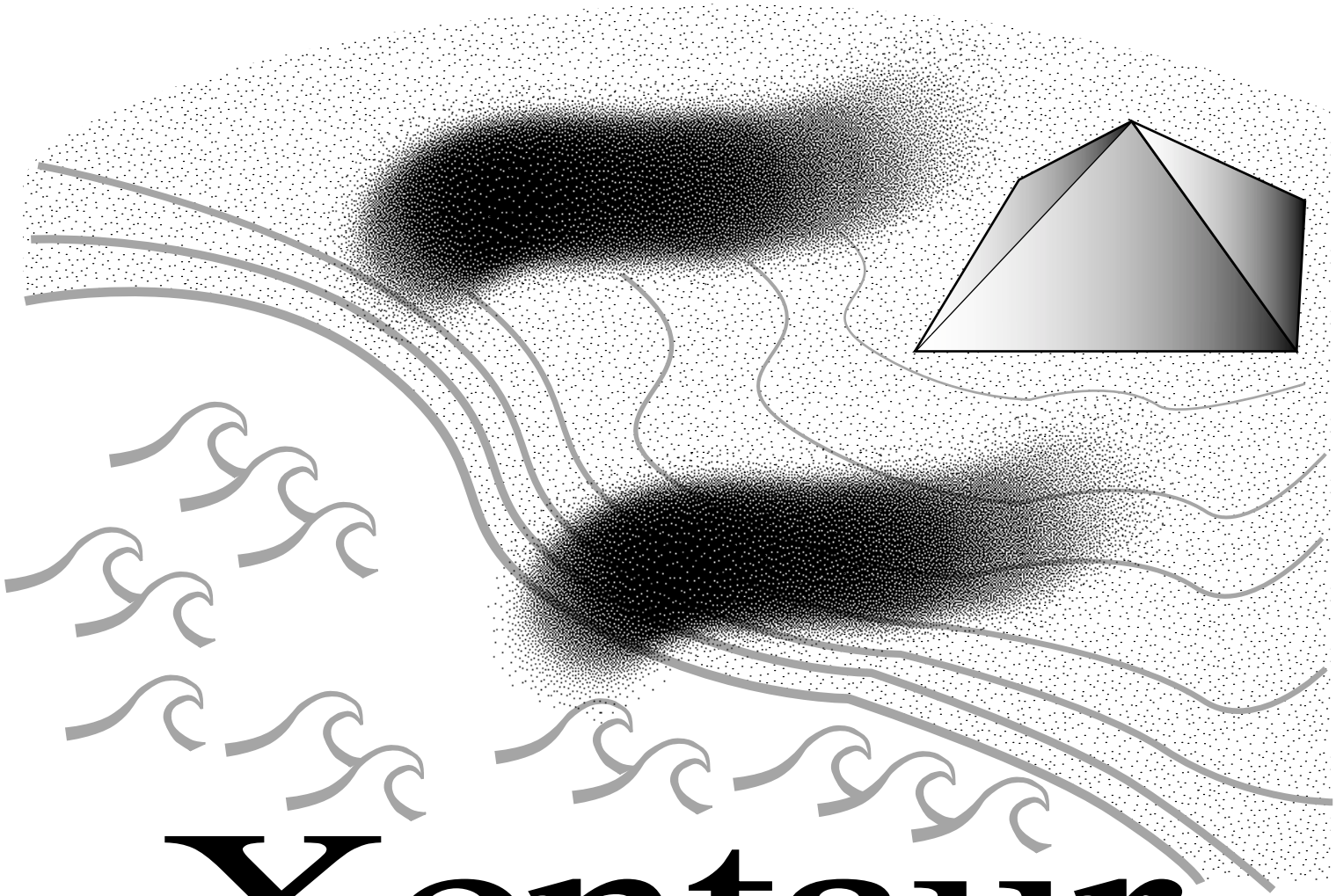
or contact ELGA at the number above.

User's Manual

Dewpoint Transmitter
Model XDT



with HTF™ Technology



Xentaur

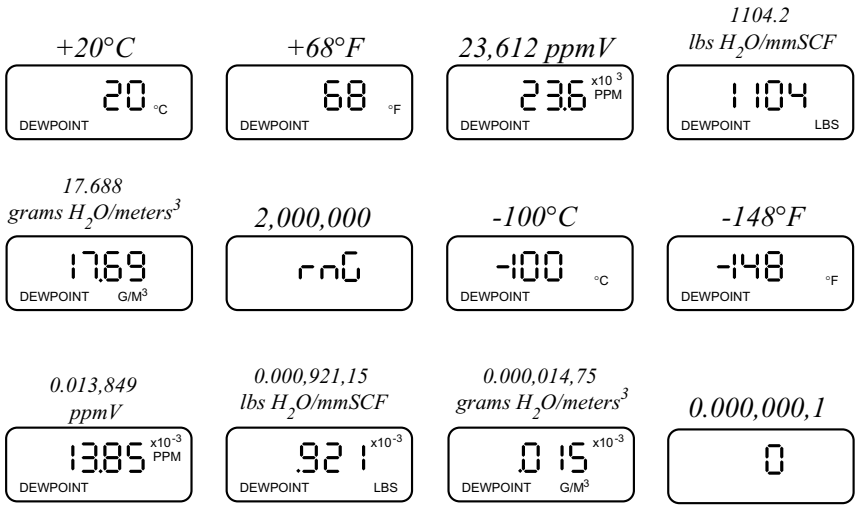
3.4 Operating the Instrument

3.4.1 Starting up

The instrument is ready for use as soon as the power cabling is connected. When power is applied the instrument will initialize its program and for a moment display XEN, then it will enter the Operating State. If the MODE button is held pressed while the instrument is performing its power-up initialization, it will enter the Set-Up State, which allows the user to select setup variables of the instrument.

3.4.2 Display Conventions

1. To display characters with the 7 segment numeric display, the following pseudo-alphanumerics are used:
   Numbers:
   0 12 3 4 5 6 7 8 9
   0 1 2 3 4 5 6 7 8 9
   Letters:
   ABCDEF GH IJ L NOP QRS TUXYZ
   A B C D E F G H I J L N O P Q R S T U X Y Z
   Symbols:
   ? - .
   ? - .
2. The instrument will indicate whether a particular mode allows changing a parameter by showing the word "SET" in the upper left corner of the display. Be careful not to change any parameter inadvertently.
3. °C°F appear simultaneously, to indicate the sensors' attenuation in decibels.
4. Values larger than ±1999 or smaller than ±0.01 are displayed in powers of $10^{\pm 3}$. As required, either a "10^{3}" or "10^{-3}" will appear above and to the right of the displayed value, the value will be rounded off to 3½ digits. The display will show RNG (out of **raGe**), if the number to be displayed is larger than 1,999,000. Twelve examples follow; for each the number and units desired to be displayed are shown in *italics*, depicted immediately below them is the resultant 3½ digit LCD display:



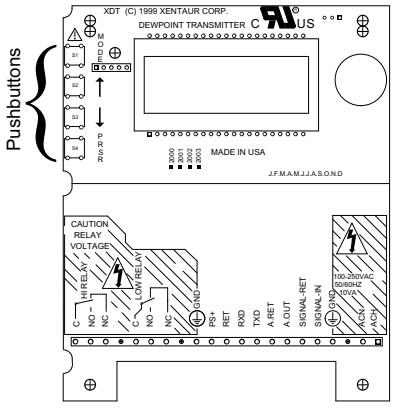
3.4.3 Push Buttons

Four push buttons provide user control of the instrument. They are designated MODE, UP, DOWN and PRESSURE CORRECT. These push buttons are vertically lined up on the upper left side of the bare circuit board, with the MODE button on top. There is also a connector provided which allows the use of external switches. The XDT-NEMA makes use of the circuit board mounted push-button switches, to access them one must open the cover of the XDT-NEMA enclosure. The XDT-PM is available in several versions:

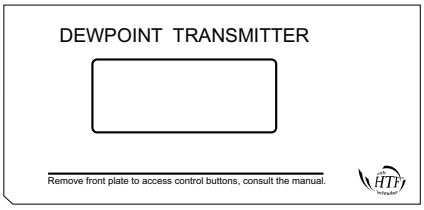
- With a solid silk screened front face plate, which must be removed to access the circuit board

switches described above.

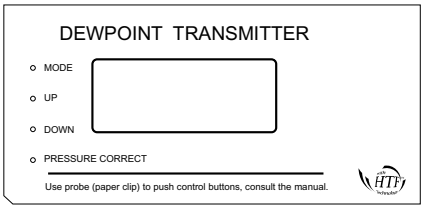
- With a front face plate which has labeled holes placed immediately above the circuit board switches, thus the operator may push the switches without removing the face plate, by making use of a probe such as a paper clip.
- With a front plate containing four membrane switches connected to the circuit board, providing the operator with a easy to use interface.



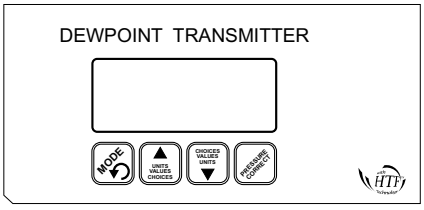
Bare board, or Instrument opened for access.



Panel Mounted Instrument with a solid silkscreened face plate



Panel Mounted Instrument with a silkscreened face plate with holes



Panel Mounted Instrument with membrane switches

In general the MODE button navigates through the different user options “Modes”; the UP and DOWN buttons modify the units, values or choices in the selected mode. Refer to the flow diagrams in Appendix A for detailed overview of button functionality. A button may be held down for a prolonged time, for accelerated incrementing or decrementing of numeric values.

3.4.4 Operating State

Upon power up, the unit performs certain initialization tests (see table in section 3.6), and enters the ‘Operating State’, in the Viewing Dewpoint mode. Depressing the ‘MODE’ button will change modes (see appendix A) in the following order: ❶Viewing Dewpoint ❷Alarms ❸Start Calibration ❹Viewing Serial Number (back to) ❶Viewing Dewpoint. The unit will return to Viewing Dewpoint mode if no buttons are pressed for 30 seconds, unless it is performing a calibration.

3.4.4.1 Viewing Dewpoint Mode

In this mode the user can view the dewpoint, this is indicated by the presence of the ‘DEWPOINT’ legend on the lower left of the display. The available engineering units in which to view the moisture content are °C, °F, PPM, LBS and G/M^3; the UP and DOWN buttons scroll back and forth through these units in respective order. The °C and °F are dewpoint readings. The PPM is

parts per million by volume computed at the sensor pressure (more about pressure later). The LBS and G/M^3 are density measurements, pounds of water per million standard cubic feet and grams of water per standard cubic meters, respectively, both in Natural Gas, they are computed according to data derived by IGT Research Bulletin 8, taking into account sensor pressure.
Note that the analog output is linear to the selected engineering units, therefore be mindful that while scrolling through various units the analog output may change even though the measured dewpoint is stable.

The PSI legend flashes at the bottom of the display, when there is pressure correction in the computation of the displayed values. A short press of the 'pressure correct' button toggles the unit in and out of pressure correct mode. When there is no pressure correction applied, the PSI legend does not appear.
Sensor Pressure is used in the context that this is the pressure inside the sample cell when performing the measurement, i.e. it is the operating pressure of the sensor.
Gas Pressure is used in the context that this is the pressure at which the dewpoint is to be calculated.
Pressure Correction is used in the context that the values displayed signify the moisture content at some pressure (we refer to this as the 'Gas Pressure') different from the pressure at the sensor.
Note that PPM, LBS and G/M^3 readings are by definition unaffected by pressure correction because only the pressure at the sensor affects their value. While °C and °F are affected by pressure correction by reporting what the dewpoint would be at the Gas Pressure when the dewpoint is what is measured at the pressure at the sensor. However, this also implies that whether pressure correction is applied or not the PPM, LBS and G/M^3 readings are affected by the setting of the sensor pressure.
A long press of the Pressure Correct button, while in the pressure correct mode (flashing PSI legend), changes the unit to the View/Set Sensor Pressure sub-state. The display has the 'SET' and 'PSI' legends on, and alternately shows SEN and the currently set value for the sensor pressure. The up and down buttons allow the user to modify the sensor pressure, while a short press of the pressure correct button toggles the Sensor Pressure setting between whatever value is on the display and 14.7 psi ---- this is a quick way to go back to atmospheric settings. A long press of the pressure correct button changes the unit back to the Viewing Dewpoint Mode. Pressing the 'Mode' button changes the unit to the View/Set Gas Pressure sub-state. The display has the 'SET' and 'PSI' legends on, and alternately shows GAS and the currently set value for the gas pressure. The up, down and pressure correct buttons operate in the same manner as in the Sensor Pressure sub-state. Pressing the 'Mode' button changes the unit back to View/Set Sensor Pressure sub-state, and so forth.

Notes:
1. Instruments are shipped from the factory in the locked mode and must be unlocked before this procedure can take place (see section 4.3 #7 to unlock).
2. The factory default settings are: 14.7psi for both sensor and gas pressure and pressure correction disabled.
3. When Pressure correction is disabled all dewpoints are computed by assuming that both Sensor and Gas Pressures are 14.7psi.
4. Pressure correction will effect the analog output but not the alarm relay trip-points. The analog output will track the pressure corrected dewpoint, the relays will trip on the uncorrected dewpoints.

3.4.4.2 Alarms

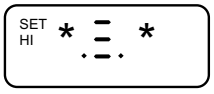
There are two independent optional alarms, they are named HI and LO alarms. Each alarm can activate a single pole double throw relay rated at 10A 250VAC or 30VDC per contact. Instruments for use in Division 2 Hazardous Areas have hermetically sealed relays rated at 3A 125VAC. Specially ordered instruments may have a third alarm, refer to the supplied addendum for relay contact rating, pinouts and user interface issues. The alarms can be set with a trip-point at any dewpoint within the range of the selected sensor. There is also a selectable hysteresis (with a minimum value of ±0.5°C to prevent relay chatter) which allows driving systems such as regenerative dryer purge valves in "dewpoint demand mode". The polarity of the alarm is also selectable, thus one may choose whether the relay energizes above or below the trip point, to allow fail safe design in case of XDT power loss, or in case of any other errors or failures which will cause the relays to de-energize.
When an alarm relay is deenergized the corresponding HI and/or LO indicator flashes on the display while viewing the dewpoint.

The behavior of the alarm when a sensor failure (e.g. open or short) is detected is also programmable. The options upon sensor failure are:

1. Fail High - put the alarm in a state as if the dewpoint is high, e.g. A.X.H
2. Fail Low - put the alarm in a state as if the dewpoint is low, e.g. A.X.L
3. Fail Flashing - Energize/Deenergize the relay alternating once every 2 seconds, e.g. A.X.F
4. No Special Handling - if sensor is open the alarm is in a low dewpoint state; if the sensor is shorted, the alarm is in a high dewpoint state, e.g. A.X.N

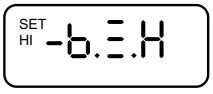
Setting or checking the present setup of the alarms is illustrated with the following example:

EXAMPLE : - Set the 'HI' alarm to de-energize the relay when the dewpoint is wetter than -75°C with minimal hysteresis (±0.5°C), and faults such as sensor failure cause relays to react as if there is high dewpoint i.e. if sensor cable breaks the relay de-energizes.
When following these instructions, it may be helpful to refer to Appendix A.

1. Make sure that the instrument is not in the locked mode.
2. While in the viewing 'Dewpoint Mode' push the UP or DOWN buttons until the °C indicator appears.
3. Push the MODE button until the display shows: 

   the asterisks '*****' take the place of characters that may appear depending on previous settings; the '**SET**' indicator means that changes can be made; the '**HI**' indicator means that we are changing the HI Alarm, (alarm #1).

Note that if the instrument does not have the alarm options installed this MODE (User Option) will not appear.

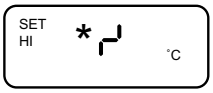
4. Push the UP or DOWN buttons until the display shows: 

   the -B means energize below or de-energize above set dewpoint, the H means faults look like high dewpoint. If the display shows LOC, the alarm changes are locked out, repeat step 1.

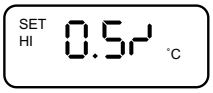
5. Push the MODE button. The display will show: 

   the '**DEWPOINT**' indicator means that we are changing the alarm trigger dewpoint

6. Push the UP or DOWN buttons until the display shows: 

7. Push the MODE button. The display will show: 

   the Z indicates that we are changing the hysteresis of the alarm.

8. Push the UP or DOWN buttons until the display shows: 

9. Push the MODE button until the instrument goes to the dewpoint display mode.
10. If it is desired to prevent inadvertent alarm settings changes by unauthorized people, activate the Lockout.

The Alarm Relays switch on non-pressure corrected dewpoints. Thus enabling or disabling the pressure correction wil not effect the relays.

The instrument will retain the alarm settings even if the power is turned off.

Pressing the MODE button changes to the Start Calibration Mode.

3.4.4.3 Start Calibration

The instrument is calibrated at the factory with the sensor it is shipped with and does not need to be re-calibrated prior to installation.
The calibration mode allows two different types of calibrations.

- SpanCheck™: an Automatic Calibration using the sensor's ability to saturate, thus no additional materials or equipment are required, this calibration is most useful after long periods of usage and a suspicion of performance degradation.
- Single point calibration: the calibration curve derived from SpanCheck is modified at a single point using the output of the sensor as it is exposed to a gas with a known dewpoint. This calibration is most useful when the sensor is exposed to hygroscopic substances which constantly alter the equilibrium between the sensor and the gas being measured (e.g. glycol), or when the sensor is exposed to corrosive gasses and may drift. If the known gas is chosen to be at a dewpoint at or close to the critical measurement point of the process then an extreme accuracy of the process may be maintained even in the most harsh of applications.

In general we recommend to perform SpanCheck in 12 month intervals (*not more often*), and single point calibration as often as practically possible. When it is time to perform both calibrations, then first disable the single point calibration, then perform the SpanCheck calibration, then perform the single point calibration. This procedure is not necessary but it is preferred when both calibration are performed.

3.4.4.3.1 SpanCheck™ Mode

The instrument is calibrated at the factory with the sensor it is shipped with and does not need to be re-calibrated prior to installation.

Instrument calibration is recommended in approximately 12 month intervals, and the XTR65W sensor should be re-calibrated after prolonged exposure to liquid water. Simply follow steps 1 - 7 of the procedure below, removing the sensor from the sample gas stream. To avoid injury, make sure the gas stream is depressurized before removing the sensor.
It is recommended to keep the sensor exposure to room air as short as possible, in order to avoid super saturation of the sensor. While super saturation is not damaging to the sensor, it will prolong the initial dry-down time after you install the sensor in the sample stream. Therefore, remove the sensor from the packaging container only after you are ready to proceed with the calibration procedure and install the sensor in the sample stream immediately after the calibration procedure is completed. If you are not ready to use the sensor right away after calibration, put the sensor back in the shipping container for dry storage.
The instrument must be calibrated with the sensor it will be used with.The calibration procedure takes advantage of the sensor's ability to saturate (refer to Appendix F) and is executed by the instrument computer, by performing the following steps:
If a single point calibration is in effect with a reference dewpoint below -70°C, it should be disabled (see next section) before performing SpanCheck calibration.

1. If the instrument is locked and a calibration is attempted; it will display LOC and will not perform the calibration. To unlock the instrument consult section 3.4.5.-10
2. Push the MODE key a few times until the display shows CAL.
3. Press the UP button. The display will show CNF, prompting you to confirm that you want to start the calibration procedure. You can abort the calibration procedure by pressing the MODE key.
4. Remove the sensor from its packaging container or sample stream, so that the porous metal filter is visible and the sensor is exposed to in-hand micro-climate (refer to explanation below). Close the packaging container as soon as you have removed the sensor to avoid degradation of the desiccant inside the container. You may want to re-use the container at a later date.
5. Expose the sensor to in-hand micro-climate, and push the UP button again to confirm that you want to start the calibration procedure. The display will flash AC for 60 seconds, while the sensor is saturating. Make sure you keep the sensor exposed to in-hand micro-climate until the display shows END.
6. After 60 seconds, the display will flash the selected sensor type (see *Selecting a sensor type 3.4.5.-2)* and then the instrument will calculate the slope and offset of the sensor curve while displaying the calculations and then will display END for a few seconds, after which the instrument will automatically go into measuring mode. The sensor calibration is completed. (The display may flash SAT, indicating that the sensor has super-saturated. As soon as the sensor is exposed to an atmosphere with a dewpoint lower than the saturation dewpoint, the display will indicate the dewpoint measured by the sensor.) The display may show alternating SEN and 2LO as an indication that the measured capacitance is too low to be from a saturated sensor, in this case make sure that the sensor is properly plugged in, and repeat the calibration procedure.
7. Install the sensor in the sample cell or adapter fitting or put it back into the packaging container for later use.

The instrument will retain the calibration even if the power is turned off.

Under certain conditions, an over (super) saturated sensor may need to be completely dried out before a calibration is performed. Symptoms of these conditions are a sensor that will not go through the SpanCheck™ function to the END display, or a sensor that will not dry down after calibration. To dry, install sensor in either a known dry gas stream i.e. instrument quality air or dry nitrogen, or place sensor in a dry can or bottle of desiccant and seal the container from outside air (the shipping container is designed for this purpose). After a minimum dry out period of 24 hours, proceed with the calibration procedure of your choice.
SpanCheck™ calibrates sensors by using micro climates. Please contact your representative if you have any questions about how to create such micro climates.
A perfectly acceptable and accurate for calibration micro-climate may be created for the XTR100 and XTR65 sensors by cupping the sensor in the palm of one's hand during the SpanCheck™ procedure. Remember that the micro-climate does not have to be accurate, it just has to be higher than the designed saturation level. The dewpoint of the micro-climate within the fingers is usually higher than the dewpoint of the room air and probably well above the +20°C upper range of the sensor. On a dry day, one may need to exhale in the hand before cupping the sensor to guarantee a high dewpoint. The sensor should be warmed up close to body temperature before performing this procedure. Care must be taken that the sensor temperature is not below the temperature of the hand, as in such case condensation could occur and super saturate the sensor. For the same reason, avoid exhaling directly onto the sensor.

3.4.4.3.2 Single Point Self Calibration, manual or scheduled

The instrument is calibrated at the factory with the sensor it is shipped with and does not need to be re-calibrated prior to installation.

Single point calibrations should be performed whenever the measurement is in question, or on a scheduled basis depending on the application. Consult with your representative to establish criteria for specific applications.
The single point calibration is performed on the premise that the sensor is exposed to a gas with a known dewpoint for a time sufficient to equilibrate. Then the sensor output is measured, and the calibration curve is adjusted to provide measurement computations which correspond to the known dewpoint. Measurements over the full sensor range are linearly adjusted to this known point.
The single point calibration provided by this instrument may be performed manually, or (when a sample system is ordered equipped with an electrically actuated switchover valve) unattended on a repetitive timer scheduled basis. The user interface for both is the same, with additional steps for interval setting and automatic stabilization time outs for the instrument with the electrically actuated valve.

Manual Single Point Self Calibration procedure for instruments without electrically actuated switchover valve:

- Refer to the unshaded area of the flow diagram on the second page of Appendix A.
- Expose the sensor to a known dewpoint
- Wait at least 15 minutes for the sample system to be stable, if the known gas is of a low dew-

point the waiting time may have to be increased - specially if the sensor was wet before the procedure is initiated. Consult with your representative to determine sufficient waiting time for your application.

- Make sure the instrument is unlocked.
- Press the MODE button a few times until the display shows CAL.
- Press the DOWN button to select the Self Calibration mode. The display will show SLF/CAL
- Press the UP button to confirm entry into the Self Calibration mode. The display will show the reference dewpoint which has been previously programed into the instrument, the SET and DEWPOINT legends will also appear. Use the UP and DOWN buttons to modify this dewpoint to match the dewpoint of the known gas to which the sensor is exposed.
- Press the MODE button, the display will show BEG/S.C., prompting to begin the Self Calibration.
  If the MODE button is pressed the calibration will be canceled and instrument will go to the Serial Number mode. All setup will still be in effect, e.i. newly entered reference dewpoint will remain in the instrument's memory.
  If the DOWN button is pressed the Self Calibration corrections will be disabled; any Self Calibrations performed previously will not be used in correcting the computed dewpoint of the instrument.
- Press the UP button to initiate the Self Calibration. the display will show CNF/SC?, prompting for a confirmation that the Self Calibration should be performed.
  If the DOWN or Pressure Correct buttons are pressed the Self Calibration will be aborted.
- Press the UP button to confirm the Self Calibration. The display will show alternately S.C./STB /-41.5, indicating that Self Cal Stabilization is being checked and currently the instrument is measuring -41.5°C. When the measured dewpoint is stable within 0.5°C for 3 minutes the instrument will record the new single point self calibration values and finish by going to the display dewpoint mode. Note that the program will spend at least 3 minutes on this stage of the calibration.
- The sensor may now be exposed to the sample gas and the instrument will display the measurement using the newly acquired calibration values.

Scheduled Timer Activated Single Point Self Calibration procedure for instruments with electrically actuated switchover valve and on-board battery backed real-time clock:

- Make sure that your sample system is properly connected according to the sample system instructions. When the time-outs and stabilization times are summed from the calibration stages below, it can be determined that the calibration reference gas will be used for at least 18 minutes, the user should make sure that there is sufficient amount of gas available. If the reference gas is provided from a compressed gas bottle, make sure that there is sufficient pressure in the bottle, for some bottles there is a cut-off pressure below which the dewpoint is not guaranteed. Make a note of the exact dewpoint of the reference gas as it will be required in the next steps.
- Refer to the unshaded area of the flow diagram on the second page of Appendix A.
- Make sure the instrument is unlocked.
- Press the MODE button a few times until the display shows CAL.
- Press the DOWN button to select the Self Calibration mode. The display will show SLF/CAL
- Press the UP button to confirm entry into the Self Calibration mode. The display will show the reference dewpoint which has been previously programed into the instrument, the SET and

DEWPOINT legends will also appear. Use the UP and DOWN buttons to modify this dewpoint to match the dewpoint of the reference gas.

