Primozone®

OPERATION & INSTALLATION MANUAL

PRIMOZONE® GM1-4 3.0 OZONE GENERATOR

Software version 2.0

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NOTE: Check your local regulations for any restrictions on ozone generators, power connections/regulation etc.

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CE Declaration

Declaration of Conformity

CE

EC Declaration of Conformity

We, **Primozone Production AB, Terminalvägen 2, S-246 42 Sweden**

herewith declare that the Product

Product: Ozone Generator
GM1-3.0, GM2-3.0,
GM3-3.0, GM4- 3.0,
GM1-3.0 EXT, GM2-3.0 EXT,
GM3-3.0 EXT, GM4- 3.0 EXT

Brand name: Primozone® GM1-GM4 3.0

Primozone® GM1-GM4 3.0 EXT

Article numbers: 102082, 102083, 102084, 102085
102086, 102087, 102088, 102089

to which this declaration relates is in conformity with the provisions of the following EC Directives:

Machine Directive 2006/42/EC

Low Voltage Directive 2014/35/EC

Electromagnetic Compatibility Directive 2014/30/EC

and that the standards and/or technical specifications referenced overleaf on page 2 have been applied

The signatories are acting on behalf of and with the power of the attorney of the company management.

Löddeköpinge, December 16, 2020

Mikael Scott

Teknisk Chef

Declaration of Conformity

Manufacturer: Primozone Production AB

Product: Primozone® Ozone Generator
Type: GM1-3.0, GM2-3.0,
GM3-3.0, GM4- 3.0,
GM1-3.0 EXT, GM2-3.0 EXT,
GM3-3.0 EXT, GM4- 3.0 EXT

Reference of standards and/or technical specifications applied for this EC Declaration of Conformity, or parts thereof:

Harmonized standards:

Standard No	Subject	Supporting document
EN 60204-1:2016	• Safety of machinery – Electrical equipment of machines – Part 1: General requirements	• Final product test and verification GM1-GM4 3.0.docx
Emission: EN 55011A:2016 + A1:2017 EN 61000-3-2:2014, EN 61000-3-3:2013 Immunity: EN 61000-6-2:2005, EN 61000-4-2, -3, -4, -5, -6, -8, -11	• EMC Emission & Imunnity for industrial enviroments	• EMC test report • Report No 20034 • KEMET Electronics AB
EN 9614-1:2009	• Acoustics — Determination of sound power levels of noise sources using sound intensity — Part 1: Measurement at discrete points.	• dB-test GM1-4. docx
EN 60529:1991 + A1:2000 + A2:2013.IEC 60529:1989 + A1:1999 + A2:2013.	• Classification of degree of protection provided by enclosure.	• Report • Report Ref.No 9F011102 • RISE Research Institute of Sweden AB
EN 61558-1:2005 EN 61558-2-16:2009	• Safety of power transformers, power supply units and similar Part1: General requirements and tests	• Intertek Semko AB • Verificate Report No. 1308754-1
EN 1050: 1997	• Safety of machinery – Principles of risk assessment	• RA GM1-GM4 3.0.docx

Table of Contents

1 Safety Precautions

1.1 Working Precautions

All personnel must read and understand the safety precautions before installing or operating ozone systems, i.e. ozone generator modules (GM) and GM peripherals.

NOTE! In addition to the instructions and guidelines in this manual, make sure to follow all local safety regulations.

1.1.1 Warning Signs Related to Work Safety

This manual contains precautionary messages of two different levels of severity: warning and caution. The following examples display the appearance of these two messages, respectively:

WARNING

It is mandatory to follow the instructions of a warning message. Failure to do so may cause severe injury or death to personnel.

CAUTION

It is mandatory to follow the instructions of a caution message. Failure to do so may cause injury to personnel or severe damage to the equipment.

1.2 Electricity

The GM1-4 has an input voltage of 230 V, 50/60 Hz.

WARNING: HIGH VOLTAGE

Unauthorized personnel may not touch the inner components of the GM. Physical contact with electrical parts can cause severe injury or death.

Personnel trained in installation by Primozone may perform work on the inner components of the GM. The lockable main power switch must be locked in the 0 position during installation.

WARNING: TURN OFF THE LOCKABLE MAIN POWER SWITCH

Do not open the door of the ozone generator unless the main power switch has been turned OFF and locked.

Lock the main power switch in OFF position before any work on the electrical components is started.

Figure 1 | Main Power Switch

CAUTION

Do not open the ozone generator unless trained by Primozone personnel or in possession of written authorization.