- Press the MODE button, the display will alternately show 720 / HRS / INTR, indicating that the calibrations are scheduled at 720 hours interval. Use the UP and DOWN buttons to change the interval time to whatever is determined to be most effective for your application, consult with your representative if you are in doubt. An interval of 0 Hrs (appears as a blank on the display), disables any further scheduled unattended calibrations, however the instrument will continue to make use of calibration values acquired previously or manually in the future. Pressing the Pressure Correct button will cause the instrument to momentarily display 150 / HRS / LEFT, indicating that there are 150 hours left until the next scheduled calibration is performed. This is a useful indication in cases where it is not known when the next calibration will be performed.
- Press the MODE button, the display will show BEG/S.C., prompting to begin the Self Calibration.
  - If the MODE button is pressed the calibration procedure will be canceled and instrument will go to the Serial Number mode. All setup will still be in effect, e.i. newly entered reference dewpoints, the scheduled interval time etc. will still be used by the system.
  - If the DOWN button is pressed the Self Calibration corrections will be disabled; any Self Calibrations performed previously will not be used in correcting the computed dewpoint of the instrument. However newly entered reference dewpoints and the scheduled interval time will still be in effect; thus when the time elapses a Self Calibration will be performed and its values will be used in correcting the computed dewpoint from that time on.
- Press the UP button to initiate the Self Calibration. the display will show CNF/SC?, prompting for a confirmation that the Self Calibration should be performed.
  If the DOWN or Pressure Correct buttons are pressed the Self Calibration will be aborted, however everything set until now will remain in effect.
- Press the UP button to confirm the Self Calibration. The display will show SLF/CAL/-41.5 indicating that self calibration has started and it is measuring a dewpoint of -41.5°C, (this is also the entry place into the procedure when the scheduled time elapses). Now the instrument will "freeze" the analog output and the alarm relays so that they are not influenced by the reference gas dewpoint. Then the instrument will activate the electrically actuated switchover valve and thus introduce the reference gas to the sensor, and initiate a 15 minute time out allowing the system to reach equilibrium. (Since the program will perform the above when the scheduled interval elapses, this step may be occurring in an unattended mode, thus the reference gas bottle and regulator must be left in the open positions, the switchover valve will keep them from being exhausted.)
- After the 15 minute stabilization time out, the display will show alternately S.C./STB /-41.5, indicating that Self Cal Stabilization is being checked and currently the instrument is measuring -41.5°C. When the measured dewpoint is stable within 0.5°C for 3 minutes the instrument will record the new single point self calibration values. Note that the program will spend at least 3 minutes on this stage of the calibration.
- The electrically actuated switchover valve will be deactivated thus introducing the sample gas to the sensor, and the dewpoint will be monitored for stability. The display will show S.C./FIN/-42 indicating that self calibration has finished and it is measuring a dewpoint of -42°C. When the measured dewpoint is stable within 0.5°C for 3 minutes the instrument will "unfreeze" the analog output and relays and go to the display dewpoint mode.

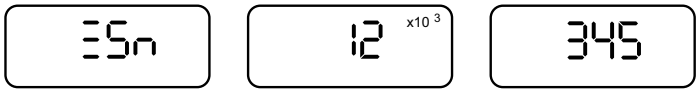
- The instrument will display the measurement using the newly acquired calibration values.

The instrument computes the dewpoint from the measured capacitance of the sensor. The sequence of computations is as follows:

- The capacitance is converted to percent of full scale (-100°C to +20°C dp), using the low dB, low dew, and saturated dB when performing SpanCheck values.
- Cal Adj is applied to correct the mid point of the curve.
- If enabled, the multi-point calibration table is applied to further correct the transfer function.
- If enabled, the single point calibration is applied to fine tune the transfer function.
- The corrected percent of full scale is converted to dewpoint.

3.4.4.4 Viewing Serial Number Mode

In this mode the user can view the instrument serial number. The display shows the serial number by alternately displaying XSN and the number. If the number is larger than 1999 then it is displayed in 2 parts, first part is the thousands signified by the $x10^3$ legend in the upper right corner of the display and the second part is the units. For example serial number 12345 will be shown as:



Pressing the UP and DOWN buttons simultaneously resets the instrument, this is useful in installations where power can not be turned on and off easily. Pressing the Pressure Correct button will cause the instrument to enter the setup state.

Pressing the MODE button, returns the unit to the Viewing Dewpoint Mode.

3.4.5 SetUp State

To enter the Setup State power-up the unit (or reset it from the serial number Mode), and hold the MODE key pressed while the unit is initializing. Refer to Appendix B for a flow diagram of the SetUp State.

The setup state provides eleven capabilities, each one controlled from its own mode. Depressing the MODE button navigates through the modes in the following order: ❶Select Alternate Display Units ❷Select Sensor Type ❸Set Measured Attenuation of Sensor at a Low Dewpoint ❹Set the Low Dewpoint at which the Attenuation was measured ❺Set the Calibration Mid-range Adjust ❻Analog Output select 4/20mA or 0/24mA ❼Perform a Test and Verification of the Analog Output ❽Set dewpoint corresponding to low end of Analog Output ❾Set dewpoint corresponding to high end of Analog Output ❿Lock/Unlock the instrument ❶❶Sensor Cable Compensation (back to) ❶.

These eleven functions are explained in their respective sections which follow. Note that modes 6,7,8&9 will appear only on instruments with the analog output option. *Changes can be made only to an unlocked instrument*, the changes are stored (when the MODE button is pressed) and retained even if the instrument power is turned off.

1. **Display of alternate units**: In this mode, a second engineering unit can be chosen to be displayed alternating with the engineering unit selected in the operating state, for example, a dewpoint can be alternately shown in °C and in PPM.

CAUTION:
2), 3), 4) and 5) are set at the factory and need only be modified when a sensor is changed.

2. **Selecting the sensor type**: In this mode the user can select the software matching the type of sensor installed in the instrument: `XT1` : XTR-100 (-100°C to +20°C);
   `XT6` : XTR-65 (-65°C to +20°C);
   `DB` : show impedance of any sensor, disable Open and Short error massages.

3&4**Adjusting low end sensor attenuation and dewpoint**: These modes are used to enter a data pair representing a low dewpoint and the sensor attenuation measured at this low dewpoint. (see Sensor Theory of Operation appendix F). This data pair should not be modified unless the sensor is replaced (refer to procedures for replacing a sensor in appendix L). The sensor shipping container is labeled with the proper values.

5. **Calibration Adjustment**: In this mode the user can enter a sensor specific Adjustment Value to improve the instruments' accuracy in the range of -50°C to -10°C, this adjustment has very little or no effect outside this range. The Calibration Adjustment Value is printed on the shipping container supplied with the sensor, or may be derived if the sensor can be exposed to a known reference.

   Deriving an Adjustment Value: If the adjustment value for your sensor is not known, contact your representative and follow the instructions below for entering known values. If the value is not available, then it may be derived using a manual method, provided that a moisture calibration facility is available.

   The calibration must be done in the range of -25°C to -20°C (attempting to calibrate outside this range may cause inaccuracies), the dewpoint must be kept stable during calibration and it must be measured accurately by a reference instrument such as a chilled mirror. One must also note the state of pressure compensation and turn it on or off as applicable to the reference.

   The necessary steps are described below (also refer to the Set-Up State flow diagram in Appendix B):

   a. Make sure that the low attenuation and low dewpoint are correctly entered for this sensor.
   b. SpanCheck™ the sensor.
   c. Dry-down the sensor for at least 12 hrs.
   d. Expose the sensor to the known dewpoint (-25°C to -20°C), for a sufficient time (at least 30 min.)
   e. Go to the `CAL/ADJ` mode and press the UP button, the display will show the current value, in the range of -1.99 to +1.99 followed by blinking horizontal lines.
   f. Observe the display, if the buttons are not being pressed; the display will every few seconds show for a short duration the dewpoint as being computed at the moment (utilizing the current cal-adjust value in the computation).
   g. Use the UP or DOWN buttons to modify the cal-adjust value and observe the alternately displayed dewpoint. Perform this adjustment until the dewpoint matches the value shown by the reference instrument.
   h. Press the MODE button to go to the next mode, this will save the new cal-adjust value, and it will be retained even if power is turned off.

   Entering a known Adjustment Value: If the sensor is being replaced an adjustment value should be supplied with the sensor, to enter it into the instrument:

a. Go to the CAL/ADJ mode and press the UP button, the display will show the current value, in the range of -1.99 to +1.99 followed by blinking horizontal lines, ignore the alternately displayed dewpoint.
b. Use the UP or DOWN buttons to modify the cal-adjust value as necessary.
c. Press the MODE button to go to the next mode, this will save the new cal-adjust value, and it will be retained even if power is turned off.

6. **Analog Output Span selection 4/20 mA or 0/24 mA:** By pushing the UP or DOWN buttons, the user may select the desired span of the analog output.
7. **Testing the analog output**: By pushing the UP, DOWN, or Pressure Correct buttons, the user forces the analog output to its high, low and mid-range values, respectively. This facilitates the hook-up and testing of the user's monitoring equipment.

8&9 **Output range setting**: These modes are used to set dewpoints corresponding to the low and/or high end of the Analog Output. The factory default values are: low end at -100°C, and high end at +20°C. For detailed discussion of the necessary considerations when choosing the analog output range, refer to appendix J.

10. **Lock/Unlock the instrument** with *optional SECURED* password protection
The Lock/Unlock feature of the instrument allows the owner to block access to parameter settings, protecting the instrument from unauthorized or inadvertent changes. Attempting to change settings while the instrument is locked will display LOC and beep.

- When in the Lock/Unlock Mode and the instrument is locked the display will show "SET LOC". The instrument may be unlocked by pressing the "UP" button. If "SEC" is displayed, refer to the Secured Password Protection section below.
- When the instrument is unlocked the display will show "SET UN/LOC". The slash (/) denotes that the display is alternately showing UN and LOC, this is necessitated by the 3.5 digit limitation of the display. Pressing the "DOWN" button will lock the instrument.
- Pressing and holding either the "UP" or "DOWN" buttons, will save the locked or unlocked setting depending on the button, and reset the instrument. This feature is useful in situations where it is difficult or undesirable to power off the instrument.
- Pressing the MODE button will navigate to the Sensor Cable Compensation mode.

Secured Password Protection

Instruments may be specially ordered with password protection. To unlock the instrument the user must supply a password, which consists of a number in the range of -1999 to 1999 (approximately 4000 unique passwords). Instruments that require a password, will display "SEC" (secured) when the user attempts to unlock by pressing the "UP" button. After approximately 1 to 2 seconds the instrument will display "000", with the first digit flashing. The flashing denotes the cursor position, which means that the "UP" and "DOWN" buttons will increment or decrement this digit respectively. Pressing the "MODE" button will move the cursor (flashing digit) to the right. Pressing and holding the "MODE" button will signal the instrument to read the password and if correct to unlock the instrument. As discussed above an unlocked instrument will display "SET UN/LOC". The user may enter the assigned password by pressing the UP, DOWN and MODE buttons. The first digit is unique in that it consists of 1½ digits in the range of -19 to 19, this allows entering the full range of assignable numbers.

An example is used to illustrate the unlocking of a password-protected instrument. Suppose the password is 1234. After an attempt to unlock, the user will see "SEC" followed by "000", with the first 0 flashing. Pressing the "UP" button twelve times will display "1200" (overshooting a num-

ber can be corrected by reversing the use of the UP and DOWN keys), with the "12" flashing. Pressing the "MODE" button will flash the next "0". Pressing the "UP" button three times will display "1230". Pressing the "MODE" button will flash the last "0". Pressing the "UP" button four times will display "1234". Pressing and holding the "MODE" button, will display "SET UN/LOC", indicating that the instrument is now unlocked. It may be locked without the password, same as any other instrument.

Note: To avoid unauthorized changes, it is imperative that instrument is returned into the locked mode.

11. **Sensor Cable Compensation:** As noted in other paragraphs this instrument measures the impedance of the sensor (in the form of attenuation in decibels) from which it computes the dewpoint. At very low dewpoints the sensor capacitance is small enough to be in the same order of magnitude as a long coaxial cable. Thus the measurement circuit must be compensated for the impedance of the sensor cable. **Instruments which are delivered with a cable are already compensated at the factory and should not be compensated again**, however if a new cable is connected, the following procedure should be used for compensation (also refer to the Set-Up State flow diagram in Appendix A):
    a. Disconnect the sensor from the cable by unplugging the BNC connector, keep the cable connected to the instrument.
    b. Prepare a means by which the BNC connector at the end of the cable could be reliably shorted (using a jumper clip etc.), do not attempt to short at the instrument screw terminals as this approach will not account for the cable resistance.
    c. Go to the CNF/CBL/OPN (Confirm Cable Open) mode.
    d. Leave the BNC connector open and press the UP key. The instrument will show OPN and beep for a few seconds. Then it will show CNF/CBL/SHR (Confirm Cable Short).
    e. Short the BNC connector and press the UP key, the unit will show SHR and beep for a few seconds. Then it will show CNF/CBL/OPN again.
    f. Leave the BNC connector open again and press the UP button. The instrument will show OPN and beep for a few seconds. Then it will show END

    The compensation data will be retained even if power is turned off.

3.5 Resetable Audio-Visual Alarm Option (NFPA compliant)

When the instrument is ordered with an Audio-Visual Alarm option, it is provided in the XDT-NEMA enclosure, outfitted with two front panel momentary push buttons in NEMA sealed rubber boots. The instrument complies with the recommendations of NFPA 99, 1996 edition.

- The alarm set point is programmed on a third alarm, hence the HI and LO alarm relays are free to be used for additional purposes The third alarm is properly configured to 39°F at the factory, but when necessary may be modified by the user. Refer to the notes following HI & LO Alarms in the *Flow Diagram of Operating State User Interface* in appendix A.
- The visual indicator is the display backlight. When there is no alarm condition the LCD display is not backlit but can still be easily and clearly read (in an extremely dark room the backlight may be momentarily turned on by pressing the TEST button). However as long as an alarm condition exists the LCD will be backlit in red. This lit-up front window of the instrument is the visual indicator.

- This configuration is also equipped with a NEMA sealed audio indicator (>80dB @ 3ft) mounted in the instrument enclosure. It is activated when an alarm condition occurs, it may be disabled by momentarily pressing the RESET button on the front panel. When the alarm condition ceases to exist, the audio indicator is automatically re-enabled, ready to be activated on next alarm condition.
- A momentary TEST button on the front panel allows testing both the visual and audible indicators.

3.6 Troubleshooting the Instrument

This instrument performs diagnostic tests on power up as well as once every two minutes. The table that follows, depicts all possible error/unexpected messages that may be displayed on the instrument. For each message the table has explanations for the reason, and if necessary a suggested action to remedy it.
The instrument contains a fuse which may open if the instrument is subjected to voltages exceeding the specifications. Under these circumstances the unit display will be blank and the instrument will not draw any current when powered up. The user may replace the fuse with a comparable 0.5A, 250V fast acting fuse, to locate the fuse refer to the XDT mechanical drawing in Appendix E.

DISPLAY	EXPLANATION		REQUIRED ACTION
LO ERR 🔔	PROM check sum failed.	power on tests	cycle power if problem persists, return to your representative for service.
HI ERR 🔔	RAM write/read test failed.		
% ERR 🔔	Unidentified power-up failure.		
C.S.F / 🔔	EEPROM ***C***heck ***S***um ***F***ailed.		
ERR / AD 🔔	***A/D*** converter failure.	system tests once per 2 min.	
ERR / REF 🔔	***Ref***erence voltage for A/D out of spec.		
LO / BAT 🔔	***Lo***w ***supply*** voltage.		
LO RNG / TEMP 🔔	Instrument ***lo***w ***temp***erature ***rang***e has been exceeded.		make sure that the unit is at a temperature of -10°C to +50°C.
HI RNG / TEMP 🔔	Instrument ***hi***gh ***temp***erature ***rang***e has been exceeded.		
OPN / 🔔	Sensor circuit is ***open***.	dewpoint display tests	see table in sensor troubleshooting section 2.5
SAT / 🔔	Sensor is ***sat***urated.		
SHR / 🔔	Sensor circuit is ***shor***ted.		
...	Trying to calculate dewpoint for undefined sensor.		select sensor and recalibrate.
DB 🔔	Trying to calibrate an undefined sensor.	calibration tests	see calibration instructions.
SEN / 2LO 🔔	***Sen***sor reading is '***too' lo***w to be from a saturated sensor, thus can not be calibrated		
2LO	While Compensating for cable length, the measurement did not correspond to the expected open or short values.	cable tests	Check the means of opening & shorting the sensor cable. see section 3.4.5 - 11
2HI			
ERR / EEP 🔔	***EEP***ROM write cycle not completed.	miscellaneous	if this persists, return for service.
LOC 🔔	Attempting to modify a ***loc***ked unit.		unlock unit, see set-up state 3.4.5.-10.
SEC 🔔	Attempting to unlock a ***sec***ured unit.		
HI (flashing while viewing DEWPOINT)	The HI Alarm (alarm #1) relay is deenergized.		See section 3.4.4.2 Setting the Alarms.
LO (flashing while viewing DEWPOINT)	The LO Alarm (alarm #2) relay is deenergized.		
A.O. / OPN 🔔	The Analog Output 'sees' an open circuit		check the cables connecting the analog output, make sure the terminating impedance is less that 500**Ω**.
PSI flashing when displaying dewpoint	Pressure correction is enabled, the dewpoint is computed using programmed pressures		refer to section 3.4.4.1
-70°C (-94°F) with flashing **DEWPOINT**	An XTR-65 sensor is measuring less than -70°C or -94°F D.P.		check instrument upgrade to XTR-100 sensor
RNG	number can not be displayed in 3½ digits		
XEN 🔔	Turn on message, ***Xen***taur (*Greek* Ξ=X)		
display is dark	No power to instrument		check power to instrument, check fuse

Legend: 🔔 denotes a beeping accompaniment to the message.
/ denotes alternately flashing messages.

3.7 Maintenance

The XDT-PM and XDT-NEMA instrument enclosures may be cleaned when necessary using a damp (moist) cloth.The XDT-OEM bare circuit board may be cleaned by blowing air across the circuit board. The sensor should not be cleaned as it may be damaged.

Spare parts may be ordered through your representative.

Glossary

0/24 mA . . . . . range of current for the current loop (0mA=minimum reading, 24mA=maximum reading)

4/20 mA . . . . . range of current for the current loop (4mA=minimum reading, 20mA=maximum reading) - preferred because less than 4mA can indicate a fault or open circuit, also there is at least 4mA available to power equipment

7 segment . . . . . type of display configuration - where 7 segments can be used to form the numbers 0 through 9 and most letters

A/D . . . . . analog to digital - a device or circuit that converts an analog voltage to a digital number

absorption . . . . . retention by penetration into bulk of material

adsorption . . . . . retention as a surface layer on a material

accuracy . . . . . quantification of the magnitude of error of a measurement, or degree of conformity with a standard.

Al_2O_3 . . . . . aluminum oxide

attenuation. . . . . the decrease in intensity of a signal, as a result of absorption of energy, measured in decibels (dB).

AWG . . . . . American Wire Gauge (size of the wire, cross section area of the wire)

baud. . . . . Bits per second of data transfer (over the serial interface)

bit(s) . . . . . Binary digit(s) - ones and zeros

BNC . . . . . a connector type, used with coaxial cables

bypass mounting . . . . . sensor mounting in a slip stream of sample, which feeds back into the process stream

CE . . . . . Conformitée Europeane; symbol affixed to a product indicating its conformance with directives issued by the European Community (EC)

CENELEC . . . . . Comité Europeen de Normalisation Electrotechnique (European Committee for Electrotechnical Standardization); amongst many others has set standards for intrinsic safety

check sum . . . . . an arithmetic total on a set of data: e.g. the data in the instrument's memory is summed, and compared to a previously stored sum to check for corrupted data

coalescing . . . . . formation of liquids in gas samples, or separation and collection for disposal of liquids from gas samples

control drawing . . . . . schematics and system drawing of hazardous area approved apparatus with control number issued by approval agency

CSA. . . . . Canadian Standards Association

CTS . . . . . Clear To Send - a label for a RS232 interface control line

cUL . . . . . indicates UL evaluation of a product to Canadian safety requirements

current loop . . . . . a circuit where the variation in the current flow is used to indicate the value of a measurement from the instrument, only 2 wires are

used for the circuit (see 4/20)

dB . . . . . see - decibel

DB25. . . . . a style and size of connector - in this case with 25 pins

DB9. . . . . a style and size of connector - in this case with 9 pins

decibel. . . . . a dimensionless unit representing the logarithm of the ratio of two values

DEMKO . . . . . independent test laboratory and the European National Certification Body for Denmark for the safety testing of electrical products

desiccant . . . . . drying agent, usually made from molecular sieve, silica gel or activated alumina

desorption . . . . . release of a previously absorbed or adsorbed substance

dewpoint . . . . . saturation temperature of a gas in regards to another gas

dewpoint demand mode . . . . scheme to control the switching between the desiccant towers of a dryer based on the actual dewpoint

dielectric constant . . . . . measure of the ability of a material to hold an electric charge when placed between two metal plates, most commonly measured relative to that of free space

Div 2 . . . . . see Division 2 Hazardous Areas

Division 2
Hazardous Areas. . . . . areas classified as hazardous under abnormal conditions (0.1-10 hrs/year)

DSR. . . . . Data Set Ready - a label for a RS232 interface control line

DTR . . . . . Data Terminal Ready - a label for a RS232 control line

EEPROM . . . . . Electrically Erasable Programmable Read Only Memory - a device that can remember information, even when it has no power applied to it

electromagnetic
compatibility. . . . . compatibility with directives issued under CE or with FCC standards, concerning electromagnetic interference

EMI. . . . . Electro-Magnetic Interference - external electrical or magnetic signals from natural or man-made sources that can interfere with a device

G/M^3 . . . . . see - grams per cubic meter

grams per cubic meter. . . . . the mass of water vapor present in unit volume of moist air at standard temperature and pressure.

HTF™ . . . . . Hyper-Thin-Film aluminum oxide sensor technology developed by Xentaur Corp

hygrometer . . . . . device measuring the amount of water present in a sample

hygroscopic. . . . . property of attracting water or water vapor

hysteresis. . . . . lagging in effect behind it's cause depending upon whether the condition is approached from above or below the value of interest; purposefully programmed into control systems with relays to avoid chatter

IGT Research Bulletin 8 . . . . Institute of Gas Technology, has developed Charts of the Equilibrium Moisture Content of Natural Gases in the Range of -40°F to 250°F and 14.7 to 5000 psi

impedance . . . . . the ratio of voltage to current at a specified frequency measured in Ohms, a resistor of the same value would act the same as the measured circuit

in-hand micro-climate . . . . . the warm and moist “climate” created when cupping the sensor in ones hand.

in-situ . . . . . measurement with sensor located in the process stream

intrinsically safe . . . . . incapable of releasing enough electrical or thermal energy to cause the ignition of flammable substances listed for a hazardous area classification

LBS H_2O/mmscf. . . . . see - pounds of water per million standard cubic feet

LCD . . . . . Liquid Crystal Display - a display that uses a special material (that is sensitive to electrical voltages) to affect the transmission or reflection of light

monograph . . . . . a systematic learned exposition of a subject, e.g. a chart representing dewpoint conversions for differing pressures.

National Electrical Code . . . . a set of US standards related to accepted practices for electrical wiring

NFPA. . . . . National Fire Protection Agency (issuer of the National Electrical Code (NEC))

NIST . . . . . National Institute of Standards and Technology

NPT . . . . . National (American Standard) Pipe Taper; an ASTM (American Society for Testing and Materials) standard of tube fittings with tapered threads

parity . . . . . a way of incorporating error checking into a RS232 data transmission (on a character by character basis) to check if the data has been received correctly

pounds of water per million standard cubic feet . (LBS H_2O/mmscf) the mass of water vapor present in unit volume of moist air at standard temperature and pressure.
a measurement unit for moisture, typically used in the natural gas industry

ppm . . . . . parts per million - usually based on volume measure, but must be stated whether it is by volume or by mass (weight)

ppmV . . . . . parts per million based on volume measure, volume of water vapor per total volume of gas for an ideal gas.

pressure correction . . . . . computation of dewpoint at a pressure different from the pressure at the sensor

PROM . . . . . Programmable Read Only Memory - a device that can be programmed so that data is permanently stored in it (typically used for computer programs)

RAM . . . . . Random Access Memory - a device that holds data as long as it has power applied to it (the data can be changed with out limit)

regenerative dryer purge . . . . small flow of dry air from drying column passing through regenerating column and desorbing water from desiccant at low pressure

response time . . . . . time it takes for a sensor to react to change in its environment

RG58 . . . . . a type of coaxial cable - the letters/numbers refer to the electrical characteristic of the cable (resistance/capacitance per foot of length)

RG6 . . . . . A type of coaxial cable - the letters/numbers refer to the electrical characteristic of the cable (resistance/capacitance per foot of length)

RS-232C . . . . . a specification for electrical signaling (also referred to as RS232) that describes the voltages, rate of change of the voltages, and the signal names and uses for the signals

RTS . . . . . Request To Send - a label for a RS232 interface control line

sample system . . . . . equipment used to bring conditioned sample to the sensing element; it may include regulators, filters, heaters/coolers, flow meters, valves and other accessories.

saturate . . . . . reaching maximum holding capacity

sintered . . . . . produced by a process of compacting and heating metal powder, resulting in the formation of a solid, permeable object.

slip stream . . . . . partial stream extracted from a process stream, of which it is representative

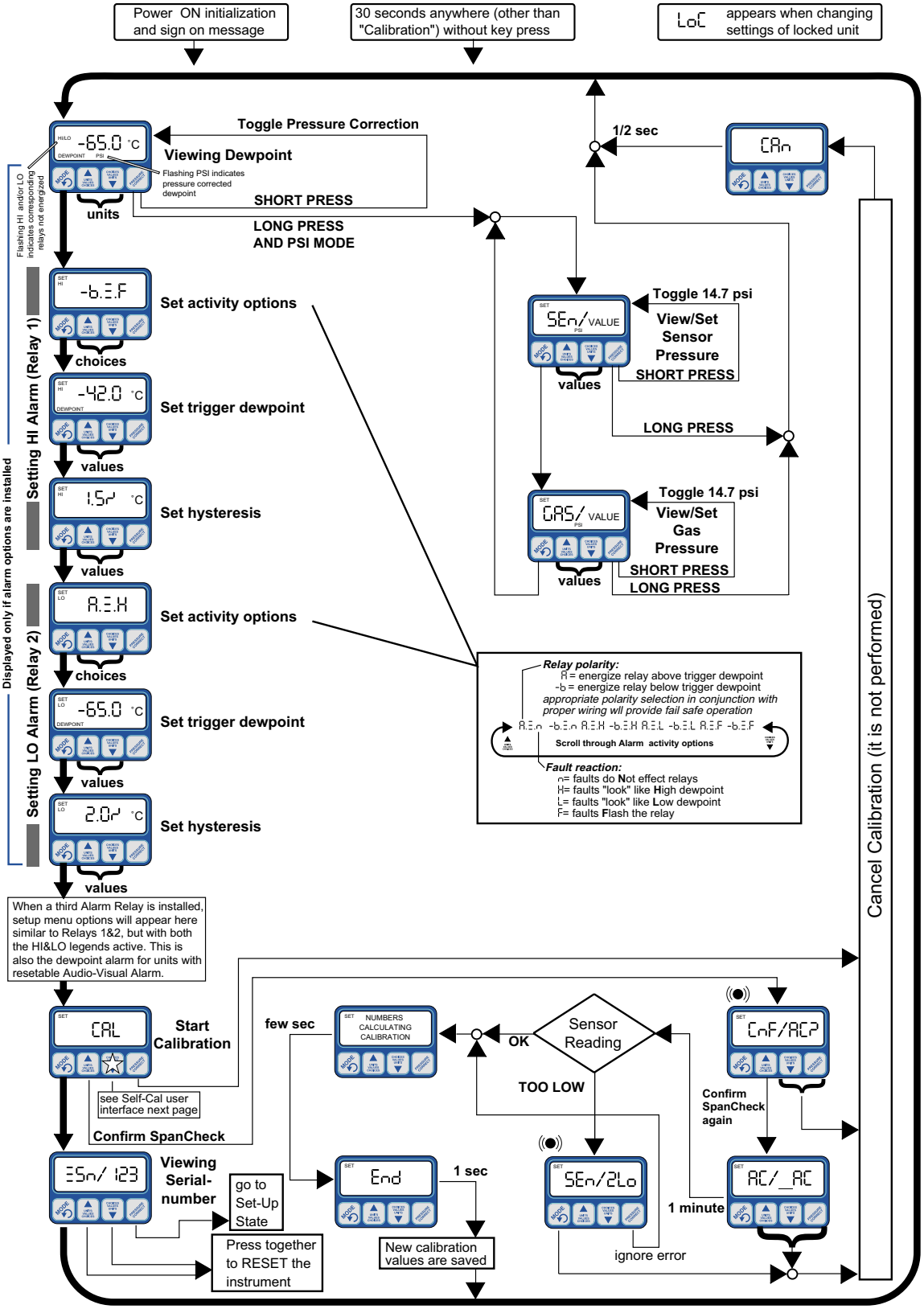
SpanCheck™ . . . . . method to check the response of an HTF™ sensor at the upper end of its measurement range

stability . . . . . a measurement's degree of insensitivity to disturbances.

UL . . . . . Underwriters Laboratories Inc., an organization which evaluates, tests and certifies products for specific safety situations.

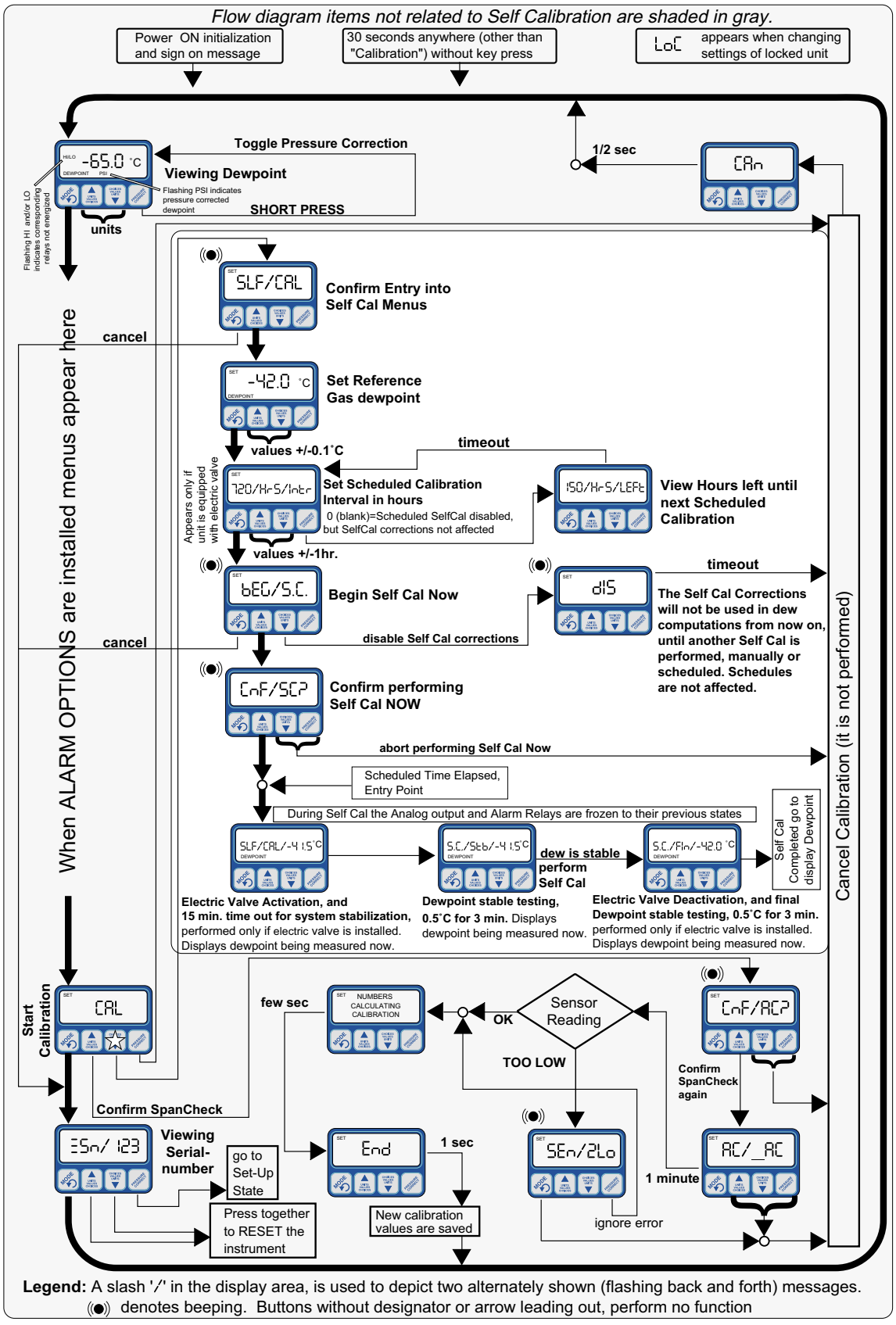
uncertainty . . . . . quantification of the error that can be expected from a measurement, characterizing the range in which the true value can be expected to be in.

Appendix A: Flow Diagram of Operating State User Interface

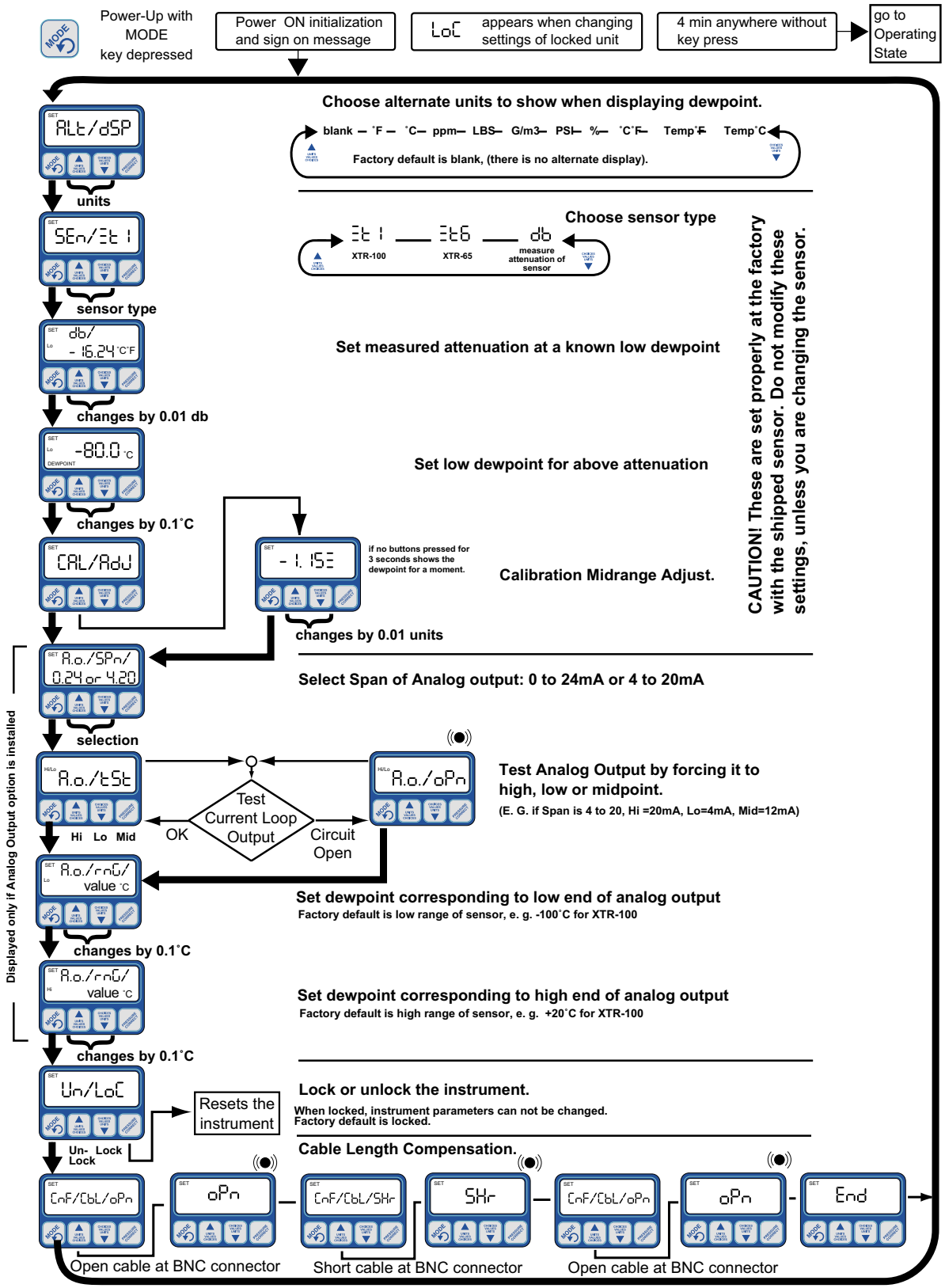


Legend: A slash '/' in the display area, is used to depict two alternately shown (flashing back and forth) messages.
((●)) denotes beeping. Buttons without designator or arrow leading out, perform no function

Flow Diagram Operating State User Interface (continued) Manual & Scheduled Self Calibration

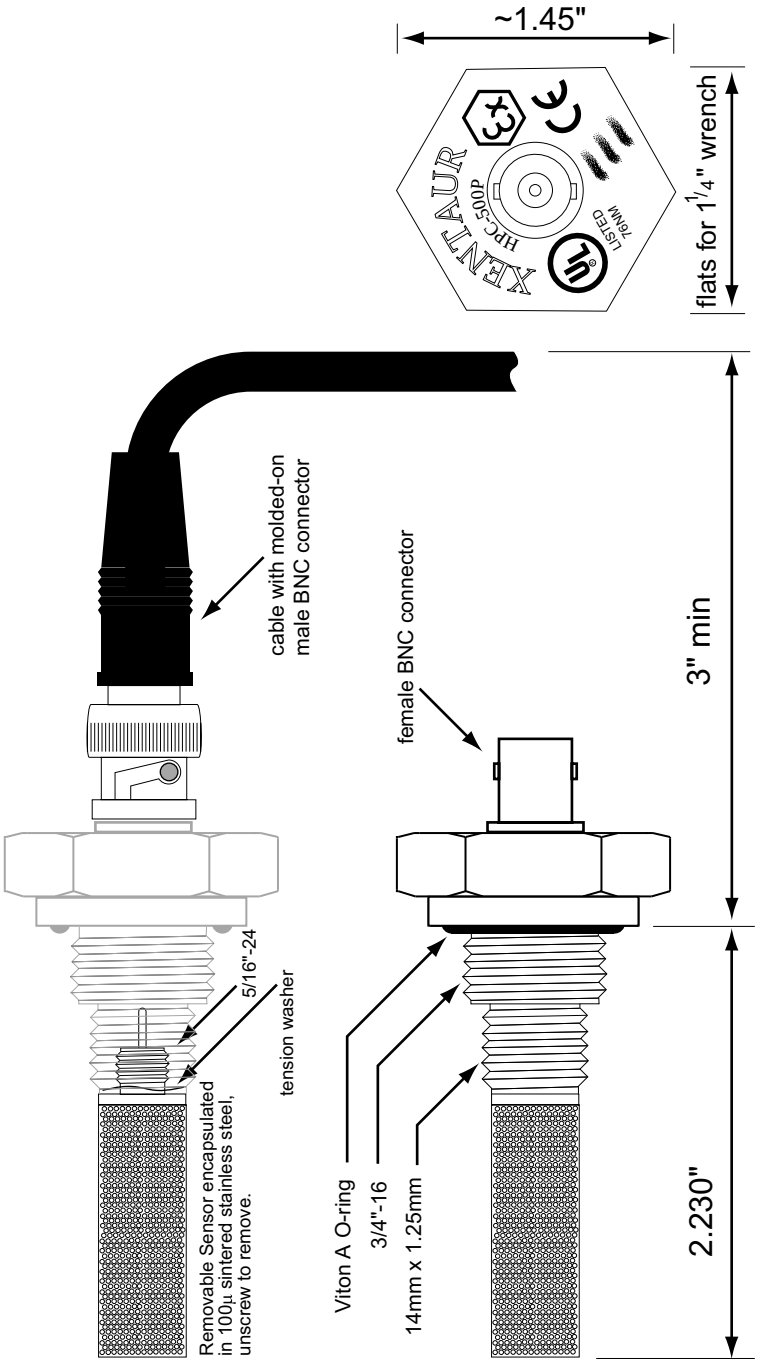


Appendix B: Flow Diagram of Set-Up State User Interface

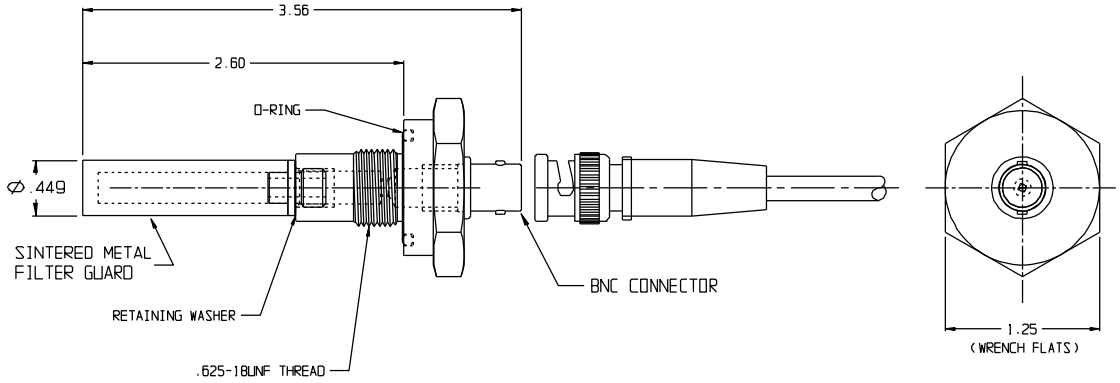


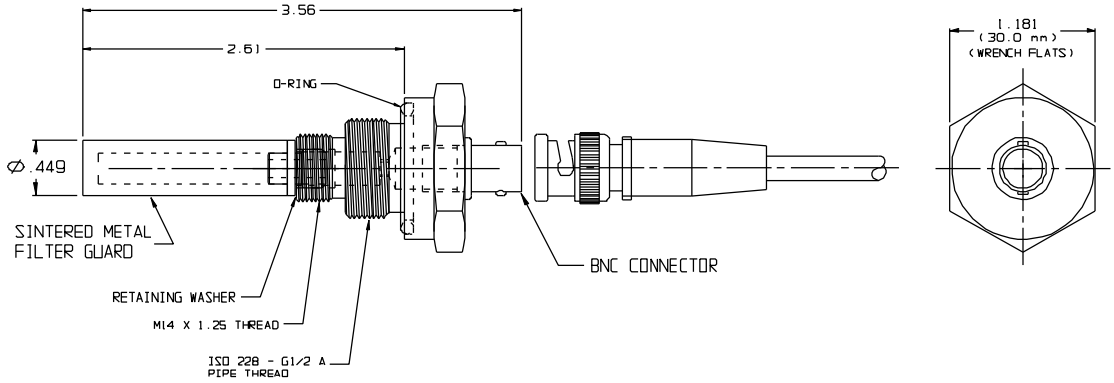
Legend: A slash '/' in the display area, is used to depict two alternately shown (flashing back and forth) messages.
(●)) denotes beeping. Buttons without designator or arrow leading out, perform no function