1.3 Chemical Precautions

WARNING: OXIDIZING

May cause or intensify fire; oxidizer.
May cause fire or explosion; strong oxidizer.

WARNING: ACUTE TOXICITY

Toxic if swallowed.
Toxic in contact with skin.
Toxic if inhaled.

WARNING: HEALTH HAZARD

May cause respiratory, reproductive or organ toxicity that causes damage over time (a chronic, or long-term, health hazard).

1.3.1 Oxygen

Oxygen (ICSC no. 0138) is a colorless, odorless and tasteless gas. The risk of fire is increased if there is a leakage of oxygen from the system. If an oxygen leak is detected, make sure to minimize the risk of sparks or open flames, ventilate the area, and seek service personnel.

High oxygen concentration can cause oil and grease to spontaneously combust.

WARNING: OXIDIZING

May cause fire or explosion; strong oxidizer. Keep away from open flames and combustible materials.

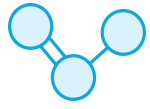
1.3.2 Ozone

Ozone (ICSC no. 0068) is a pale blue gas with a characteristic odor. It is highly reactive and can cause harm to the skin and respiratory organs. An Ozone Material Safety Data Sheet can be found at:

www.primozone.link/o3safety

WARNING: TOXIC GAS

Ozone is a toxic gas. Do not inhale ozone. Do not eat, drink or smoke when using ozone equipment.



WARNING: OXIDIZING

May cause fire or explosion; strong oxidizer. Keep away from open flames and combustible materials.

WARNING: HEALTH HAZARD

Ozone causes damage to the lungs through prolonged or repeated exposure if inhaled.

OZONE ALARM

Install an ozone sensor within 2 meters of the ozone generator. Ensure good ventilation. See "3.9 Installation of External Gas Alarm" ▶ 20 for more information about the ozone alarm.

The human nose can detect ozone in the air at concentrations above 0.02 ppm. At 5 ppm, ozone may be directly lethal. Any off-gas from an ozonation process, that potentially could contain ozone, should be taken care of responsibly by installing a Primozone ozone destruct system, or equivalent.

If breathing issues arise in presence of ozone, please:

- Seek medical assistance.
- Ensure that the affected person has access to fresh air and remains at rest in a comfortable position for breathing.

2 Introduction

2.1 Manual Contents

This manual covers installation and daily operation of the GM. Permission levels of GM usage are described in *Table 1* ▶ 11.

Table 1 | Usage permissions of the Primozone GM.

	1	2	3	4
Training	✓	✗	✗	✗
Service	✓	✗	✗	✗
Access to service settings	✓	✓	✗	✗
Installation	✓	✓	✗	✗
Access to ozone settings	✓	✓	✓	✗
Ozone production	✓	✓	✓	✗

1. *Personnel approved in Service training by Primozone*
2. *Personnel approved in Commissioning training by Primozone*
3. *Personnel approved in Operation training by Primozone (Operators)*
4. *Untrained personnel*

2.1.1 Additional Features

Applies only to machines with certain add-ons.

Certain sections of the manual are enclosed in boxes with green dashed lines, as exemplified here. This indicates that the information applies only to GMs with certain added features.

2.1.2 Date of Publication

This manual was published 31 Jan 2024.

2.2 Purpose

The Primozone® GM is a series of high-performance ozone generators which use oxygen to produce ozone. Ozone is a highly oxidative agent which can be used in a wide field of applications.

2.3 Basic Design

The GM1-4 is available in four models. The number in the product name denotes its number of reactors: GM1, GM2, GM3, and GM4.

2.3.1 Ozone Reactor

The Primozone ozone reactors are cylindrical aluminum blocks mounted inside the generators. The reactors enclose small electrical discharges which continuously convert part of the inlet oxygen into ozone.

CAUTION: RISK OF MOISTURE

Ozone reactors are extremely sensitive to moisture. Even small amounts of water during operation are likely to damage the internal surfaces of the reactors beyond repair.

If the GM is connected to a water dissolution system, it is highly recommended to use a Primozone Back Flow Protector (BFP).

2.3.2 MiniSEPT

The mini Self-regulating Electrical Power Transformer – abbreviated as MiniSEPT – is a compact power supply which regulates the power needed for the electrical discharges inside an ozone reactor. Each ozone reactor inside the GM is paired with one MiniSEPT, which allows for redundancy in case of hardware failure.

2.3.3 Steel Chassis

Only personnel who have completed Service or Commissioning training by Primozone may open the chassis.