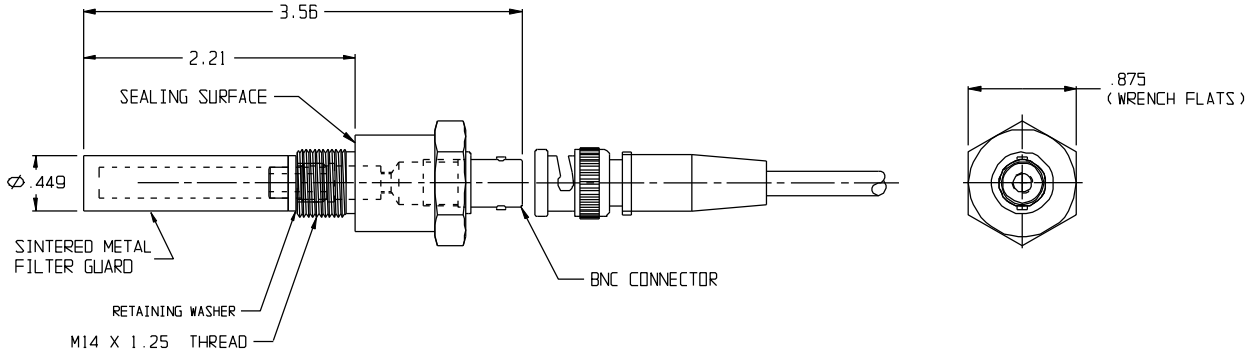
Appendix C: Sensor Mechanical

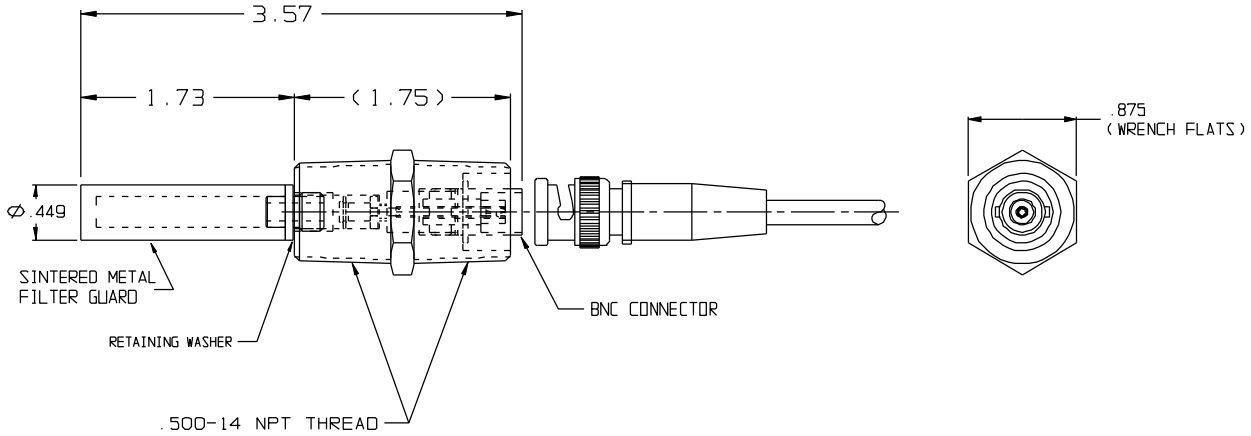


Appendix D: Optional Sensor Fittings

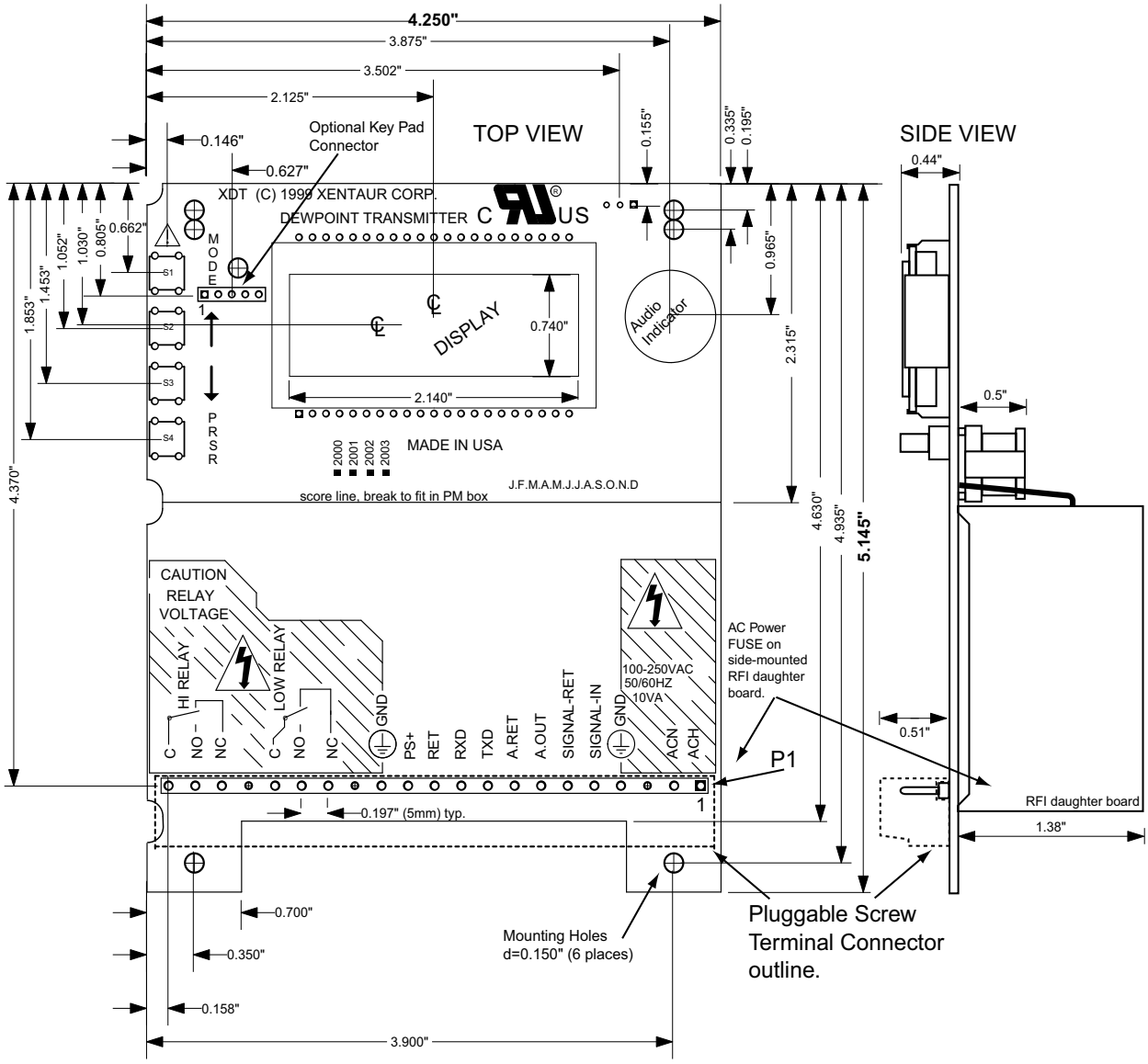




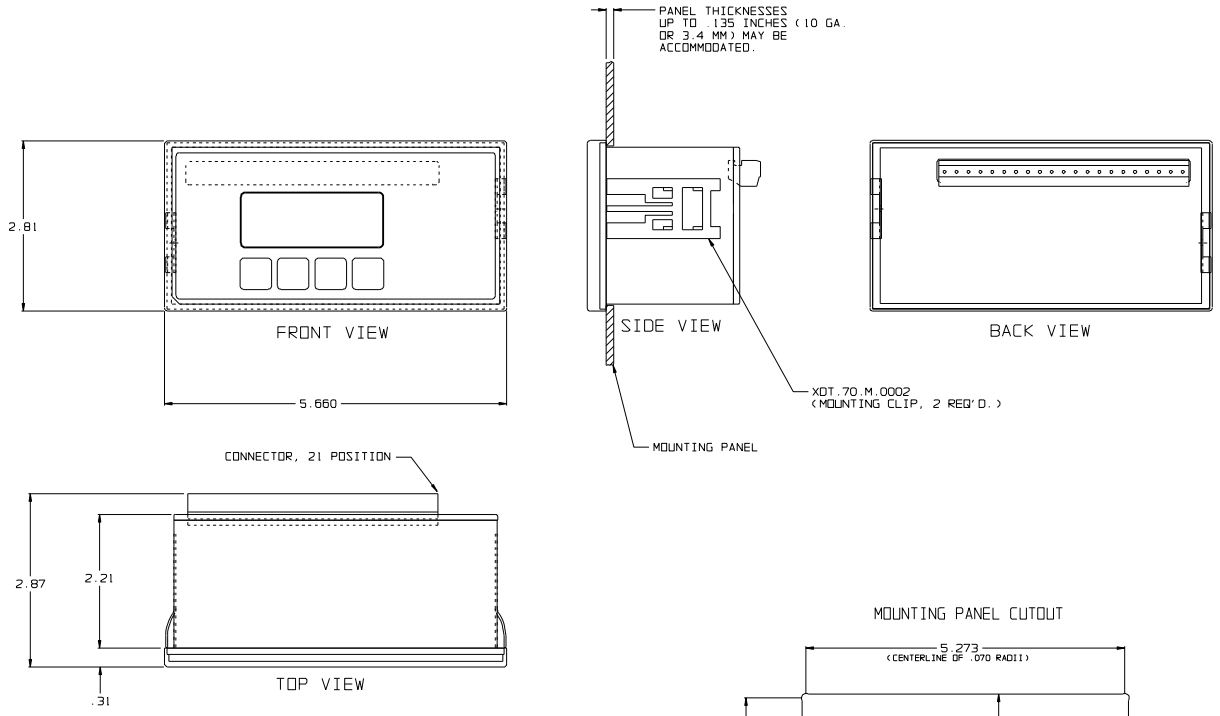




Appendix E: XDT Circuit Board Dimensions

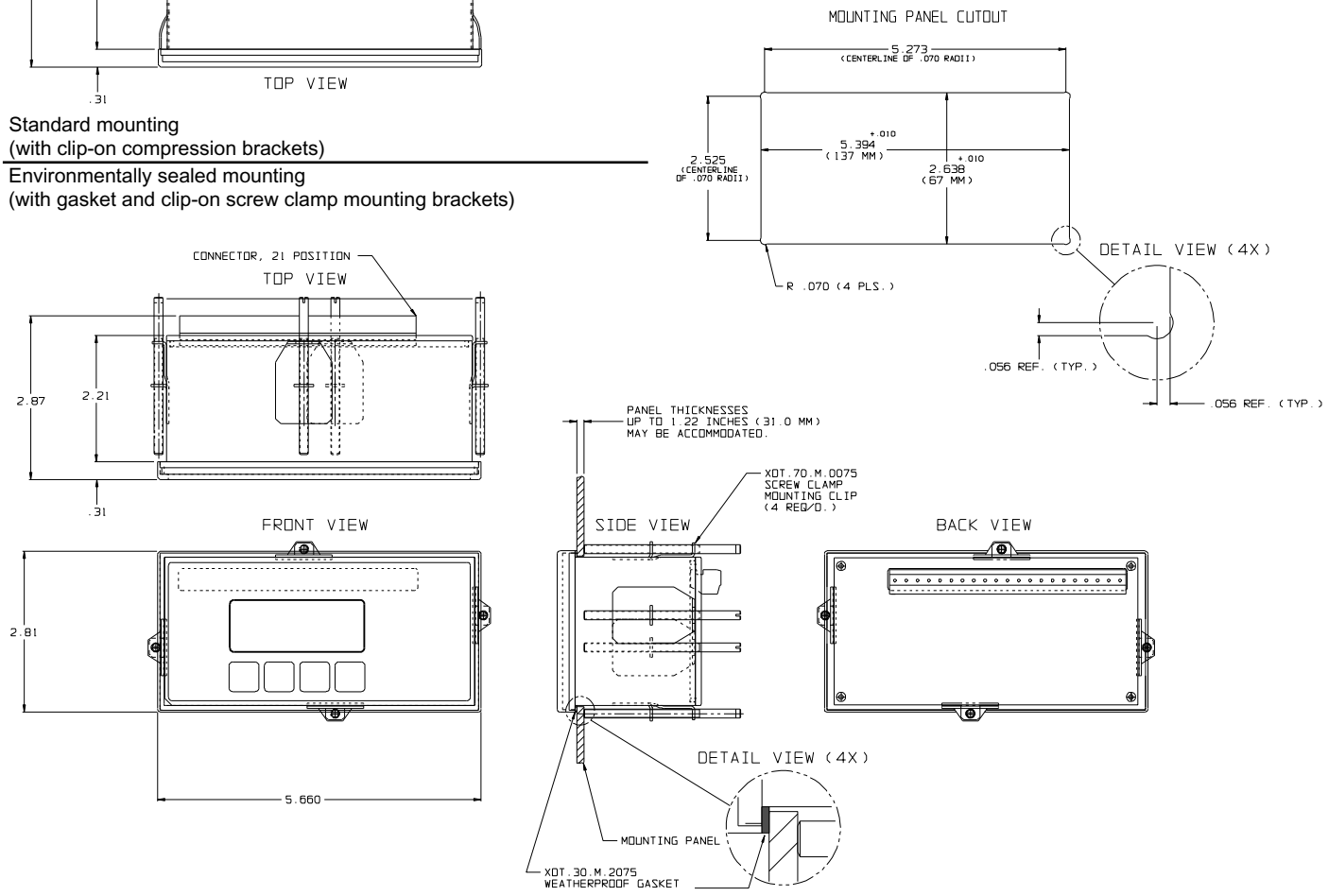


Appendix E (continued): XDT-PM Enclosure Mounting Dimensions

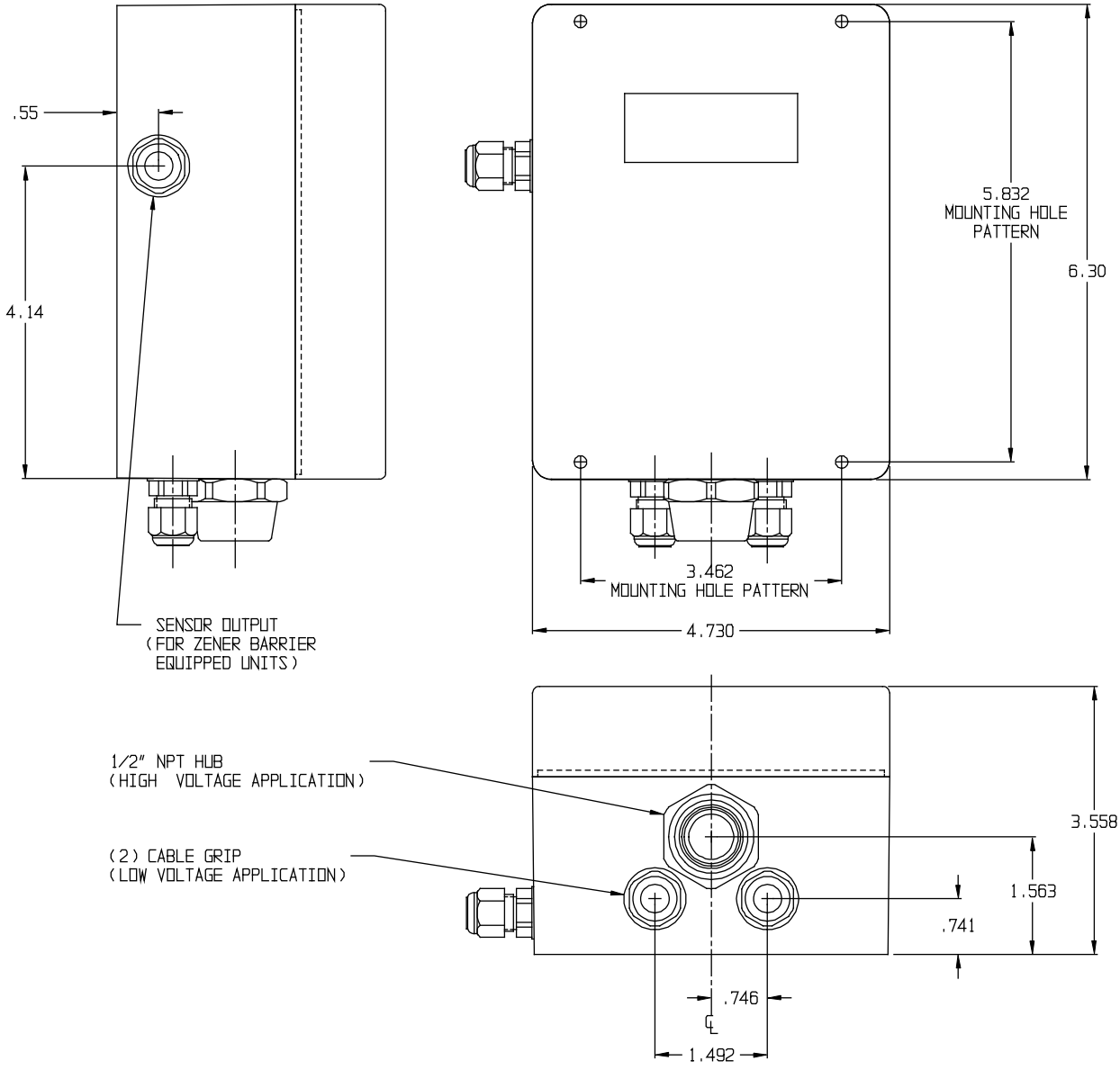


Standard mounting
(with clip-on compression brackets)

Environmentally sealed mounting
(with gasket and clip-on screw clamp mounting brackets)



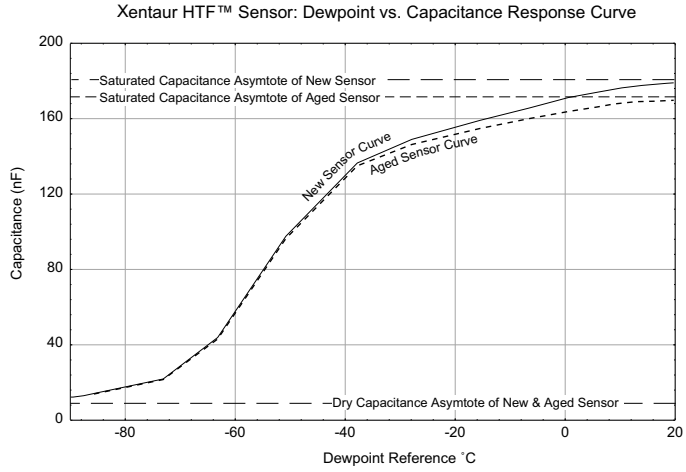
Appendix E (continued): XDT-NEMA Enclosure Mounting Dimensions



Appendix F: Sensor/SpanCheck™ Theory of Operation

The Sensor is constructed as a capacitor whose dielectric consists of porous Aluminum Oxide as well as the gas that has entered in the pores of the Aluminum Oxide. The plates (electrodes) of this capacitor are an aluminum substrate and a porous gold layer deposited on top of the Aluminum Oxide, the porous gold electrode allows transfer of gases into or out of the Aluminum Oxide pores.

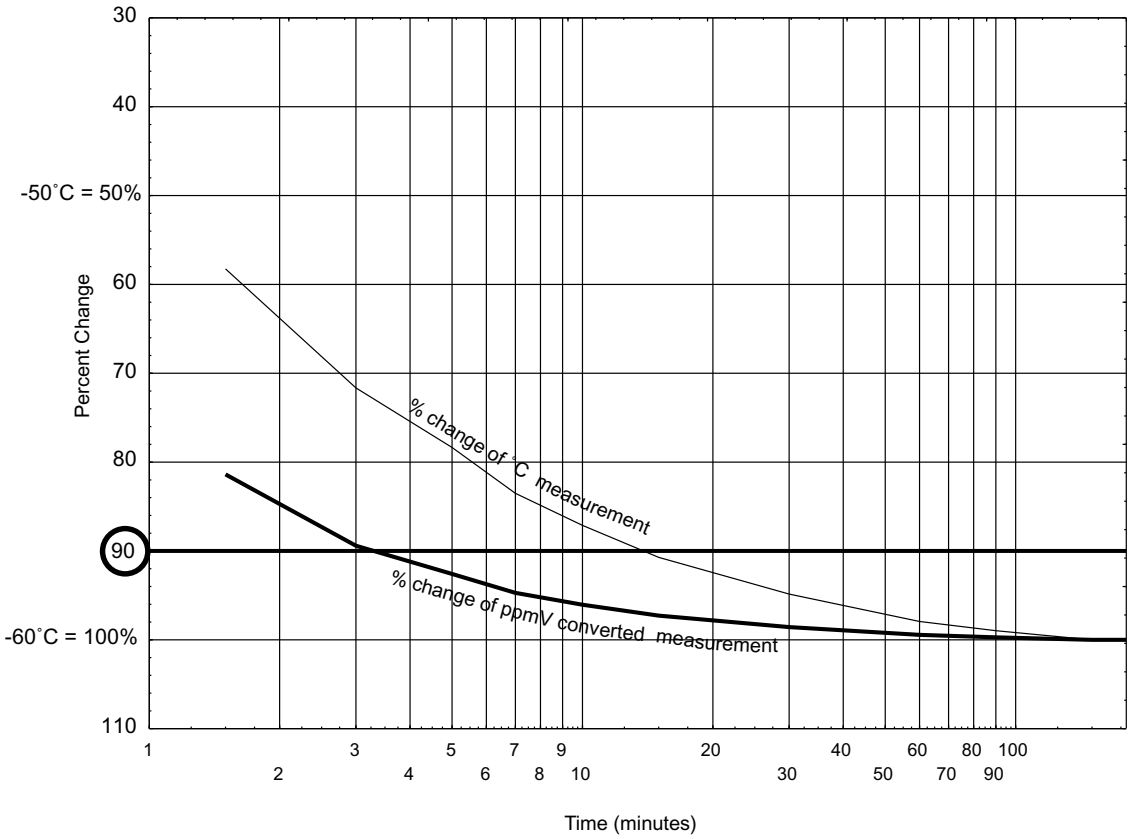
The capacitance due to the Aluminum Oxide is always constant, while the capacitance due to the gas varies according to the gas content and pressure. Since the dielectric constant of water is orders of magnitude larger than that of any gases being measured, the quantity of water vapor present in the pores changes the capacitance of the sensor to a much greater extent than any other system variable. For the same reason (the extremely large dielectric constant of the water molecule), any capacitance variations arising from the Aluminum Oxide, such as changes due to temperature, are insignificant in relation to the capacitance due to the water content. Thus the sensor capacitance varies greatly in proportion to the water content in the surrounding gas. The sensor is designed such that the relationship of the quantity of water and the resultant capacitance has an "S" shaped curve. At the extremely dry end the curve is asymptotic to the capacitance due to the Aluminum Oxide and the gas, while at the very wet end the curve is asymptotic to the capacitance due to water molecules packed extremely tightly (saturated) in the pores of the Aluminum Oxide. This upper end is an excellent indication of the total pore volume; while the lower end of the curve is an indication of the distance between, & area of the capacitor plates (electrodes), this is the intrinsic capacitance of the sensor. Therefore knowing these two points, a sensor can be calibrated with compensation for small manufacturing deviations.



As the sensor is used in real world applications, it is exposed to various elements and stress; like any other sensor it may over time drift from calibration. However one must note that the intrinsic capacitance will not change with use because it is based simply on the dielectric constant of Al_2O_3 and the distance between, & area of the plates (electrodes), thus the original factory measured values will always be valid. What may change is the pore volume, due to clogging with contaminants, residual oxidation, metal migration, etc. Thus to re-calibrate the sensor the instrument needs only to "know" the capacitance at the wet end of the curve. As discussed previously the capacitance at the wet end approaches asymptotically a saturated pore capacitance, therefore if the sensor is saturated (the exact water content will not be important since the curve is asymptotic), then the instrument can measure the capacitance and re-calibrate the sensor. This is referred to as SpanCheck™.The advantages of this unique capability of Xentaur HTF™ sensors and instruments are obvious in time and cost savings for re-calibration, as well as ease of sensor replacement.

Appendix G: Dewpoint Response time Analysis

Manufacturers of dewpoint sensors will make unbelievable claims of speed. But without supporting data revealing the conditions under which the measurements were made, such as flow rate, temperature, the dewpoint at which the test was performed, and most importantly the units of measure. This last aspect can be extremely deceiving, consider the following example.
At Xentaur we have performed a variety of tests to determine the response time of ours as well as the competitor's sensors. For this discussion let's consider a step change of -40°C to -60°C dewpoint, in other words a challenging but typical dry-down. An XTR-100 sensor w/SS sintered filter was placed in an electro-polished stainless steel manifold, the temperature was 23°C and the sample flow rate was 3 LPM. The dewpoint was generated with a computer controlled mass flow valve gas dilution dewpoint generator, and was verified with a NIST and NPL calibrated MBW chilled mirror. The system was allowed to achieve equilibrium at -40°C dp overnight, then the dewpoint was abruptly changed to -60°C, the change is depicted below as time 0.
The graph below shows the percent change of recorded dewpoint (°C), the same data is also shown in percent change of the recorded dewpoint converted to ppmV. It is immediately obvious how a sensor that has response times exceeding ten minutes can be claimed to have response time of 3 minutes, simply by manipulating the units of measure. The logarithmic relationship between dewpoint and ppmV makes the ppmV reading appear faster. Since the response time is stated in percent change, the units of measure are automatically hidden from the audience.



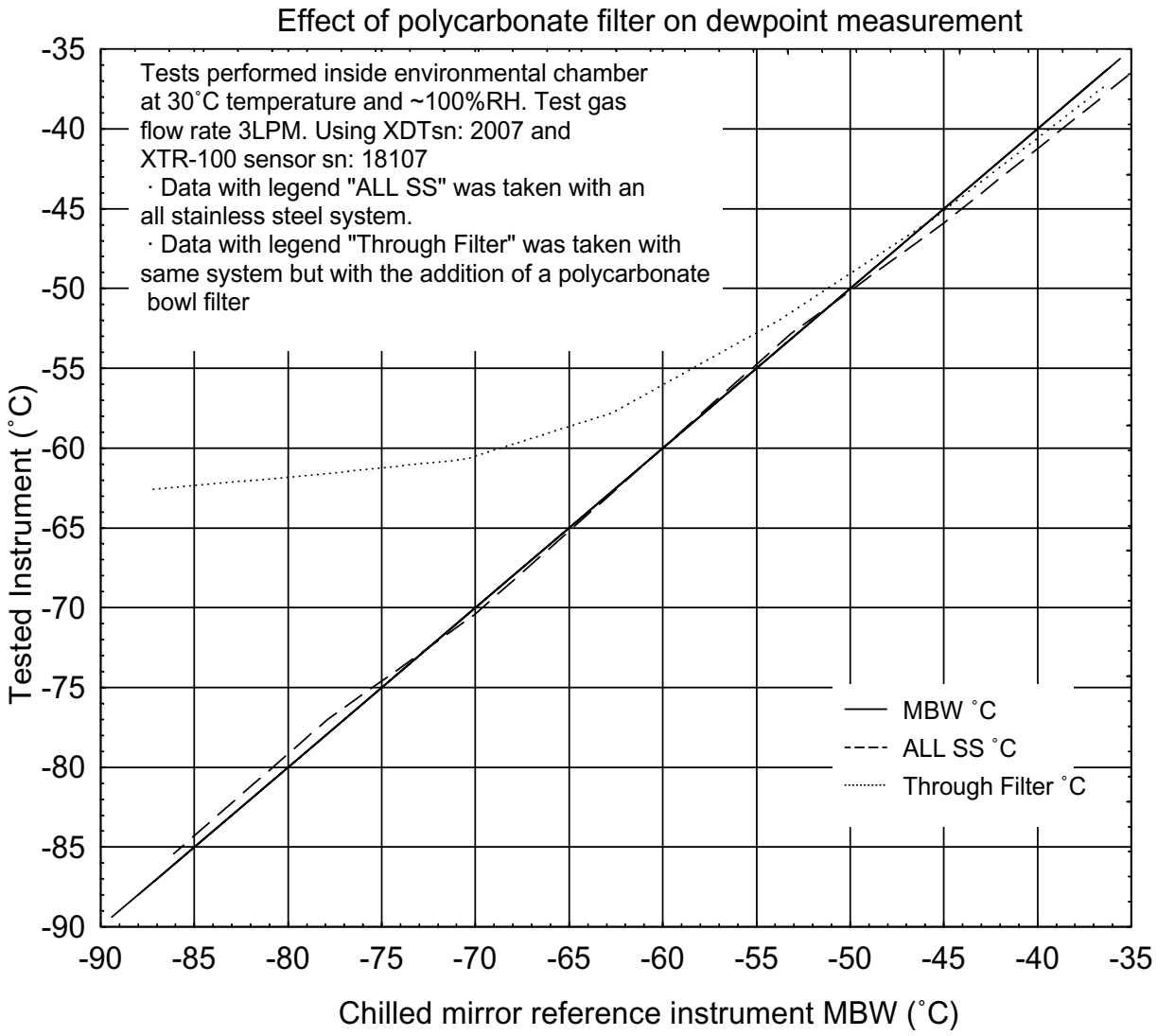
Of course analyzing on a wet-up step will produce much faster results, because all sensors are fast on wet up, since Al_2O_3 (like most materials) adsorbs faster than it desorbs. Testing with a small step e.g. in the -10°C to 0°C dewpoint range will produce even faster results, and allow manufacturers to make far-fetched claims of response time of 5seconds for a 90% of step change. The customer has to be aware of these manipulations of data and be able to ascertain the real-world response time they can expect out of a sensor.

As can be seen from the graph the Xentaur sensor is appreciably faster than any competitors'. This is due to the Hyper Thin Film (HTF) technology, an explanation of the workings of the sensor is provided in theXentaur Hyper-Thin-Film (HTF) Aluminum Oxide Technology notes. We can comfortably make the claim that the Xentaur XTR-100 sensor is faster than any on the market today.

To compensate for their sensors' slow response some manufacturers resort to software acceleration of response time, even though this scheme provides a seemingly faster response to a single step change, it creates great errors in real systems where multiple changes occur consecutively in differing directions. The sensors' real response lag to consecutive step changes in differing directions is erroneously interpreted as belonging to a single step change, and thus large errors of measurement are introduced for long periods of time. An analogy of this situation can be imagined with a defender in a football (soccer) game. A slow player cannot defend by just anticipating the next move of the forward wing; he will simply be faked out by a series of back and forth maneuvers (consecutive step changes in differing directions). While a fast defender cannot be faked out, he simply follows the forward wing as fast as he moves (Hyper Thin Film).

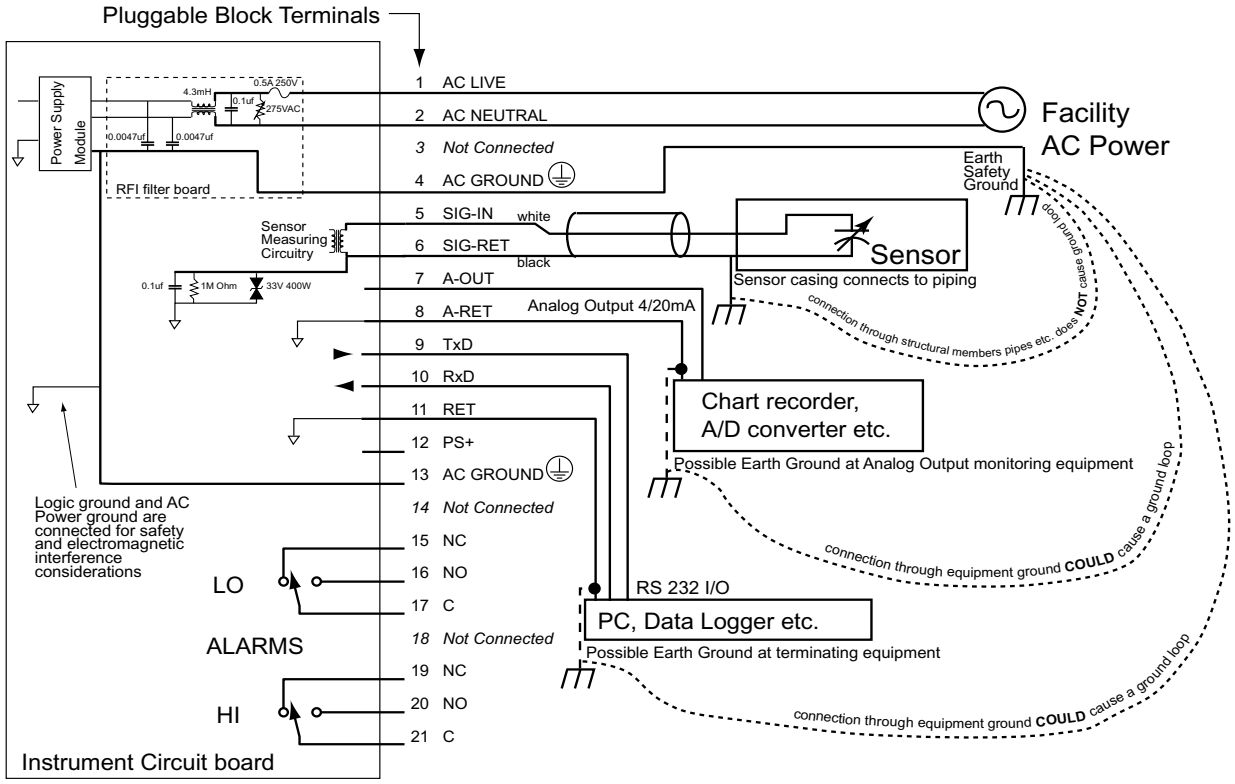
Appendix H: Sample Gas Filter Considerations

Sample treatment with pre-filtering may be a necessity in many instances. However the filter housing and element may affect the dewpoint reading and/or the response time of the system. Below is a graph comparing measurements from the same calibrated sensor with and without a filter utilizing a polycarbonate bowl. All other parameters, which may affect the measurement, were kept constant. Outside of the sample system, a rather hot and humid environment was created, to illustrate a worse case condition. As can be seen the filter does not cause problems for dewpoints greater than -50°C. However the systems' ability to make precise measurements quickly deteriorates for dewpoints below -55°C.



With this in mind the user should select the appropriate filter construction materials. It is important to note that a stainless steel housing filter will not cause measurement errors, however if the filter element inside the housing is made of hygroscopic fibers, then there will be a delay introduced in the measurement.

Appendix I: XDT Grounding Considerations



1. The sensor ground is isolated from the signal and frame grounds, however it is shunted to frame ground with a 33V Transient Voltage Suppressor,1M Ohm resistor and 0.1uF capacitor to prevent electrostatic buildup and noise pickup. When the sensor is connected to equipment which is grounded to earth ground (because of pipes etc.), there is no ground loop because the sensor is not connected to the earth ground on the circuit board.
2. The optional Analog Output and RS-232 Output are both referenced to the circuit board logic ground, which is jumpered at a single point to the AC power ground. Therefore if these outputs are connected to equipment which connects the signal grounds to earth ground (this is a common occurrence in PC's), then a ground loop may be formed. This can be best avoided by removing the signal to earth ground connection at the termination equipment; if that is not possible then the AC power ground connection to XDT logic ground may be removed but this may cause a EMI problem. Please consult with your representative for information on optional isolated analog and RS-232 outputs. Keep in mind that in general, a ground loop on a digital line such as RS-232 will not cause problems.
3. The Earth Safety Ground (AC GROUND) at pin 4, should not be omitted since the RFI filter capacitors will cause half the line voltage to develop at the instrument's ground. This may have safety and EMI implications.
4. When installing DC powered instruments (15 to 30VDC at pins #12 and #11), similar conditions may exist, if the DC power source is earth grounded.

Appendix J: Analog Output vs. Dewpoint

The current output of the XDT, varies with the measured dewpoint. To use the current to calculate the value of the dewpoint measurement, one must know the settings of the low and high ends of the analog output range, then:

$$D = \frac{(I - Z) \times (H - L)}{S} + L$$

where: I = current supplied by XDT analog output in mA.
Z = value of zero output of current loop in mA: for 4/20 = 4, for 0/24 = 0.
H = value of High end of Analog Output range, converted to selected engineering units
L = value of Low end of Analog Output range, converted to selected engineering units
D = dewpoint measured by instrument in selected engineering units.
S = span in mA of current loop output: for 4/20 = 16, for 0/24 = 24.

Consult section 3.4.5.7&8 and/or appendix B, to check and set the Analog Output low and high ranges; the factory default settings are -100°C and +20°C respectively.
For example a unit with factory default settings, supplying 12mA is computed to be measuring a dewpoint of -40°C:

$$\frac{(12 - 4) \times (20 - (-100))}{16} + (-100) = -40$$

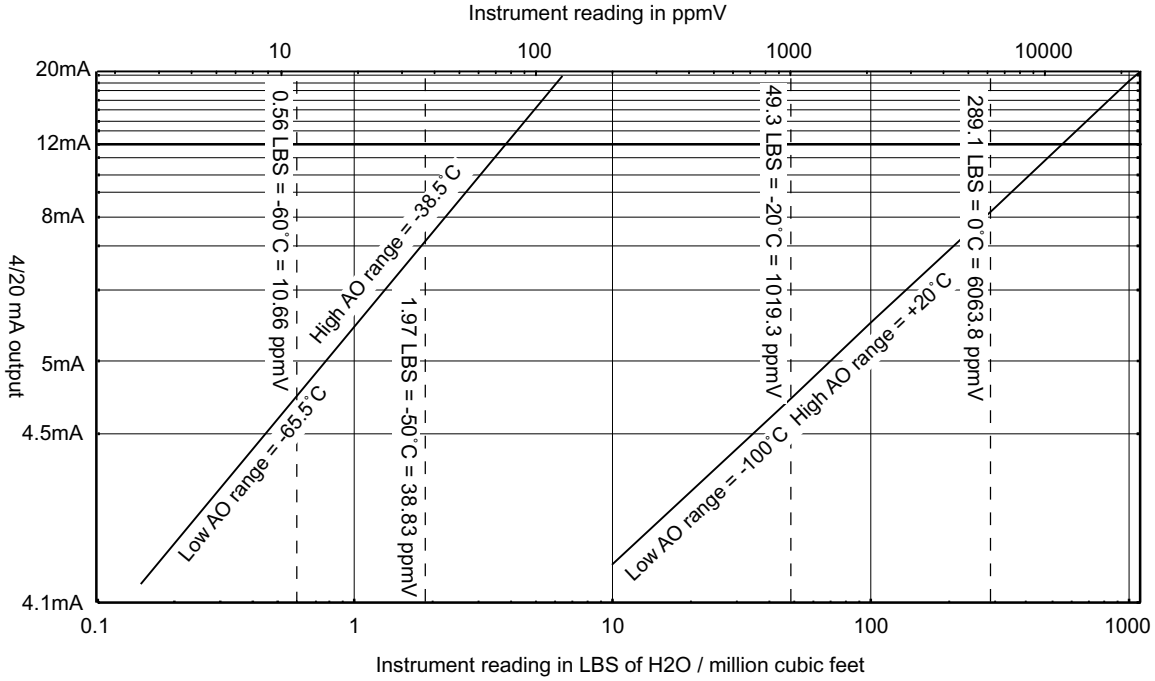
Note that the computation is such that the current is linear to the selected engineering units. Hence, selecting ppmV or LBS or G/M3 units, will cause the analog output to be linearly proportional to those units (approximately logarithmically proportional to dewpoint), refer to the graph that follows. Naturally selecting °C or °F will cause the analog output to be linearly proportional to dewpoint.

When monitoring in ppmV or LBS or G/M3, the analog output low & high ranges may have to be adjusted to provide a useful output. Consider an example where the area of interest to be monitored is 10 to 100 ppmV, and the analog output is set up with the factory defaults of -100°C to +20°C (which is 0.014 to 23612 ppmV); then the current loop output will vary only from ~4.1 to ~4.2 mA in the area of interest (consult with the graph on the following page). In most instances this would be an unacceptable output for proper monitoring of the measurement. In this example the user should adjust the analog output low & high ranges such that the output range is better suited to the measurement of 10 to 100 ppmV. It may be useful to select the low and high ranges to be 5 and 150 ppmV respectively, thus out of range conditions will be detected properly. Then the low range will be set to 5ppmV which is -65.5°C dewpoint, and the high range will be set to 150ppmV which is -38.5°C dewpoint. Now the current loop output will be 4.55 to 14.48 mA in the range of 10 to 100 ppmV, the ~10mA variation is more than sufficient for a good measurement by the user's equipment. One may carry out similar calculations for LBS or G/M3 and choose the appropriate settings.While making these computations it may be useful to obtain a copy of Xentaur's dewpoint calculator, this is a Microsoft Windows™ program which simplifies the process of converting dewpoint measurement units. It is available at www.xentaur.com. If you are not certain how to carry out such calculations, send by e-mail to xentaur@xentaur.com or by fax to (631) 345-5349, your system specifics, and some one will get back to you with appropriate analog output settings.

In general, if the dewpoint is monitored in °C or °F, there is no need to change the factory default

-100°C to +20°C settings, because the 4-20mA provides sufficient resolution to measure the output better than the specified accuracy of the sensor.

Relationship of 4-20mA output and instrument reading in ppmV or LBS



Appendix K: RS-232C Interface Protocol

The instrument uses a simple protocol to communicate to a host computer through its RS-232C interface, see section 3.3.2.5 for electrical connections. The interface is configured as 9600 baud, Even Parity, 8 Bits, 1 Stop; and it echoes all received characters.
To illustrate the protocol, the following notation conventions are used in this section:
The characters sent or received are depicted in bold. Send refers to sending from the host computer to the XDT. Receive refers to receiving from the XDT into the host computer. The commands and arguments are shown in capital letters while place holders for choices are labeled with lowercase italic letters, with the allowed characters shown below, "nn" denotes a numeric value. Bytes which are not characters are shown with diagonally placed mnemonics, for example Escape is depicted as $^{\mathbf{E}}\mathbf{S}_{\mathbf{C}}$, this signifies a single byte (hex 1B). Optional characters or command arguments are encompassed with brackets [ ].
The commands may be sent in either upper or lower case. Arguments may be delimited with space or comma.

HELP command
Lists all of the available commands.

send: **H[ELP]**$^{\mathbf{C}}_{\mathbf{R}}$

receive: **Help** **?** **Data** **SN**$^{\mathbf{C}}_{\mathbf{R}}{}^{\mathbf{L}}_{\mathbf{F}}$
Who **Reset** **Login**$^{\mathbf{C}}_{\mathbf{R}}{}^{\mathbf{L}}_{\mathbf{F}}$

DATA command
Selects the reporting format of the current measurement.
This formatting will be retained until the next DATA command even if the power is turned off.

send: **DA[TA]** ***units*** [***interval*** [***mode***]]$^{\mathbf{C}}_{\mathbf{R}}$

C	nn	N
F		G
P		
L		
G		
D		
U		

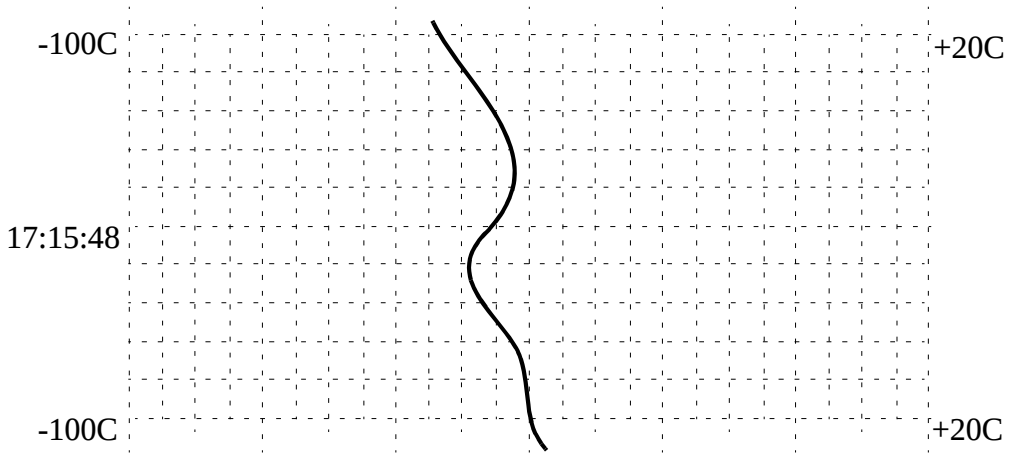
The *units* argument selects the units in which the measurement will be reported.
C,F,P,L & G select the dewpoint in °C,°F,ppm,Lbs H_20/mmscf and gm/m^3 respectively.
D selects decibels which is the measured sensor attenuation.
U selects using whatever units are selected by the user on the display.

The *interval* argument is optional, if it is not entered then the measurement will be reported only on a query with the "?" command. However if it is desired for the unit to report the measurement on a regular interval without a query then an interval in seconds may be specified in the range 1 to 255 seconds. This feature allows the user to log the measurement on a dumb terminal or a printer.

The *mode* argument is optional and may be specified only if an interval was specified. It may be "N" for numeric reporting or "G" for graphic reporting of the measurement. The mode argument defaults to numeric mode. The graphic mode may be chosen only for °C or °F, it will plot a graph of the measurement on printers which can respond to the Epson Graphic Commands, and have at least 80 character columns.

In the NUMERIC mode the instrument will report the measurement in the following format
$^{B}_{L}$*Measurement Units*$^{S}_{P}$*Elapsed Time*$^{S}_{P}$*Alarm Status*$^{C}_{R}{}^{L}_{F}$
The bell character is used to denote the beginning of each line. The measurement is a floating point decimal number. The units are the appropriate character string: "**degF**", "**degC**", "**ppmV**", "**LbsH2O/mmscf**" or "**g/m3**". The elapsed time since the unit was powered up (with 24hr roll over) is in HH:MM:SS format. The alarm status appears only if alarms are installed, it is indicated with a character string: **HiAlrm** or **LoAlrm** or **NoAlrm**.
If an error condition exists then the report will have the following format:
$^{B}_{L}{}^{B}_{L}$*ErrorString*$^{C}_{R}{}^{L}_{F}$
The ErrorString may be one of the following:
"**Error SensOpen"** or "**Error SensShort"** or "**Error SensSat"**.

In the GRAPHIC mode the instrument will transmit Epson Graphic Command compatible data strings at the selected interval. Each string has the following format:
$^{D}C_1{}^{E}S_C A^{0}_{1}{}^{E}S_C K^{n}_{n}{}^{m}_{m}$.....$^{L}_{F}{}^{C}_{R}{}^{E}S_C A^{0}_{9}{}^{D}C_3$
where: DC1 selects the printer; Escape A 01 sets the advance to 1 dot per line; Escape K nnmm selects the graphic mode with mmnn bytes to follow; then the graphic bytes are sent 1 byte per horizontal dot (corresponding to 1 °F or °C being plotted) where the MSbit represents the dot the other bits are not used; Line Feed & Carriage Return advance the line; Escape A 09 sets the advance to the normal 9 dots per line, DC3 deselects the printer.
In addition every 200 lines, a text line will be sent to alternately time-stamp the plot or label the extreme dewpoint axis.
This will produce a graph which looks as follows.



The printer should have at least 80 character columns, and it is best to use continuous form paper.

"?" command
Requests a single report of the measurement in the currently selected format.
send:**?**$^{C}_{R}$ The unit will respond in the format selected with the Data command, for example:
receive: $^{B}_{L}$**-59.3degC**$^{S}_{P}$**01:23:45**$^{S}_{P}$**NoAlrm**$^{C}_{R}{}^{L}_{F}$
The default factory setting for the instrument is to respond in numeric format in the user chosen units. See the section about the DATA command for more details.

Serial Number Command

send: **SN**$^{C}_{R}$

receive: **Ser**$^{S}_{P}$**Num**$^{S}_{P}$**nn**$^{C}_{R}{}^{L}_{F}$

where nn is the instrument serial number

Who Command

send: **WH[O]**$^{C}_{R}$

receive: **Dev**$^{S}_{P}$**Type=XDT**$^{S}_{P}$**Ver=n.n**$^{C}_{R}{}^{L}_{F}$

where n.n is the instrument software version

Reset Command

send: **R[ESET]**$^{S}_{P}$**Y**$^{C}_{R}$

the unit will perform power on reset.

Login Command

send: **L[OGIN]**$^{C}_{R}$

receive: **Level**$^{S}_{P}$**0**$^{C}_{R}{}^{L}_{F}$

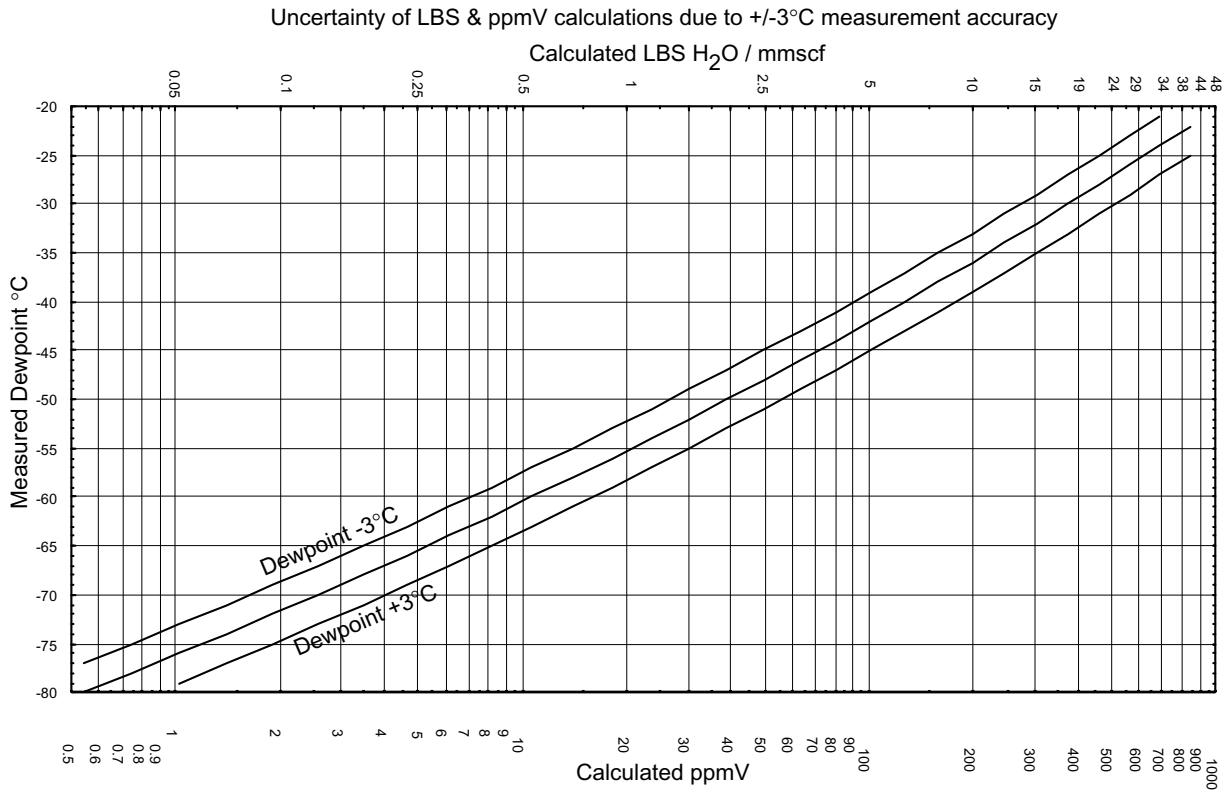
Appendix L: Procedure for Exchanging XDT Sensors

To exchange sensors one must know the measured low attenuation of the sensor at some low dew-point as well as the calibration adjustment value. These numbers can be found on the shipping container serial number label.

Through the following steps it is helpful to refer to **Appendix A: Flow Diagram of XDT Set-Up State User Interface**

1. Power up (or reset) the XDT while holding down the MODE key, in order to enter the Set-Up state. Make sure that the instrument in unlocked, refer to section 3.4.5.-10.
2. Press the MODE key to go to the **"Choose Sensor Type"** mode. Make sure that the proper sensor type is chosen, e.g. XT1 (for XTR-100) or XT6 (for XTR-65).
3. Press the MODE key to go to the **"Set Measured Attenuation @ low dewpoint"** mode. The display will show the currently entered attenuation in decibels (dB), this is indicated by having both the **°C** and **°F** on the display. Use the UP or DOWN keys to select the value which appears on the shipping container label. Note that this value is a negative number typically in the range of -18.0DB to -14.0DB.
4. Press the MODE key to go to the **"Set low dewpoint"** mode. The display will show the currently entered low dewpoint. Use the UP or DOWN keys to select the value which appears on the shipping container label.
5. Press the MODE key to go to the **"Calibration Midrange Adjust"** mode. The display will alternately show CAL and ADJ. Press the UP key once to see the entered calibration adjustment value. The display will alternately show the currently entered value and the dewpoint being measured, when showing the Cal Adj value the number (in the range of -2.0 to +2.0) will be followed by a blinking "X", and when showing the dewpoint the display will have the appropriate legend e.g. **°C**. Use the UP or DOWN keys to select the value which appears on the shipping container label.
6. Press the MODE key five (5) times to go to the **"Lock or Unlock"** mode. The display will alternately show UN and LOC. Press the DOWN key to lock the instrument. The display will alternately show only LOC.This prevents inadvertent changes.
7. Press the MODE key once.
8. Now the instrument has stored in it's EEPROM, the calibration values associated with the new sensor, HOWEVER NOTE THAT IT IS STILL NOT CALIBRATED. The instrument may now be reset.
9. Perform the SpanCheck Procedure in section 3.4.4.3.1.
10. Install the sensor in the sample system and measure. If for some reason the Cal Adj value must be re-entered or modified to improve accuracy the unit does not have to be SpanChecked again.

Appendix M: Uncertainty in LBS & ppmV calculations



Xentaur Return Authorization Number Request Form

- Xentaur must approve and assign a Return Authorization Number (RAN) to any instrument being returned.
- The RAN must appear on all paperwork and packaging.
- The issuance of a RAN does not automatically imply that the instrument is covered by our warranty.
- In order to serve you better and protect our employees from any potentially hazardous contaminants Xentaur must return unopened at the senders expense all items that do not have a RAN.

To obtain a RAN fill out this form and fax to (631) 345-5349.
this document may be obtained in electronic format at www.xentaur.com and e-mailed back

Customer Information

Company Name: _____ Address: _____
Contact Name: _____ _____
Phone: _____ _____
Fax: _____ _____

Equipment Information

Part or Model Number: _____ Serial Number: _____
Original Purchase Date: _____ PO Number: _____

Reason for Return: _____

Failure and hookup description if applicable:

_____
_____
_____
_____

Use Information

Process material(s) and/or environments (including radiation) to which the equipment has been exposed. **An RAN will not be issued without this information.**

_____
_____
_____
_____

Certified by: Name: _____ Title: _____
Signature: _____ Date: _____

OSHA Hazard Communication Standard 29CFR 1910.1200 mandated that we take specific steps to protect our employees from exposure to potential hazards. Therefore, a letter certifying that the equipment has been decontaminated must accompany all equipment exposed to hazardous contamination.

Index

W

XENTAUR CORPORATION, 84F HORSEBLOCK ROAD, YAPHANK, NY 11980 U.S.A. TEL (631) 345-3434 FAX (631) 345-5349

Dräger Polytron 8200/8310

Instructions for use

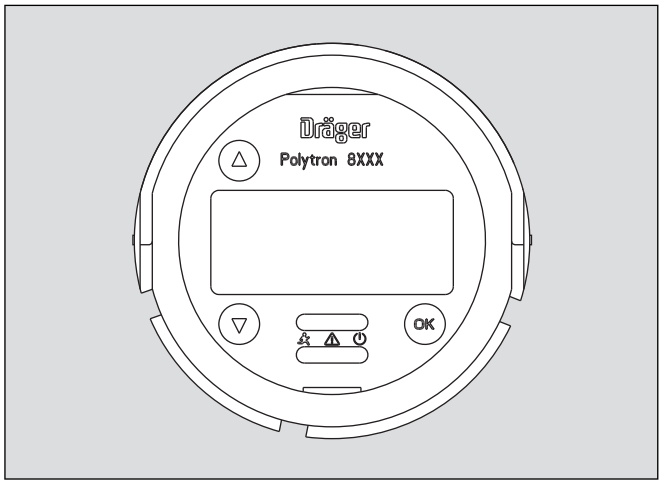
WARNING

Strictly follow the Instructions for Use.
The user must fully understand and strictly observe the instructions. Use the product only for the purposes specified in the Intended use section of this document.

4 Operation

4.1 Operating fundamentals

4.1.1 Menu navigation



00733300.eps

It is possible to scroll throught he menu items by tapping the ▲ and ▼ symbols with the magnetic wand (Part Number 4544101, blue). OK confirms a function.

NOTICE

The housing cover should be fitted when using the magnetic wand. If the housing cover is not fitted, the magnetic wand might activate two or more buttons at the same time (crosstalk).

Graphic symbols facilitate navigation in the various menus.

- Together with the text » Back «, » Menu «, etc., exit the menu or go back 1 step.
- Closed folder
  Further functions or sub-menus are located under this item.
- Opened folder
  The functions and sub-menus available here are listed under this item.
- Function
  When activated, functions can be executed in one or more steps.
- Selection activated
  For functions that can be selected and activated, the activation is initiated by taping » OK «.
- List closed above / complete
  There are no further functions, menus or sub-menus listed above.
- List can be scrolled upwards
  There are further functions, menus or sub-menus listed above.
- List closed below / complete
  There are no further functions, menus or sub-menus listed below.
- List can be scrolled downwards
  There are further functions, menus or sub-menus listed below.
- Next
  Perform context-related action.
- 3/3 Number / total number of steps (screens) within the function.
- 2/2 Entry
  Enter data with » ▲ « and » ▼ «.

4.1.2 Changing parameter values or the parameter status

1. Select the desired menu item with ▲ and ▼.
2. Confirm the menu item with OK.
   The current value or status will be displayed.
3. Using ▲ and ▼, the value of a numerical parameter can be changed or preset values can be selected.
4. As soon as the desired value or the selection is displayed, tap OK to validate/confirm the new parameter.
5. Tap OK to access the next higher level.

- If exiting using **Back to menu** or **Previous**, all changes will be discarded.

4.1.3 Exiting menus

- ▲ Tap **Back to measurement** and OK to exit the menu.

4.2 Display and LEDs

In measurement mode, the current gas concentration, the name of the gas and the measurement units are shown on the display. The green LED lights.

In addition, the following symbols may be displayed:

- " ↑ ↑ ↑ ↑ ", if the measurement range is exceeded
- " **- - - -** " and " **X** " in the event of a malfunction. The yellow LED lights, (see chapter 4.2.2 on page 12).
- "SIL", when SIL status is activated.

When the optional relay PCB is used:

- If the first alarm has been triggered, the red LED gives single flashes.
- If the second alarm has been triggered, the red LED gives double flashes.

4.2.1 Special symbols

The following special symbols, which indicate the device state, may be displayed on the right hand side in measurement mode.

- Warning message present –
  to display warnings, see chapter 7.1.1 on page 17.
  Information can be called up in Info mode, see chapter 4.3 on page 12.
- Fault message present –
  To display the fault, see chapter 7.1.2 on page 17
- Maintenance signal will be output on the interface, see chapter 8.3.2 on page 21.
- Measurement range of analog interface exceeded
- Measurement less than range of analog interface
- Analog interface is set to a fixed value (e.g. Multidrop HART communication) and is not transmitting any measurements.
- "Preventive" maintenance: The sensor is ready for operation
- "Preventive" maintenance: The sensor is ready for operation but is close to the end of its life cycle.
- "Preventive" maintenance: The sensor is still ready for operation but should be changed as soon as possible.
- The datalogger is active in rolling mode.
  To activate/deactivate, see chapter 8.5.2 on page 24.
- The datalogger is active in stacking mode.
  To activate/deactivate, see chapter 8.5.2 on page 24.
- SIL SIL is activated (observe Safety Manual - Order Number 9033307).

4.2.2 LED symbols

Symbol	LED	Description
	red	Alarm triggered
	yellow	Malfunction / Warning
	green	Switched on Measurement mode

NOTICE

The alarm triggering function is only available when the optionally integrated relay module is used.

When the optional relay PCB is used:

- If the first alarm has been triggered, the red LED gives single flashes. A1 relay is activated.
- If the second alarm has been triggered, the red LED gives double flashes. A2 relay is activated.
- If an alarm can be acknowledged and is acknowledged, the LED stops flashing and lights continuously instead until the alarm condition is no longer present. The corresponding relay is deactivated.

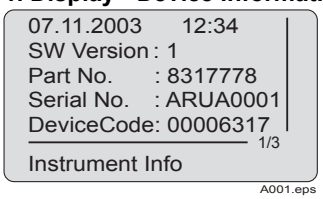
4.3 Activating the Info mode

The Info mode is used to present information about the central device settings and states.

- Tap ▲ and hold for 3 seconds.
  The device information appears on several displays. No changes can be made.
- Tap ▲ or ▼ briefly to switch between the displays.
- The Info mode can be ended at any time by selecting OK.
- If no button is selected within 30 seconds, the device reverts automatically to the measurement mode.

Example of the Info mode
(Displays vary depending on sensor):

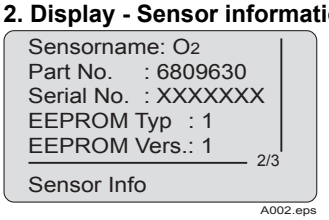
1. Display - Device information:



A001.eps

- Date and Time
- Software version
- Part number of the device
- Serial number of the device
- Device code

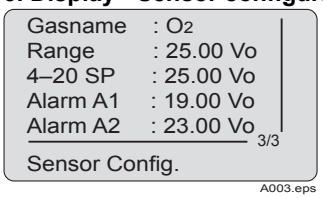
2. Display - Sensor information:



A002.eps

- Sensor description
- Part number of sensor (only for certain sensors)
- Serial number of sensor (only for certain sensors)
- Software version (only for certain sensors)
- Software revision (only for certain sensors)

3. Display - Sensor configuration:



A003.eps

- Gas description
- Maximum measurement limit and measurement units for the sensor
- Measurement range and measurement units for the analog interface. Only displayed when the 4-20 mA interface is enabled.

- A1 Alarm limit and measurement units[1]
- A2 Alarm limit and measurement units[1]

4.4 Switching to the Quick Menu mode

- Tap ▼ and hold for 1 to 2 seconds.
  The Quick Menu will open. This menu is displayed without any password request. No changes can be made.
  The selected information about status and device settings can be retrieved (e.g. warning messages, error messages, installed modules and calibration data).

4.5 Switching to Menu mode (password protected)

1. Tap ▼ and hold for longer than 3 seconds.
   The password request appears.
2. **Enter the password** and confirm.
   The screen for password entry appears.
3. Set the password and confirm the entry.
   The menu hierarchy corresponding to the entered password will open.

- An error message appears if the entered password is invalid.

Password presets:
Password for the **Calibration** menu: _ _ _ 1
Password for the **Settings** menu: _ _ _ 2

4.6 Measurement mode

WARNING

The configuration and calibration settings must be checked before the device is operated in measurement mode.

- Switch on the power.
  - The device runs through a start-up sequence (LCD test by inverting the video, LED test, software version and initialization) and starts the warm-up phase. The display indicates that the sensor will be ready to operate in hh:mm:ss (the countdown begins) and the Polytron 8200/8310 sends the Maintenance signal.
  - After the warm-up phase, the device passes into the measurement mode.
  - The current gas concentration, the selected gas and the units of measure appear on the display.
  - The ⏻ LED lights green.
  - The sensor is ready to take measurements.

NOTICE

The correct date and time settings are important for many functions (see chapter 8.2.3 on page 19).

4.6.1 Analog signals

In measurement mode the output current of the device is between 4 and 20 mA and is proportional to the measured gas concentration.

The device uses various current values to indicate different operating modes. This conforms to the NAMUR NE43 recommendation. The 4-20 mA interface on the device can be customized and configured to individual requirements. The device is provided with suitable standard settings at the factory (see chapter 12.3 on page 29).

1 Only displayed when relay is configured.

5 Calibration

Repeat the calibration of the device at regular intervals as specified in the particular sensor data sheet.

CAUTION

Danger to health! Do not inhale the test gas. Observe the hazard information in the corresponding safety data sheets. Provide venting into a fume cupboard or outside the building.

Always calibrate the zero point first before the sensitivity. Otherwise the calibration will be faulty!

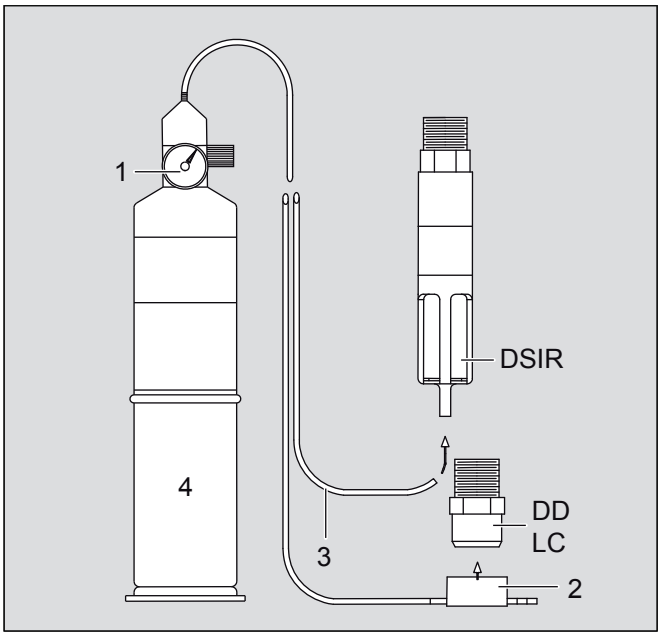
NOTICE

Calibration is not possible if the date and time are not set (see chapter 8.2.3 on page 19).

Dräger recommends calibrating devices with the gas that is to be measured operationally. This method of measured gas calibration is more accurate than a surrogate gas calibration. A surrogate gas calibration may only be performed as an alternative if a measured gas calibration is not possible.

5.1 Calibrating the device

1. Connect the pressure reducer to the calibration gas cylinder.
2. Attach the calibration adapter to the sensor.
3. The gas flow should be between 0.5 and 2.0 L/min.
4. Connect the hose to the calibration adapter.



1 Pressure reducer
2 Calibration adapter
3 Test gas cylinder
4 Hose

For DSIR only (see also Instructions for Use for DrägerSensor IR)

1. Position the magnetic wand on the sensor button marked with ⇩0 and hold it there for at least 5 seconds.
   A negative value will be displayed for as long as the magnetic wand is held on the button (e.g. -10 %LEL). This will start the automatic zeroing of the sensor.
2. Remove the magnetic wand.
   The sensor ends the automatic zeroing after approx. 30 seconds. A negative value (e.g. -10 %LEL) is displayed again as confirmation.

After the zero-point calibration of the DrägerSensor IR, the instrument should show 0 %LEL in the display. If this is not the case, a zero-point calibration must be performed on the instrument (see chapter 5.1.1 on page 14).

5.1.1 Zero point calibration

NOTICE

Ambient air can also be used instead of nitrogen or synthetic air to zero the sensor, provided it is insured that the ambient air contains no measured gas or any other gas for which the sensor may exhibit cross-sensitivity (see the details in the sensor data sheet). In this case, neither a gas cylinder nor a calibration adapter is required for the zero point calibration.

1. Select **Calibration > Zero Calibration** and confirm.
   The Maintenance signal is transmitted.
   The message **Apply zero gas** appears.
2. Apply zero gas (synthetic air or nitrogen) to the sensor.
3. Select **Next** and confirm.
   The current value is displayed.

After the displayed value is stable:

4. Set the value to 0 and confirm.
   The message **Please wait…** appears.
   The actual value is displayed.

- Actual value within the permissible range:
  - Select **Next** and confirm.
  - Shut off the test gas and remove the calibration adapter from the sensor or disconnect the hose.

5.1.2 Span calibration

1. Check which gas category is set (only for DrägerSensor IR, see also the Instructions for Use for the DrägerSensor IR).
1. Select **Calibration > Span calibration** and confirm.
2. Apply calibration gas (e.g., 50 % LEL methane).
   The current value is displayed.

After the displayed value is stable:

3. Set the value to 50 and confirm.
4. Shut off the test gas and remove the calibration adapter from the sensor or disconnect the hose.

5.2 Performing Auto Calibration

The device offers the option of an automatically sequenced calibration. This reduces the number of otherwise manual interactions with the device. The auto calibration is only suitable for experienced users, as calibration errors can occur here as a result of tightened procedures.

NOTICE

Not all of the available sensors and gases support auto calibration. If the function is not available, a manual calibration must be performed.

1. Select **Settings > Sensor > Autocal. set.** to enable or disable the function.
2. Supply fresh air or feed nitrogen or compressed air at a flow rate of 0.5 - 2.0 L/min to the sensor.

WARNING

It must be insured that during the zero point calibration, no measured gas is present in the supplied calibration gas. Particularly with a fresh air calibration, Dräger recommends performing a second, independent measurement. Some sensors may only be calibrated with synthetic air or nitrogen (observe the relevant sensor data sheets).

3. Select **Calibration > Auto cal.** and confirm.
   - **Please wait...** is displayed and a calibration of the zero point is performed automatically.
   - After a successful zero point calibration, the span calibration is started.
   - The calibration gas concentration, the units and, where appropriate, the calibration gas are displayed and can be changed.
4. Start the calibration with **Next**; **Back to menu** aborts the calibration.

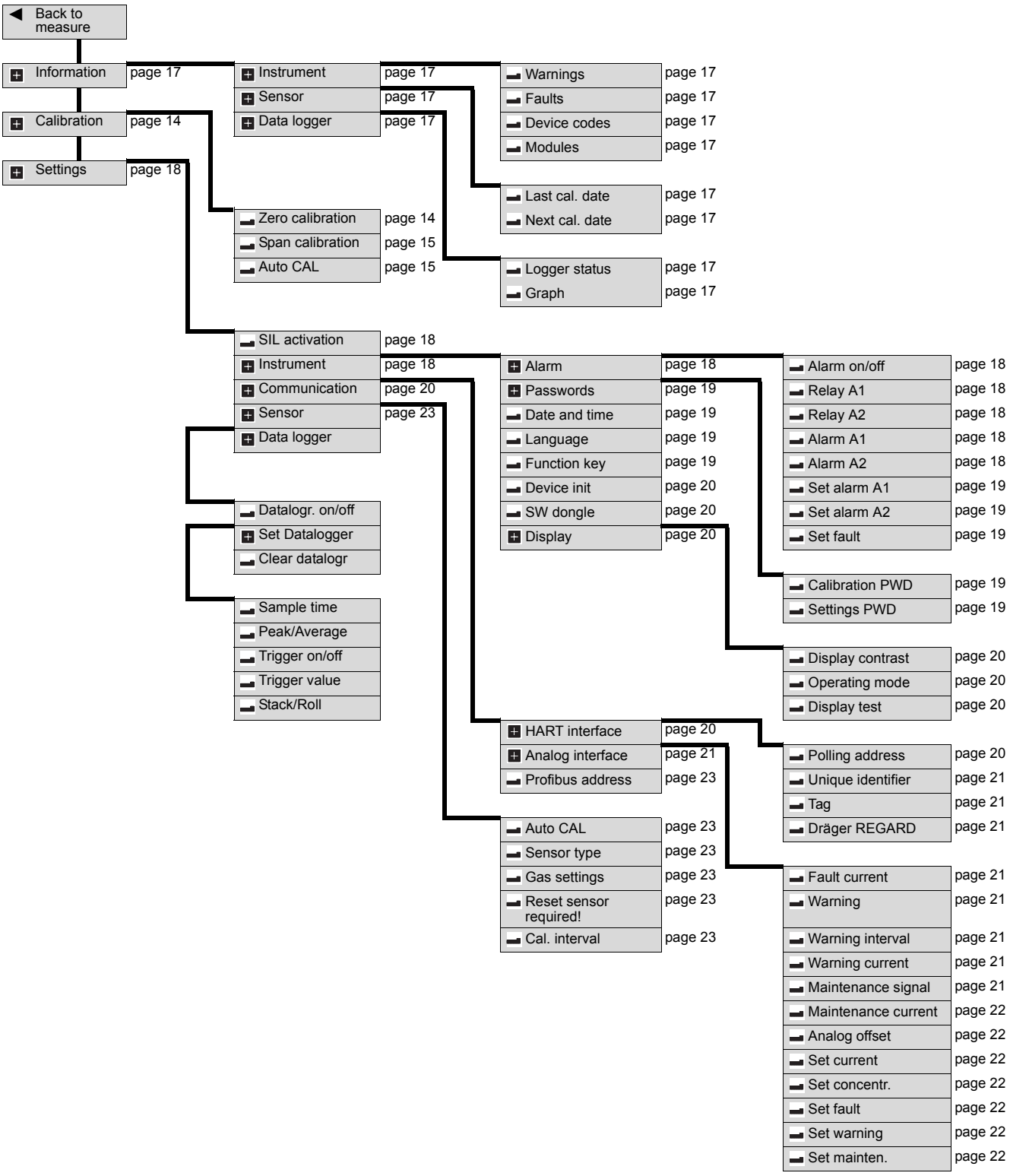
NOTICE

After 10 minutes, without confirmation the device reverts to measurement mode without performing a calibration.

5. Feed the relevant calibration gas to the sensor at a flow rate of 0.5 - 2.0 L/min.
   - When the measured value is stable, the device performs the calibration automatically.
   - After a successful calibration, the measurement and the message **Value OK?** are displayed
6. When the measurement is stable, shut off the calibration gas and wait until the measurement is below any possible alarm thresholds again.

- The calibration is performed again with **Redo**.
- Complete the calibration with **Accept value**.
  The device returns to the measurement mode.

6 Menu overview



7 Information menu

Specific data about the device, the sensor used and the measured gas are summarized in this menu. The menu can be accessed without a password. Changes to the data are not possible.

7.1 Device settings

7.1.1 Displaying warning messages

To display warnings in plain text with warning numbers, see chapter 9 on page 25.
The ⚠ symbol is displayed when there is a warning present.

- Select **Information > Instrument > Warnings** and confirm.
  Warnings are displayed in plain text.
  If several warnings are present, this is indicated in the upper right-hand corner of the display, e.g., 1/3 = Screen 1 of 3.

7.1.2 displaying fault messages

To display faults present in plain text with fault numbers, see chapter 9 on page 25.
The ☒ symbol is displayed when there is a fault present.

- Select **Information > Instrument > Faults** and confirm.
  Faults are displayed in plain text.
  If several faults are present, this is indicated in the upper right-hand corner of the display, e.g., 1/2 = Screen 1 of 2.

7.1.3 Displaying device codes

Display of codes for faults/warnings in a numerical table (hexadecimal).
The ☒ symbol is displayed when there is a fault present.

- Select **Information > Instrument > Device codes** and confirm.
  Faults are displayed as a hexadecimal numerical code in tabular form. If all the numerical groups are displayed as **00**, there are no faults or warnings present.

NOTICE

The fault code is very helpful for technical support and should always be stated in full in the event of a fault.

7.1.4 Displaying installed modules

Display of the installed hardware modules.

- Select **Information > Instrument > Modules** and confirm.
  A list of all possible modules is displayed. The installed modules are identified by a ■, those not installed by a □.
- Mark a module and request detailed information with OK.

7.2 Sensor information

This menu contains the functions for retrieving the calibration data.

7.2.1 Display last calibration date

Display the date of the last calibration.

- Select **Information > Sensor > Last cal. date** and confirm.
  The date of the last calibration is displayed

7.2.2 Display next calibration date

Display the date of the next calibration.

- Select **Information > Sensor > Next cal. date** and confirm.
  The date when the next calibration of the sensor is due is displayed.

7.3 Datalogger information (only with data dongle)

This menu contains the functions for querying the datalogger.

7.3.1 Displaying the datalogger status

- Select **Information > Datalogger > Logger status** and confirm.
  The current status of the datalogger is displayed: Datalogr. : on or off (datalogger on or off)
- To switch the datalogger on/off, see chapter 8.5.1 on page 24.

7.3.2 Displaying a graph of measured values

Show the measurements from the sensor on a 15-minute time axis.

- Select **Information > Datalogger > Graph** and confirm.

8 Settings menu

This menu contains all the functions that are required for the individual configuration of the device.

8.1 Switching SIL lock on or off

NOTICE

SIL lock is only available for certain sensors (see also the sensor data sheets or the Dräger Polytron 8X00 Safety Manual).

With this function, the device can be protected against unauthorized changes to the configuration with a password. Changing the configuration (e.g., changing the measurement range from 100 %LEL to 50 %LEL) will cause the device to display all the safety-relevant parameters to the user once more before it returns to the measurement mode. The correctness of the parameters and settings must be confirmed.

1. Select **Settings > Instrument > Set SIL**.
2. Select the desired state **On** or **Off** and confirm.

NOTICE

When SIL is activated, the device displays all the important parameters and setting before returning to measurement mode. Check the parameters and settings carefully and confirm.

8.2 Device settings

8.2.1 Alarm settings (only with installed relay module)

Alarms issued via relays and LEDs.

CAUTION

In the normal state, the relays in the relay module are energized. That is, the relays change their state if the power supply is interrupted!

Switching the alarm on or off

1. Select **Settings > Instrument > Alarm > Alarm on/off**.
2. Select the desired state **On** or **Off** and confirm.

CAUTION

If the alarm is inactive, the alarm state will not be issued by the LEDs or the relay interface! A warning message ▯ will be shown on the display!

Configuring Relay A1 or A2

This function is used to define whether the alarm relay is energized in standard operation or in an alarm state. If the configuration of the relay is set to "Normally energized", the corresponding relay contact is closed in the normal case and drops out in the event of an alarm. This configuration results in an alarm being triggered in the event of a loss of power to the transmitter (fail-safe). The fault relay is factory-configured to "Normally energized" and cannot be changed.

1. Select **Settings > Instrument > Alarm > Relay A1** or **Relay A2** and confirm.
2. Select **Normal energy supply** oder **Energy supply during alarm** and confirm.

Configuring Alarm A1 or A2

1. Select **Settings > Instrument > Alarm > Alarm A1** or **Alarm A2** and confirm.
2. Select the line for entering the alarm limit and confirm.
3. Set the threshold and confirm.
   The setting for the alarm threshold is displayed.
4. Select **Next** and confirm.
   The setting for the alarm direction is displayed.
5. Select **Rising** or **Falling** and confirm.
6. Select **Next** and confirm.
   The setting for the alarm direction is displayed.
7. Select **Latching** or **Non Latching** and confirm.
8. Select **Next** and confirm.
   The setting for the acknowledgement is displayed.
9. Select **Acknowledgeable** or **NonAcknowledgeabl** or **PreAcknowledgeabl** and confirm.
10. Select **Next** and confirm.
    The function for setting the A1 hysteresis is opened.

NOTICE

This function permits the setting of a zone within which a triggered relay maintains its status until the gas concentration is outside the zone. This function prevents relays from chattering at an alarm threshold.
Example: A2 at 40 %LEL methane
Maximum possible hysteresis: 3 %LEL
Alarm activation at measured values ≥40 %LEL
Alarm deactivation at measured values ≤37 %LEL (40 %LEL - 3 %LEL)

11. Select the line for entering the hysteresis and confirm.
12. Set the hysteresis for A1 and confirm.
    The hysteresis setting for A1 is displayed.
13. Select **Next** and confirm.
    The settings for A1 are displayed.
14. Select and confirm with **Confirm**.
    The settings for the A1 alarm are now complete.

The functional relationship between the various settings is explained in the following table:

Latching and acknowledgeable	The alarm must be acknowledged manually. The alarm can be acknowledged when the alarm condition is still present.
Latching and not acknowledgeable	The alarm must be acknowledged manually. The alarm can only be acknowledged when the alarm condition is no longer present.
Latching and pre-acknowledgeable	The alarm must be acknowledged manually. The alarm can be acknowledged when the alarm condition is still present but will only be reset when the alarm condition is no longer present.
Non-latching and acknowledgeable	The alarm is acknowledged automatically when there is no longer any alarm condition present, or it can be acknowledged manually.
Non-latching and not acknowledgeable	The alarm is acknowledged automatically when there is no longer any alarm condition present. The alarm cannot be acknowledged manually.
Non-latching and pre-acknowledgeable	Corresponds to the alarm behavior for "Non-latching" and "Not acknowledgeable".

Testing Alarm A1

NOTICE

When the function **Set Alarm A1** is exited in the menu, the Polytron 8200/8310 reverts automatically to measurement mode.

This function simulates the A1 alarm status.

1. Select **Settings > Instrument > Alarm > Set Alarm A1** and confirm.
2. Select **On** or **Off** and confirm.

When the function is activated, the relay and the interface are set to the A1 alarm status and the red LED gives single flashes.

Testing Alarm A2

NOTICE

When the function **Set Alarm A2** is exited in the menu, the Polytron 8200/8310 reverts automatically to measurement mode.

This function simulates the A2 alarm status.

1. Select **Settings > Instrument > Alarm > Set Alarm A2** and confirm.
2. Select **On** or **Off** and confirm.

When the function is activated, the relay and the interface are set to the A2 alarm status and the red LED gives double flashes.

Testing Fault status

NOTICE

When the function **Set fault** is exited in the menu, the Polytron 8200/8310 reverts automatically to measurement mode.

This function simulates the Fault alarm.

1. Select **Settings > Instrument > Alarm > Set fault** and confirm.
2. Select **On** or **Off** and confirm.

When the function is activated, the Fault relay and the 4-20 mA interface are set to the fault current and the yellow LED lights.

8.2.2 Changing passwords

The passwords for calibration (zero and span calibrations) and for the settings (full configuration) can be defined in this menu.

1. Select **Settings > Instrument > Passwords > Calibration/ Settings PWD** and confirm.
2. Select the line for the password settings and confirm.
3. Set the password and confirm.
   The setting for the password is displayed.
4. Select **Confirm** and confirm.

8.2.3 Setting the date and time

1. Select **Settings > Instrument > Date and time** and confirm.
2. Select the desired line and confirm in order to switch to the Change mode.
3. Set each digit and confirm each setting.
4. Select **Confirm** and confirm.

8.2.4 Changing the display language

1. Select **Settings > Instrument > Language** and confirm.
2. Select the desired language from the list and confirm.

8.2.5 Configuring the function key

This function is used to assign a predefined function to the ▲ key. The selected function is activated by briefly taping the ▲ key.

1. Select **Settings> Instrument > Function key** and confirm.
2. Select the desired function and confirm.

- Repeating the confirmation deactivates the selected function.
- If **Bumptest** is selected:
  The maintenance symbol 🔧 is shown on the right hand side of the display and the maintenance signal is output. Repeating the confirmation ends the bump test and the device reverts to the normal measurement mode.
- In measurement mode, the selected function can be activated by briefly taping ▲.

Selection options:

Graph (only with datalogger)	The measurements from the sensor are displayed graphically on a time axis (see chapter 7.3.2 on page 17).
Faults	Faults are displayed in plain text (see chapter 7.1.2 on page 17).
Warnings	Warnings are displayed in plain text (see chapter 7.1.1 on page 17).
Bump test	The bump test allows gas to be applied without an alarm being issued. The maintenance signal is output on the 4-20 mA output.
Sensor vitality	Shows the remaining sensor vitality (only available for certain sensors).

8.2.6 Resetting the device to factory settings

The following device parameters are reset to the factory settings with this function (see chapter 12.3 on page 29).

- Alarm parameters
- Passwords
- Language
- Function key
- HART interface
- Data logger
- Analog interface
- Relay configuration

1. Select **Settings > Instrument > Device init.** and confirm.
2. Select **Confirm** and confirm in order to reset the device to the factory settings.

8.2.7 Deactivating the software dongle

This function allows the SW dongles to be deactivated before they are removed or in the event of a fault.
A dongle can only be reactivated by switching the power to the device off and on.

1. Select **Settings > Instrument > SW dongle > Dongle datalogger/Dongle sensortest/Dongle diagnostic** and confirm.
2. Select **Deactivate func.** and deactivate Dongle datalogger/ Dongle sensortest/Dongle diagnostic with ⓞⓚ.

8.2.8 Display settings

Changing the contrast

1. Select **Settings > Instrument > Display > Display contrast** and confirm.
2. Change the contrast and confirm.

Changing the display mode
The display of measured values can be turned on or off with this function.

1. Select **Settings > Instrument > Display > Display mode** and confirm.
2. Select **Standard** or **Non display** and confirm.

If "Non display" has been selected, the display shows the start screen and the symbols.

If the relay option is set and an alarm is triggered, the display shows the current gas concentration and the red LED flashes, regardless of the selected display mode.

Switching the display test on or off
The function of the display and the LEDs is tested with this function.

1. Select **Settings > Instrument > Display > Displaytest** and confirm.
2. Select **On** or **Off** and confirm.

When this function is activated, the display is shown inverted and all the LEDs are lit.

8.3 Communication settings

8.3.1 Settings for the HART interface (only for devices with the optional HART interface)

This group contains the setting functions for the HART interface.

Setting the polling address
The polling address configures the device for analog operation (4 to 20 mA) or multidrop operation. Analog operation (4 to 20 mA) is activated by setting the polling address to 0. For multidrop operation the polling address must be configured to a value between 1 and 15, which will result in the analog interface being deactivated and set to a constant current of approx. 1 mA. To allow the control unit to request the Unique Identifier (unique HART address) with HART command #0, all the devices on a line must be configured with different polling addresses. It is advisable to choose a sequence starting with 1 and incrementing continuously.
This setting corresponds to HART command #6 (Write Polling Address).

1. Select **Settings > Communication > HART interface > Polling address** and confirm.
2. Select the address line for the entry and confirm in order to switch to the Change mode.
3. Set the polling address and confirm.
4. Select **Confirm** and confirm.

Displaying the Unique Identifier
This function enables reading of the Unique Identifier (unique HART address), which has to be known for almost all the HART addressing commands. However this information is only required for those systems that are not able to read back the Unique Identifier using HART command #0 in Short-Frame Format or HART command #11. The display corresponds to the address for HART command #0 (Read Unique Identifier) or #11 (Read Unique Identifier associated with Tag).

- Select **Settings > Communication > HART interface > Unique Identifier** and confirm.
  The Unique Identifier is displayed.

Changing the measuring point name
The tag can be used to identify special devices. It can contain up to 8 alphanumeric characters. The tag can also function as an address for reading the unique identifier from the device using HART command #11 (Read Unique Identifier Associated With Tag), even when the polling address is unknown.
This requires that a unique tag has previously been configured.

1. Select **Settings > Communication > HART interface > Tag** and confirm.
2. Select the tag line for the entry and confirm.
3. Set the tag and confirm.
4. Select **Confirm** and confirm.

Selecting Dräger REGARD
This function enables switching between different HART protocols.

NOTICE

REGARD SW 2.0 is the standard setting. REGARD SW 1.4 must be set on REGARD controllers with SW 1.4.

1. Select **Settings > Communication > HART interface > Dräger REGARD** and confirm.
2. Select **REGARD SW 2.0** or **REGARD SW 1.4** and confirm.

8.3.2 Settings for the analog interface

The test and setting functions for the analog interface are summarized in this menu.

Setting the fault current
This function is used to set the current for the fault signal on the analog interface.

1. Select **Settings > Communication > Analog interface > Fault current** and confirm.
2. Select the fault current line and confirm.
3. Set the currrent and confirm.
4. Select **Confirm** and confirm.

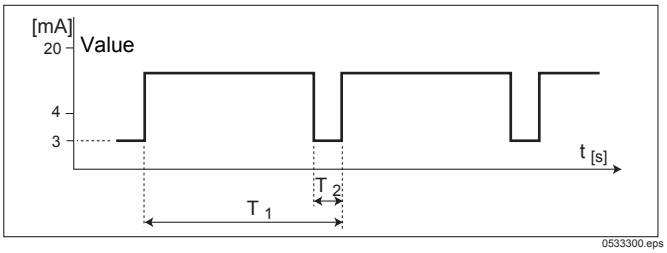
Switching the warning signal on or off
This function is used to switch the warning signal on the analog interface on and off. If an existing warning is to be output over the analog interface, the warning signal must be turned on. During a warning, the current on the analog interface is switched to the "Warning" status for one second. The measurement is transmitted for the rest of the time. The interval between warning signals and the analog signal phase can be customized.

To switch the warning signal on or off:

1. Select **Settings > Communication > Analog interface > Warning** and confirm.
2. Select **On** or **Off** and confirm.

Setting the warning interval
This function is used to set the interval between the warning signals and the analog interface.

1. Select **Settings > Communication > Analog interface > Warning interval** and confirm.
2. Select line **T1** for the entry and confirm.
3. Set the time and confirm.
   The setting for Time T1 is displayed.
4. Select **Next** and confirm.
5. Select line **T2** for the entry and confirm.
6. Set the time and confirm each setting.
   The setting for Time T2 is displayed.
7. Select **Confirm** and confirm.



Setting the warning current
This function is used to set the current for the warning signal on the analog interface.

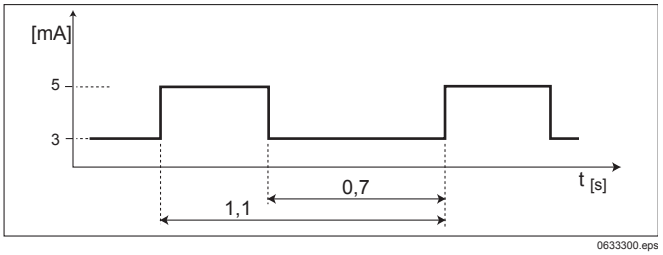
1. Select **Settings > Communication > Analog interface > Warning current** and confirm.
2. Select the current line for the entry and confirm.
3. Set the currrent and confirm.
   The setting for the warning current is displayed.
4. Select **Confirm** and confirm.

Changing the maintenance signal type
This function is sets the type of signal used on the analog interface for the maintenance signal.

1. Select **Settings > Communication > Analog interface > Maint. signal** and confirm.
2. Select **static** or **dynamic** signal type and confirm.

NOTICE

The **static** signal type is a constant current. The current can be configured.
The **dynamic** signal type is a square wave signal with the following characteristics:



Setting the maintenance current
This function is used to set the current for the maintenance signal on the analog interface.

1. Select **Settings > Communication > Analog interface > Maint. current** and confirm.
2. Select the current line for the entry and confirm.
3. Set the currrent and confirm.
   The setting for the maintenance current is displayed.
4. Select **Confirm** and confirm.

NOTICE

The maintenance current can only be set if the maintenance signal has been set to static. This function is not available otherwise.

Setting the 4-20 mA offset
This function can be used to set an adjustable offset current on the analog interface. The offset is constant over the entire range of the output signal.

1. Select **Settings > Communication > Analog interface > Analog offset** and confirm.
2. Select the current line for the entry (max. range: -0.2 to 1.5 mA) and confirm.
3. Set the currrent and confirm.
   The setting for the 4-20 mA offset is displayed.
4. Select **Confirm** and confirm.

Test functions for the analog interface

NOTICE

Alarms in the central controller may be triggered by these functions! If necessary, the alarms in the central controller must be disabled beforehand.

Setting current signals
Using this function, various currents in the range from 0 to 22 mA can be set on the analog interface.

1. Select **Settings > Communication > Analog interface > Set current** and confirm.
2. If the alarm in the control unit is disabled, confirm the message **Disable all alarm settings**.
3. Select the current line for the entry and confirm.
4. Set the currrent and confirm.
   The setting for the current is displayed.
5. Select **Next** and confirm.
6. Select **Set current out** or **Current off** and confirm.
7. Select **Next** and confirm. The function is terminated.
8. After the alarm settings in the control unit have been re-enabled, confirm the **Enable all alarm settings** message.

Setting the concentration
This function is used to set various concentrations in the range between 0 and 100 % of the selected unit of measure. The current output is set to correspond to the selected concentration.

1. Select **Settings > Communication > Analog interface > Set concentr.** and confirm.
2. If the alarm in the control unit is disabled, confirm the message **Disable all alarm settings**.
3. Select the concentration line for the entry and confirm.
4. Set the concentration and confirm.
   The setting for the concentration is displayed.
5. Select **Next** and confirm.
6. Select **Define concentr. output** or **Conc. off** and activate.
7. Select **Next** and confirm. The function is terminated.
8. After the alarm settings in the control unit have been re-enabled, confirm the **Enable all alarm settings** message.

Testing the Fault signal
This function is used to set the analog interface for the fault signal.

1. Select **Settings > Communication > Analog interface > Set fault** and confirm.
2. Select **On** or **Off** and confirm.
   The current for the Fault signal will be transmitted on the analog interface.

Testing the warning signal
This function is used to set the analog interface for the warning signal.

1. Select **Settings > Communication > Analog interface > Set warning** and confirm.
2. Select **On** or **Off** and confirm.
   The current for the warning signal will be transmitted on the analog interface.

Testing the maintenance signal
This function is used to set the analog interface for the maintenance signal.

1. Select **Settings > Communication > Analog interface > Set mainten.** and confirm.
2. Select **On** or **Off** and confirm.
   The current for the maintenance signal will be transmitted on the analog interface.

8.3.3 Profibus address

Not yet active - for future functions.

8.4 Sensor settings

8.4.1 Switching Auto CAL on or off

NOTICE

The auto-calibration from the **Calibration** menu is only available if this function is enabled.

1. Select **Settings > Sensor > Set auto calibration** and confirm.
2. Select **On** or **Off** and confirm.

8.4.2 Setting the sensor type (for DrägerSensor DD only)

This function is used to set the sensor type.

1. Select **Settings > Sensor > Sensor type** and confirm.

8.4.3 Changing the gas settings

Settings for gas type, measuring range and measurement units can be made in this menu.

1. Select **Settings > Sensor > Gas setting** and confirm.
2. Select the measured gas from the list and confirm.
   The measurement units display will be shown.
3. Select the measurement units and confirm.
   The full scale reading display will be shown.
4. Set the full scale reading and confirm.
   The setting for the full scale reading is displayed.
5. Select **Next** and confirm.
   an overview of the new gas settings is displayed.

- Return to the previous view with **Previous** or confirm the settings with **Confirm**.

Information about measurement units

The Polytron 8200/8310 represents the measured value in various optional units. The following are available:

- %LEL
- %LIE
- %UEG

The Polytron 8000 automatically calculates the correct value.

Information about the 20 mA measuring range

The full scale reading can be set with this function. At the full scale reading set, the device outputs 20 mA on the 4-20 mA interface.

8.4.4 Resetting the sensor to factory settings

This function resets all the sensor parameters to the factory default settings (see chapter 12.3 on page 29).

1. Select **Settings > Sensor > Reset sensor required!** and confirm.
2. Select **Confirm** and confirm.

8.4.5 Setting the calibration interval

NOTICE

The calibration interval can be set between 0 and 720 days.

1. Select **Settings > Sensor > Calibration interval** and confirm.
2. Set the calibration interval and confirm.

8.5 Datalogger settings (only with data dongle)

NOTICE

The functions are only available if the Polytron 8000 is fitted with the data dongle (Order Number 83 17 618), see chapter 3.10 on page 10.

The datalogger has a storage capacity of approx. 3000 measurements. At a sampling interval of 1 minute, this would allow monitoring for approx. 50 hours. The monitoring time can be significantly increased if the **Trigger** function is enabled.

The results in the datalogger can only be evaluated with the PolySoft 8000 PC software. An evaluation of the datalogger contents over the last 15 minutes is available in the menu under **Information > Datalogger > Graph** (see chapter 7.3.2 on page 17).

8.5.1 Switching the datalogger on or off

1. Select **Settings > Datalogger > Datalogr. on/off** and confirm.
2. Select **On** or **Off** and confirm.

8.5.2 Setting up the datalogger

Setting the sampling interval

1. Select **Settings > Datalogger > Datalogr. on/off > Sample time** and confirm.
2. Select the sample time and confirm.

Setting peak/average

1. Select **Settings > Datalogger > Set datalogger > Peak/average** and confirm.
2. Select the desired function and confirm.

Peak value	The measured maximum (for O_2, the minimum value) value of the concentration within the selected sampling interval is stored.
Average	The average value of all the concentrations measured within the selected sampling time is stored.

Switching the trigger on or off

1. Select **Settings > Datalogger > Set datalogger > Trigger on/off** and confirm.
2. Select **On** or **Off** and confirm.

On	Concentrations will only be stored if they exceed (relative to the last stored value) a threshold set under Trigger Value.
Off	The measurements made within the set sampling time are always stored.

Setting the trigger threshold

The trigger threshold is specified as a percentage of the full scale reading.
Example: A trigger threshold of 2 % is entered for a full scale reading of 500 ppm. Consequently the datalogger will only store measurements if they deviate (relative to the last stored value) by 10 ppm.

1. Select **Settings > Datalogger > Datalogr. on/off > Trigger value** and confirm.
2. Set the trigger value and confirm.

Setting the storage mode

1. Select **Settings > Datalogger > Set Datalogger > Stack/Roll** and confirm.
2. Select the desired condition and confirm

Overwrite	When the capacity of the datalogger is used up, the older data will be overwritten.
Hold	When the capacity of the datalogger is used up, no more data can be stored. An appropriate warning is issued.

8.5.3 Clearing the datalogger

1. Select **Settings > Datalogger > Clear Datalogr.** and confirm.
2. To clear the datalogger, select **Confirm** and confirm.

9 Troubleshooting

9.1 Fault reference

Fault number	Cause	Remedy
#001 #003 #004 #005 #011 - #014 #020 - #024 #043 #060 #067	Serious device fault, various causes.	Have the device checked by DrägerService®[1].
#002 #025 - #027 #030 - #034 #041 #042 #044 #050 #052 #081 #085	Serious data error in the device, various causes.	Reset the device to factory settings (see chapter 8.2.6 on page 20). If this fault occurs again: Have the device checked by DrägerService.
#10	4-20 mA interface cable not connected.	Disconnect the powwer supply, connect the 4-20 mA interface and reconnect the power supply.
#045	Device not detecting any sensor.	Check contacts. If this fault occurs again: Have the device checked by DrägerService.
#051 #054	Faulty zero-point.	Perform zero-point calibration (see chapter 5.1.1 on page 14).
#055	Faulty span calibration was performed.	Perform new span calibration (see chapter 5.1.2 on page 15).
#076 #080 - #084	Device fault.	Check contacts. If this fault occurs again: Have the device checked by DrägerService.

1 DrägerService® is a registered trademark of Dräger.

9.2 Warning reference

Warning number	Cause	Remedy
#101	Datalogger in Stack mode is 100 % full and is not logging any more data.	Read out the data, clear the datalogger and start again.
#102	Datalogger in Stack mode is 90 % full.	Read out the data as soon as possible, clear the datalogger and start again.
#103 #106	Data error in the device. Functions such as the datalogger or dongle functions may no longer be available.	Reset the device to factory settings (see chapter 8.2.6 on page 20). If this fault occurs again: Have the device checked by DrägerService.
#105	Device fault.	Have the device checked by DrägerService.
#104	No valid date or time set.	Set time and date (see chapter 8.2.3 on page 19).
#107	Battery almost used up.	Have the device checked by DrägerService.
#110 #111 #112	SW dongle has been removed without logging out.	Disable SW dongle (see chapter 8.2.7 on page 20).
#113	Alarms disabled.	Enable alarms (see chapter 8.2.1 on page 18).
#137	Device fault.	Restart. If this fault occurs again: Have device checked by DrägerService.
#164 #165	Sensor warm-up phase has not ended yet. Increased measurement error must be expected.	Wait until the sensor has warmed up.
#167 #170	Calibration interval expired.	Recalibrate the device (see chapter 5.1 on page 14).

10 Maintenance

10.1 Maintenance intervals

10.1.1 During commissioning

- Check calibration.
- Check signal transmission to controller and triggering of alarms.

10.1.2 Every 6 months

- Inspection by trained service personnel.

The inspection intervals must be established in each individual case and shortened if necessary, depending on technical safety considerations, engineering conditions, and the technical requirements of the equipment.
Contact DrägerService if you wish to take out a service contract and have any repairs carried out.

10.1.3 As required

- Change the sensor, see chapter 10.2 on page 27.

10.2 Changing the sensor

WARNING

As a matter of principle, always check a newly installed sensor with measured gas to insure correct operation.

CAUTION

When the sensor is changed, all settings and parameters must be checked for correctness.

The sensor is changed as follows:

1. Switch off the power to the device or declassify the area according to the local regulations.
2. Release the set screw and unscrew the housing cover from the device.
3. Lift the handle and remove the enclosure with the main electronics.
4. Disconnect the sensor cable.
5. Unscrew the DrägerSensor.
6. Pass the sensor cable through the threaded connection in the housing.
7. Screw in the DrägerSensor.

WARNING

Five threads must be engaged to insure explosion protection (see chapter 12.1 on page 29).

8. Plug the sensor cable into the socket.
9. Re-fit the sensor electronics and enclosure.
10. Screw the housing cover on again and tighten the set screw.
11. Switch on the power to the device.
12. If necessary, switch off SIL activation (see chapter 8.1 on page 18).
13. Calibrate the device if necessary (see chapter 5 on page 14).
14. If required, switch on SIL activation (see chapter 8.1 on page 18).

10.3 Changing the main electronics

CAUTION

When the main electronics are changed, all settings and parameters must be checked for correctness.

1. Switch off the power to the device or declassify the area according to the local regulations.
2. Release the set screw and unscrew the housing cover from the device.
3. Lift the handle and remove the enclosure with the main electronics.
4. Remove the protective caps for the connectors.
5. Unscrew the connector locking ring for the power supply and relay and withdraw the connector.
6. Change the main electronics.
7. Plug the sensor cable and the connector for the power supply and relay into the corresponding sockets and screw them tight.
8. Re-fit the dust caps for the connectors.
9. Re-fit the sensor electronics and enclosure.
10. Screw the housing cover on again and tighten the set screw.
11. Switch on the power to the device.
12. Check and adjust the configuration as required.
13. Calibrate the device if necessary (see chapter 5 on page 14).

11 Disposal

Disposal of electrical and electronic equipment:
EU-wide regulations governing the disposal of electric and electronic appliances which have been defined in the EU Directive 2002/96/EC and in national laws have been effective from August 2005 and apply to this device. Common household appliances can be disposed of using special collecting and recycling facilities. However, as this device has not been registered for household usage, it must not be disposed of through these means. The device can be returned to your national Dräger Safety Sales Organization for disposal. Please do not hesitate to contact the above if you have any further questions on this issue.

12 Technical data

CAUTION

Specifications and restrictions in the Instructions for Use and/or data sheets for the sensors used must be observed. For SIL applications the Dräger Polytron 8X00 Safety Manual must be observed.

The measuring range and performance characteristics are dependent on the sensor installed, see the Instructions for Use and/or data sheets for the sensors used.

Signal transmission to the central controller	
Analog	
Output current	4 mA to 20 mA
Drift below zero-point	3.8 mA to 4 mA
Measuring range exceeded	20 mA to 20.5 mA
Device malfunction	≤1.2 mA
Fault on analog output	>21 mA
Maintenance signal	3.4 mA constant signal or 1 Hz modulation between 3 and 5 mA (selectable)
Supply voltage	
Operating voltage	3-wire shielded cable, 10 to 30 V DC
Inrush current	2.5 A for 0.8 ms at 24 V DC, 10 Ω conductor resistance
Operating current (max.)	
with DrägerSensor Ex DD	105 mA at 24 V DC, no relay, sensor not remote 145 mA at 24 V DC, with relay, remote sensor
with DrägerSensor Ex LC	130 mA at 24 V DC, no relay, sensor not remote 165 mA at 24 V DC, with relay, remote sensor
with DrägerSensor IR	145 mA at 24 V DC, no relay, sensor not remote 185 mA at 24 V DC, with relay, remote sensor
Relay design (optional)	SPDT, 5 A at 230 V AC, 5 A at 30 V DC, resistive load For safety-related applications (SIL2), the maximum contact rating is reduced (see also the Dräger Polytron 8X00 Safety Manual).
Housing	NEMA 4X
Protection Class	IP 65/66/67
Dimensions (LxWxD)	
Without e-Box (DrägerSensor LC, DD)	approx. 180 x 150 x 130 mm (7" x 5.8" x 5.1")
With e-Box (DrägerSensor LC, DD)	approx. 185 x 180 x 190 mm (7.3" x 7.1" x 7.4")
Without e-Box (DrägerSensor IR)	approx. 295 x 150 x 130 mm (11,6" x 5,8" x 5,1")
With e-Box (DrägerSensor IR)	approx. 300 x 180 x 190 mm (11,9" x 7,1" x 7,4")
Weight	
Without e-Box, aluminum	approx. 2.2 kg (4.9 lbs.)
Without e-Box, stainless steel 316	approx. 4.0 kg (8.8 lbs.)
With e-Box, aluminum	approx. 3.5 kg (7.7 lbs.)
With e-Box, stainless steel 316	approx. 5.4 kg (11.9 lbs.)
Display	Resolution 128 x 64, back-lit

Environmental conditions	Specifications for the sensor: see sensor data sheet
Pressure	700 to 1300 hPa (20.7 to 38.4 in. Hg)
Humidity	0 to 100 % R. H., non-condensing
Temperature	
DrägerSensor DD, LC no relay	-40 to +80 °C (-40 to +176 °F)
DrägerSensor DD, LC with relay	-40 to +70 °C (-40 to +158 °F)
DrägerSensor IR no relay	-40 to +65 °C (-40 to +149 °F)
DrägerSensor IR with relay	-40 to +65 °C (-40 to +149 °F)
Environmental influences	See respective sensor data sheets.

12.1 Torques

(The torques are valid for the aluminum and stainless steel 316 variants)

Part	Torque Lb. In.	Torque Nm
Housing cover	min. 266	min. 30
Sensors	min. 266	min. 30
Plug	min. 266	min. 30
Cable bushing	min. 443	min. 50
Device to e-Box	71	8

If an optional e-Box is being used, fasten the device securely to the e-Box with 4 screws and a tightening torque of 8 Nm.

12.2 Tightening torque and cable size for field wiring terminals

Electronic		
Torque Lb. In.	**Cable size in AWG**	**Cable size in mm^2**
All field wiring terminals 4.4–7.0 (0.5–0.8 Nm)	20–12	0.5–2.5

12.3 Factory settings

12.3.1 Alterable settings for the Polytron 8200/8310

Menu	Standard setting	
	DrägerSensor DD, IR	**DrägerSensor LC**
A1 Alarm	20 %LEL	2.0 %LEL
A2 Alarm	40 %LEL	4.0 %LEL
A1 Relay alarm: Direction	Rising	Rising
A2 Relay Alarm: Direction	Rising	Rising
A1 latching mode	Non-latching	Non-latching
A2 latching mode	Latching	Latching
A1 Acknowledgement mode	Acknowledgeable	Acknowledgeable
A2 Acknowledgement mode	Not acknowledgeable	Not acknowledgeable
A1 enrg / wired in e-Box	Energized / NO	Energized / NO
A2 enrg / wired in e-Box	Energized / NO	Energized / NO
Maintenance password	0000	0000
LCD setting	on	on
Configuration/SIL password	_ _ _2	_ _ _2
SIL status	Off	Off
Language	English	English
Fault current	1.2 mA	1.2 mA
Warning current	3.0 mA	3.0 mA
Maintenance current	3.4 mA	3.4 mA
HART address	0	0
Auto-cal.	Off	Off
Calibration interval	360	360
Function key	Faults	Faults

12.3.2 Unalterable settings

Fault	Meaning
Fault relay / wired in e-Box	Energized / NO
Yellow Fault LED	Lights when a fault is present (see chapter 9 on page 25).
Red Alarm LED	Gives single flashes when an A1 alarm is present. Gives double flashes when an A2 alarm is present. If an alarm is configured as acknowledgeable and the alarm is acknowledged, the LED lights. Alarm hierarchy: A2 has a higher priority for the LED than A1. However the A1 and A2 relays operate independently of one another, i.e. if A1 is acknowledgeable and A2 is not and the gas concentration is so high that A1 and A2 are triggered, an acknowledgement results in the A1 relay dropping out. However the red LED continues to give double flashes as long as the A2 condition exists.

Reference Manual
00809-0100-4001, Rev KA
May 2017

Rosemount™ 3051 Pressure Transmitter

with HART® Protocol

HART COMMUNICATION PROTOCOL

EMERSON™

Section 4 Operation and Maintenance

4.1 Overview

This section contains information on calibrating and diagnostics messages on Rosemount™ 3051 Pressure Transmitters.

Field Communicator and AMS Device Manager instructions are given to perform configuration functions. For convenience, Field Communicator Fast Key sequences are labeled “Fast Keys” for each software function below the appropriate headings.

4.2 Safety messages

Procedures and instructions in this section may require special precautions to ensure the safety of the personnel performing the operations. Information that raises potential safety issues is indicated by a warning symbol (⚠). Refer to the following safety messages before performing an operation preceded by this symbol.

⚠WARNING

Explosions could result in death or serious injury.

Installation of this transmitter in an explosive environment must be in accordance with the appropriate local, national, and international standards, codes, and practices. Review the approvals section of this manual for any restrictions associated with a safe installation.

- Before connecting a Field Communicator in an explosive atmosphere, ensure the instruments in the loop are installed in accordance with intrinsically safe or non-incendive field wiring practices.
- In an Explosionproof/flameproof installation, do not remove the transmitter covers when power is applied to the unit.

Process leaks may cause harm or result in death.

- Install and tighten process connectors before applying pressure.

Electrical shock can result in death or serious injury.

- Avoid contact with the leads and terminals. High voltage that may be present on leads can cause electrical shock.

4.3 Calibration overview

Calibration is defined as the process required to optimize transmitter accuracy over a specific range by adjusting the factory sensor characterization curve located in the microprocessor. Possible procedures are:

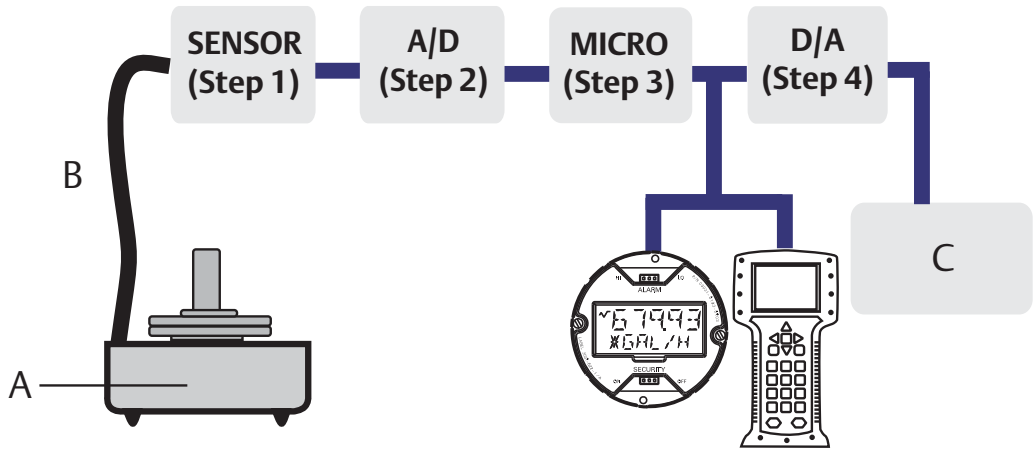
- Reranging: Setting the lower and upper range points (4 and 20 mA or 1 and 5 Vdc) points at required pressures. Reranging does not change the factory sensor characterization curve. Refer to page 17.
- Analog output trim: Adjusts the transmitter's analog characterization curve to match the plant standard of the control loop. There are two types of digital-to-analog output trims. Refer to page 68.
  - Digital-to-Analog output trim on 4–20 mA HART output (page 69)
  - Digital-to-Analog output trim on 4–20 mA HART output using other scale (page 70)
- Sensor trim: Adjusts the position of the factory sensor characterization curve due to a change in the sensor characteristics over time or a change in test equipment. Trimming has two steps, zero and sensor trims. Refer to page 72 and page 73.
- Zero trim (page 72)
- Sensor trim (page 73)

Figure 4-1 on page 65 illustrates Rosemount 3051 Transmitter data flow. Data flow can be summarized in four major steps:

1. A change in pressure is measured by a change in the sensor output (sensor signal).
2. The sensor signal is converted to a digital format that is understood by the microprocessor (Analog-to-Digital Signal Conversion). Sensor trim functions affect this value. Select these options to alter the digital signal on the LCD or Field Communicator.
3. Corrections are performed in the microprocessor to obtain a digital representation of the process input (Digital PV).
4. The Digital PV is converted to an analog value (Digital-to-Analog signal conversion). Rerange and analog trim functions affect this value. Select these options to change the range points (4–20 mA or 1–5 Vdc).

For a summary of recommended calibration procedures, refer to Table 4-1 on page 65. Also, Figure 4-1 on page 65 identifies the approximate transmitter location for each calibration task. Data flows from left to right and a parameter change affects all values to the right of the changed parameter.

Figure 4-1. Transmitter Data Flow with Calibration Options



A. Pressure source
B. Output: 100 inH_2O
C. Output 20.00 mA

Table 4-1. Recommended Calibration Tasks

Transmitter	Bench calibration tasks	Field calibration tasks
3051CD, 3051CG, 3051L, 3051TG, Range 1-4	1. Set output configuration parameters: a. Set the range points. b. Set the output units. c. Set the output type. d. Set the damping value. 2. Optional: Perform a sensor trim. (Accurate pressure source required.)	1. Reconfigure parameters if necessary. 2. Zero trim the transmitter to compensate for mounting effects or static pressure effects. 3. Optional: Perform an analog output trim. (Accurate multimeter required)
3051CA, 3051TA, 3051TG, Range 5	1. Set output configuration parameters: a. Set the range points. b. Set the output units. c. Set the output type. d. Set the damping value. 2. Optional: Perform a sensor trim if equipment available (accurate absolute pressure source required), otherwise perform the low trim value section of the sensor trim procedure.	1. Reconfigure parameters if necessary. 2. Perform low trim value section of the sensor trim procedure to correct for mounting position effects. 3. Optional: Perform an analog output trim (Accurate multimeter required)

Note
The Rosemount 3051has been carefully calibrated at the factory. Trimming adjusts the position of the factory characterization curve. It is possible to degrade performance of the transmitter if any trim is done improperly or with inaccurate equipment.

Note
A Field Communicator is required for all sensor and output trim procedures. Rosemount 3051C Range 4 and Range 5 Transmitters require a special calibration procedure when used in differential pressure applications under high static line pressure (see"Select Finish to acknowledge the method is complete." on page 74).

4.3.1 Determining calibration frequency

Calibration frequency can vary greatly depending on the application, performance requirements, and process conditions. Use the following procedure to determine calibration frequency that meets the needs of your application.

1. Determine the performance required for your application.
2. Determine the operating conditions.
3. Calculate the Total Probable Error (TPE).
4. Calculate the stability per month.
5. Calculate the calibration frequency.

Sample calculation for a standard Rosemount 3051C

Step 1: Determine the performance required for your application.

Required performance:	0.30% of span

Step 2: Determine the operating conditions.

Transmitter:	Rosemount 3051CD, Range 2 [URL=250 inH_2O(623 mbar)]
Calibrated span:	150 inH_2O (374 mbar)
Ambient temperature change:	± 50 °F (28 °C)
Line pressure:	500 psig (34,5 bar)

Step 3: Calculate total probable error (TPE).

$$TPE = \sqrt{(ReferenceAccuracy)^2 + (TemperatureEffect)^2 + (StaticPressureEffect)^2} = 0.117\% \text{ of span}$$

Where:

Reference accuracy = ± 0.065% of span

Ambient temperature effect = $\pm\left(\frac{(0.0125 \times URL)}{Span} + 0.0625\right)$ % per 50 °F = ±0.0833% of span

Span static pressure effect[1] =

0.1% reading per 1000 psi (69 bar) = ±0.05% of span at maximum span

1. Zero static pressure effect removed by zero trimming at line pressure.

Step 4: Calculate the stability per month.

$$Stability = \pm\left[\frac{(0.0125 \times URL)}{Span}\right]\% \text{ of span for 5 years} = \pm 0.0035\% \text{ of span per month}$$

Step 5: Calculate calibration frequency.

$$\text{Cal. Freq.} = \frac{(\text{Req. Performance} - TPE)}{\text{Stability per Month}} = \frac{(0.30\% - 0.117\%)}{0.0035\%} = (52) \text{months}$$

Sample calculation for Rosemount 3051C with P8 option (0.04% accuracy & 5-year stability)

Step 1: Determine the performance required for your application.

Required performance:	0.30% of span

Step 2: Determine the operating conditions.

Transmitter:	Rosemount 3051CD, Range 2 (URL=250 inH_2O [623 mbar])
Calibrated span:	150 inH_2O (374 mbar)
Ambient temperature change:	± 50 °F (28 °C)
Line pressure:	500 psig (34,5 bar)

Step 3: Calculate total probable error (TPE).

$$TPE = \sqrt{(ReferenceAccuracy)^2 + (TemperatureEffect)^2 + (StaticPressureEffect)^2} = 0.105\% \text{ of span}$$

Where:

Reference Accuracy = ± 0.04% of span

Ambient Temperature Effect =

$$\pm\left(\frac{0.0125 \times URL}{Span} + 0.0625\right)\% \text{ per } 50\,^{\circ}F = \pm 0.0833\% \text{ of span}$$

Span Static Pressure Effect[1] =

0.1% reading per 1000 psi (69 bar) = ±0.05% of span at maximum span

1. Zero static pressure effect removed by zero trimming at line pressure.

Step 4: Calculate the stability per month.

$$Stability = \pm\left[\frac{(0.125 \times URL)}{Span}\right]\% \text{ of span for 5 years} = \pm 0.0035\% \text{ of span per month}$$

Step 5: Calculate calibration frequency.

$$\text{Cal. Freq.} = \frac{(\text{Req. Performance} - TPE)}{\text{Stability per Month}} = \frac{(0.3\% - 0.105\%)}{0.0035\%} = 27 \text{ months}$$

4.3.2 Selecting a trim procedure

To decide which trim procedure to use, you must first determine whether the analog-to-digital section or the digital-to-analog section of the transmitter electronics need calibration. Refer to Figure 4-1 and perform the following procedure:

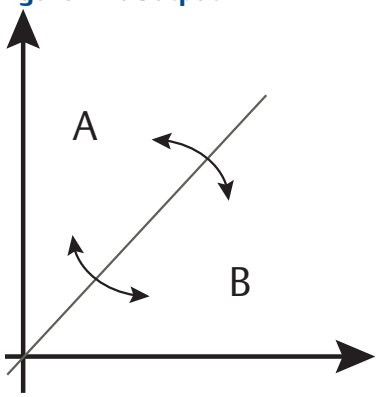
1. Connect a pressure source, a Field Communicator or AMS Device Manager, and a digital readout device to the transmitter.
2. Establish communication between the transmitter and the Field Communicator.
3. Apply pressure equal to the upper range point pressure.
4. Compare the applied pressure to the pressure process variable valve on the *Process Variables* menu on the Field Communicator or the *Process Variables* screen in AMS Device Manager. For instructions on how to access process variables, see page 15 of Section 2: Configuration.
   a. If the pressure reading does not match the applied pressure (with high-accuracy test equipment), perform a sensor trim. See "Sensor trim overview" on page 71 to determine which trim to perform.
5. Compare the Analog Output (AO) line, on the Field Communicator or AMS Device Manager, to the digital readout device.

If the AO reading does not match the digital readout device (with high-accuracy test equipment), perform an analog output trim. See "Analog output trim" on page 68.

4.4 Analog output trim

The analog output trim commands allow you to adjust the transmitter's current output at the 4 and 20 mA (1 and 5 Vdc) points to match the plant standards. This command adjusts the digital to analog signal conversion.

Figure 4-2. Output Trim



A. Output trim
B. Characterization curve

4.4.1 Digital-to-Analog trim

Field Communicator

Traditional 4–20 mA Fast Keys	1, 2, 3, 2, 1
Traditional 1–5 Vdc Fast Keys	1, 2, 3, 2, 1
Device Dashboard Fast Keys	3, 4, 2

To perform a digital-to-analog trim with a Field Communicator, perform the following procedure.

1. From the *HOME* screen, enter the Fast Key sequence "Digital-to-Analog Trim". Select **OK** after setting the control loop to manual, see "Setting the loop to manual" on page 4.
2. For 4–20 mA HART output, connect a reference meter to the transmitter by either connecting the meter to the test terminals on the terminal block, or shunting transmitter power through the meter at some point in the loop.

   For 1–5 Vdc Low Power HART output, connect a reference meter to the V_{out} terminal.
3. Select **OK** after connecting the reference meter.
4. Select **OK** at the *SETTING FLD DEV OUTPUT TO 4 MA (1 Vdc)* prompt. The transmitter outputs 4.0 mA.
5. Record the actual value from the reference meter, and enter it at the *ENTER METER VALUE* prompt. The Field Communicator prompts you to verify whether or not the output value equals the value on the reference meter.
6. Select **1: Yes,** if the reference meter value equals the transmitter output value, or **2: No** if it does not.
   a. If 1 is selected: Yes, proceed to Step 7.
   b. If 2 is selected: No, repeat Step 5.
7. Select **OK** at the *SETTING FLD DEV OUTPUT TO 20 MA (5 Vdc)* prompt, and repeat steps 5 and 6 until the reference meter value equals the transmitter output value.
8. Select **OK** after the control loop is returned to automatic control.

AMS Device Manager

1. Right click on the device and select **Calibrate**, then **D/A trim** from the menu.
2. Select **Next** after setting the control loop to manual.
3. Select **Next** after connecting the reference meter.
4. Select **Next** at the *Setting fld dev output to 4 mA (1 Vdc)* screen.
5. Record the actual value from the reference meter, and enter it at the *Enter meter value* screen and select **Next**.
6. Select **Yes**, if the reference meter value equals the transmitter output value, or **No** if it does not. Select **Next**.
   a. If Yes is selected, proceed to Step 7.
   b. If No is selected, repeat Step 5.
7. Click **Next** at the *Setting fld dev output to 20 mA (5 Vdc)* screen.
8. Repeat steps 5–6 until the reference meter equals the transmitter output value.

9. Select **Next** to acknowledge the loop can be returned to automatic control.
10. Select **Finish** to acknowledge the method is complete.

4.4.2 Digital-to-Analog trim using other scale

The scaled D/A trim command matches the 4 and 20 mA (1 and 5 Vdc) points to a user selectable reference scale other than 4 and 20 mA (i.e. 2 to 10 volts if measuring across a 500 ohm load, or zero to 100 percent if measuring from a Distributed Control System [DCS]). To perform a scaled D/A trim, connect an accurate reference meter to the transmitter and trim the output signal to scale, as outlined in the output trim procedure.

Note
Use a precision resistor for optimum accuracy. If you add a resistor to the loop, ensure that the power supply is sufficient to power the transmitter to a 20 mA output with additional loop resistance. Refer to "Power supply for 4-20 mA HART" on page 48.

Field Communicator

Traditional 4–20 mA Fast Keys	1, 2, 3, 2, 2
Traditional 1–5 Vdc Fast Keys	1, 2, 3, 2, 2
Device Dashboard Fast Keys	3, 4, 2

AMS Device Manager

1. Right click on the device and select **Calibrate**, then **Scaled D/A trim** from the menu.
2. Select **Next** after setting the control loop to manual.
3. Select **Change** to change scale, select **Next**.
4. Enter Set scale-Lo output value, select **Next**.
5. Enter Set scale-Hi output value, select **Next**.
6. Select **Next** to proceed with Trim.
7. Select **Next** after connecting the reference meter.
8. Select **Next** at the *Setting fld dev output to 4 mA* screen.
9. Record the actual value from the reference meter, and enter it at the *Enter meter value* screen and select **Next**.
10. Select **Yes**, if the reference meter value equals the transmitter output value, or **No** if it does not. Select **Next**.
    a. If Yes is selected, proceed to Step 11.
    b. If No is selected, repeat Step 9.
11. Select **Next** at the *Setting fld dev output to 20 mA* screen.
12. Repeat steps 9–10 until the reference meter equals the transmitter output value.
13. Select **Next** to acknowledge the loop can be returned to automatic control.
14. Select **Finish** to acknowledge the method is complete.

4.4.3 Recall factory trim—analog output

The recall factory trim—analog output command allows the restoration of the as-shipped factory settings of the analog output trim. This command can be useful for recovering from an inadvertent trim, incorrect plant standard or faulty meter. This command is only available with 4-20 mA output.

Field Communicator

Traditional 4–20 mA Fast Keys	1, 2, 3, 4, 2
Device Dashboard Fast Keys	3, 4, 3

AMS Device Manager

1. Right click on the device and select **Calibrate**, then **Recall Factory Trim** from the menu.
1. Select **Next** after setting the control loop to manual.
2. Select **Analog output trim** under *Trim to recall* and select **Next**.
3. Select **Next** to acknowledge restoration of trim values is complete.
4. Select **Next** to acknowledge the loop can be returned to automatic control.
5. Select **Finish** to acknowledge the method is complete.

4.5 Sensor trim

4.5.1 Sensor trim overview

Trim the sensor using either sensor or zero trim functions. Trim functions vary in complexity and are application-dependent. Both trim functions alter the transmitter's interpretation of the input signal.

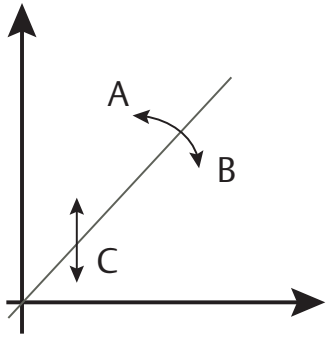
Zero trim is a single-point offset adjustment. It is useful for compensating for mounting position effects and is most effective when performed with the transmitter installed in its final mounting position. Since this correction maintains the slope of the characterization curve, it should not be used in place of a sensor trim over the full sensor range.

When performing a zero trim, ensure that the equalizing valve is open and all wet legs are filled to the correct levels.

Note
Do not perform a zero trim on Rosemount 3051T Absolute Pressure Transmitters. Zero trim is zero based, and absolute pressure transmitters reference absolute zero. To correct mounting position effects on a Rosemount 3051T Absolute Pressure Transmitter, perform a low trim within the sensor trim function. The low trim function provides an offset correction similar to the zero trim function, but it does not require zero-based input.

Sensor trim is a two-point sensor calibration where two end-point pressures are applied, and all output is linearized between them. Always adjust the low trim value first to establish the correct offset. Adjustment of the high trim value provides a slope correction to the characterization curve based on the low trim value. The trim values allow you to optimize performance over your specified measuring range at the calibration temperature.

Figure 4-3. Sensor Trim



A. Upper sensor trim
B. Sensor characterization curve
C. Lower sensor trim

4.5.2 Zero trim

Note
The transmitter PV at zero pressure must be within three percent of URL in order to calibrate using the zero trim function.

Field Communicator

Traditional 4–20 mA Fast Keys	1, 2, 3, 3, 1
Traditional 1–5 Vdc Fast Keys	1, 2, 3, 3, 1
Device Dashboard Fast Keys	3, 4, 1, 3

Calibrate the sensor with a Field Communicator using the zero trim function as follows:

1. Vent the transmitter and attach a Field Communicator to the measurement loop.
2. From the *HOME* screen, follow the Fast Key sequence “Zero Trim”.
3. Follow the commands provided by the Field Communicator to complete the zero trim adjustment.

AMS Device anager

1. Right click on the device and select **Calibrate**, then **Zero trim** from the menu.
2. Select **Next** after setting the control loop to manual.
3. Select **Next** to acknowledge warning.
4. Select **Next** after applying appropriate pressure to sensor.
5. Select **Next** to acknowledge the loop can be returned to automatic control.
6. Select **Finish** to acknowledge the method is complete.

4.5.3 Sensor trim

Note
Use a pressure input source that is at least four times more accurate than the transmitter, and allow the input pressure to stabilize for ten seconds before entering any values.

Field Communicator

Traditional 4–20 mA Fast Keys	1, 2, 3, 3
Traditional 1–5 Vdc Fast Keys	1, 2, 3, 3
Device Dashboard Fast Keys	3, 4, 1

To calibrate the sensor with a Field Communicator using the sensor trim function, perform the following procedure:

1. Assemble and power the entire calibration system including a transmitter, Field Communicator, power supply, pressure input source, and readout device.
2. From the *HOME* screen, enter the Fast Key sequence under "Sensor Trim".
3. Select **2: Lower sensor trim**. The lower sensor trim value should be the sensor trim point that is closest to zero.

Examples:

Calibration: 0 to 100 inH_2O – lower trim = 0, upper trim = 100

Calibration: –100 to 0 inH_2O – lower trim = 0, upper trim = –100

Calibration: –100 to 100 inH_2O – lower trim = -100 or 100, upper trim = –100 or 100

Note
Select pressure input values so that lower and upper values are equal to or outside the 4 and 20 mA (1 and 5 Vdc) points. Do not attempt to obtain reverse output by reversing the high and low points. This can be done by going to "Rerange" on page 17 of Section 2: Configuration. The transmitter allows approximately five percent deviation.

4. Follow the commands provided by the Field Communicator to complete the adjustment of the lower value.
5. Repeat the procedure for the upper value, replacing **2: Lower sensor trim** with **3: Upper sensor trim** in Step 3.

AMS Device Manager

1. Right click on the device and select **Calibrate**, then **Sensor trim** from the menu.
2. Select **Lower sensor trim**. The lower sensor trim value should be the sensor trim point that is closest to zero.
3. Select **Next** after setting the control loop to manual.
4. Select **Next** after applying appropriate pressure to sensor.
5. Select **Next** to acknowledge the loop can be returned to automatic control.
6. Select **Finish** to acknowledge the method is complete.
7. Right click on the device and select **Calibrate**, select **Sensor trim** from the menu.
8. Select **Upper sensor trim** and repeat Step 6.

4.5.4 Recall factory trim—sensor trim

The recall factory trim—sensor trim command allows the restoration of the as-shipped factory settings of the sensor trim. This command can be useful for recovering from an inadvertent zero trim of an absolute pressure unit or inaccurate pressure source. This command is only available with 4-20 mA output.

Field Communicator

4–20 mA Fast Keys	1, 2, 3, 4, 1
Device Dashboard Fast Keys	3, 4, 3

AMS Device Manager

1. Right click on the device and select **Calibrate**, then **Recall Factory Trim** from the menu.
2. Select **Next** after setting the control loop to manual.
3. Select **Sensor trim** under *Trim to recall* and click **Next**.
4. Select **Next** to acknowledge restoration of trim values is complete.
5. Select **Next** to acknowledge the loop can be returned to automatic control.
6. Select **Finish** to acknowledge the method is complete.

4.5.5 Line pressure effect (range 2 and 3)

The following specifications show the static pressure effect for the Rosemount 3051Range 2 and Range 3 Pressure Transmitters used in differential pressure applications where line pressure exceeds 2000 psi (138 bar).

Zero effect

±0.1% of the upper range limit plus an additional ±0.1% of upper range limit error for each 1000 psi (69 bar) of line pressure above 2000 psi (138 bar).

Example: Line pressure is 3000 psi (207 bar) for Ultra performance transmitter. Zero effect error calculation:

$\pm\{0.05 + 0.1 \times [3 \text{ kpsi} - 2 \text{ kpsi}]\} = \pm 0.15\%$ of the upper range limit

Span effect

Refer to "Line pressure effect per 1000 psi (6,9 MPa)" on page 91.

4.5.6 Compensating for line pressure

Rosemount 3051 Range 4 and 5 Pressure Transmitters require a special calibration procedure when used in differential pressure applications. The purpose of this procedure is to optimize transmitter performance by reducing the effect of static line pressure in these applications. The differential pressure transmitters (Ranges 1, 2, and 3) do not require this procedure because optimization occurs in the sensor.

Applying high static pressure to Rosemount 3051 Range 4 and 5 Pressure Transmitters causes a systematic shift in the output. This shift is linear with static pressure; correct it by performing the sensor trim procedure on page 73.

The following specifications show the static pressure effect for Rosemount 3051 Range 4 and 5 Transmitters used in differential pressure applications:

Zero effect

±0.1% of the upper range limit per 1000 psi (69 bar) for line pressures from 0 to 2000 psi (0 to 138 bar)

For line pressures above 2000 psi (138 bar), the zero effect error is ±0.2% of the upper range limit plus an additional ±0.2% of upper range limit error for each 1000 psi (69 bar) of line pressure above 2000 psi (138 bar).

Example: Line pressure is 3000 psi (3 kpsi). Zero effect error calculation:

± {0.2 + 0.2 mm×[3 kpsi – 2 kpsi]} = ±0.4% of the upper range limit

Span effect

Correctable to ±0.2% of reading per 1000 psi (69 bar) for line pressures from 0 to 3626 psi (0 to 250 bar)

The systematic span shift caused by the application of static line pressure is –1.00% of reading per 1000 psi (69 bar) for Range 4 transmitters, and –1.25% of reading per 1000 psi (69 bar) for Range 5 transmitters.

Use the following example to compute corrected input values.

Example

A Range 4 transmitter with model number 3051_CD4 will be used in a differential pressure application where the static line pressure is 1200 psi (83 bar). The transmitter output is ranged with 4 mA at 500 inH_2O (1.2 bar) and 20 mA at 1500 inH_2O (3.7 bar).

To correct for systematic error caused by high static line pressure, first use the following formulas to determine corrected values for the low trim and high trim.

Low trim value

LT = LRV - (S/100 × P/1000 × LRV)

Where:	LT =	Corrected low trim value
	LRV =	Lower range value
	S =	Span shift per specification (as a percent of reading)
	P =	Static line pressure in psi

In this example:

LRV =	500 inH_2O (1.24 bar)
S =	-1.00%
P =	1200 psi
LT =	500 inH_2O - (-1%/100 ×1200 psi/1000 × 500 inH_2O)
LT =	506 inH_2O

High trim value

HT = (URV - (S/100 × P/1000 ×URV)

Where:	HT =	Corrected high trim value
	URV =	Upper range value
	S =	Span shift per specification (as a percent of reading)
	P =	Static line pressure in psi

In this example:

URV =	1500 inH_2O (3.74 bar)
S =	–1.00%
P =	1200 psi
HT =	1500 – (–1%/100 × 1200 psi/1000 × 1500 inH_2O)
HT =	1518 inH_2O

Complete the sensor trim procedure as described on page 73. In the example above, at step 4, apply the nominal pressure value of 500 inH_2O. However, enter the calculated correct lower trim (LT) value of 506 inH_2O with the Field Communicator. Repeat the procedure for the upper value.

Note
The range values for the 4 and 20 mA (1 and 5 Vdc) points should be at the nominal URV and LRV. In the example above, the values are 1500 inH_2O and 500 inH_2O respectively. Confirm the values on the *HOME* screen on the Field Communicator. Modify, if needed, by following the steps in the "Rerange" on page 17.