2.3.4 Control Interface

A Human-Machine Interface (HMI) in the form of a touch screen is used to control the GM. The HMI is located on the front of the GM.

2.3.5 Miscellaneous Internal Components

A selection of internal components of the GM includes a programmable logic controller (PLC), a mass flow controller (MFC), a pressure sensor, two temperature sensors and a set of circuit breakers.

2.3.6 Generator Cooling

To dissipate heat produced during ozone generation, a cooling system carries **coolant** into and out of the ozone generator. The coolant consists of 70 % water and 30 % ethylene glycol.

NOTE: The term "cooling water" in earlier Primozone® documentation or equipment labeling refers to coolant.

2.4 Ozone Productivity

Two specific parameters control the GM ozone production rate: concentration and capacity. For a table listing the ozone productivity of the generators, see 7.5 ▶ 38.

Ozone productivity (measured in grams per hour) and ozone concentration (measured in grams per normal cubic meter) counteract each other. This is because a high concentration of ozone requires a long retention time inside the ozone reactor, and thus a lower flow of oxygen passing through the reactor. In addition, the rate of conversion from oxygen into ozone will be the highest if the reactor is not already saturated by ozone.

2.4.1 Gas Properties

Volumetric gas flows are often presented in the software and the documentation for the GM. The physical properties of these gases are normalized at 0 °C (32 °F) and atmospheric pressure.

3 Installation of the Primozone® GM

3.1 Connections Summary

In short, the GM needs the following five connections to work:

- Inlet oxygen
- Outlet ozone
- Inlet coolant
- Outlet coolant
- Electricity

Additionally, a signal cable is needed if the GM is operated through an external control system.

3.2 Environmental Requirements

The GM is sensitive to moisture in the form of condensate, which may be caused by a combination of high relative air humidity, and cold surface temperature. Place the GM where the prerequisites listed in *Table 2* ► 13 are met. These requirements are especially important if the cabinet door is open during installation or maintenance.

Table 2 | Environmental requirements

Air humidity	Maximum 70 % relative humidity
Air temperature (min)	5 °C (41 °F)
Air temperature (max)	40 °C (104 °F)
Air quality	The air may not contain conductive materials (for example salt or iron powder) or large amounts of dust

3.2.1 Condensation Management

To ensure that condensation does not occur despite fulfillment of specified requirements for humidity and temperature, it is crucial to consider the coolant temperature in relation to the dew point. The dew point represents the temperature at which the air becomes saturated with moisture, and as a result, condensation can occur.

3.2.2 Actions in Case of Condensation

If condensation is observed despite fulfillment of specified requirements for humidity and temperature, immediate measures must be taken to eliminate the condensation. This may include adjustments to the coolant temperature or implementation of additional dehumidification systems to maintain a safe working environment and prevent damage to equipment.

3.2.3 Dew-point Calculation

Primozone recommends regular monitoring of the dew point in relation to the coolant temperature to identify potential risks for condensation. The dew point can be easily calculated using online calculators or specific equipment that measures humidity and temperature.

3.2.4 Dew Point below Coolant Temperature

To prevent condensation, the dew point must always be kept below the temperature of the coolant. This requires careful monitoring and, when necessary, adjustment of system parameters.

3.3 Additional Required Equipment

A functional and safe Primozone ozone production system requires the following components in addition to the GM:

- One or two pressure regulators:
  - One pressure regulator to ensure that the inlet oxygen is kept at ~2.5 bar (36 psig).
  - One additional pressure regulator, **if** pressure fluctuations exceed ~1.0 bar (15 psig) (see *Figure 4* ▶ 16).
- Two filters:
  - One 0.10-micrometer oxygen filter.
  - One 0.010-micrometer oxygen filter.
- Clean, flexible PTFE hoses for upstream and downstream gas.
- Two gas valves for pressure tests.
- PTFE seal tape for thread connectors.
- A water valve and hoses for coolant.
- A visible and audible ozone alarm.
- A power cable.

3.4 Positioning

Well in advance of GM positioning, a suitable location must be arranged, including the following:

1. A smooth, level, and stable surface
2. Sufficient free space around the GM for ease of service

Weights are listed in 7.1 ▶ 37. Please follow local work-environment regulations. For detailed measurements, see 7.12 ▶ 42.

3.4.1 Wall mounting

1. Mount the two mounting brackets on the wall according to the metrics displayed in *Figure 2* ▶ 14. The diameter of the bolt holes is 11 mm.

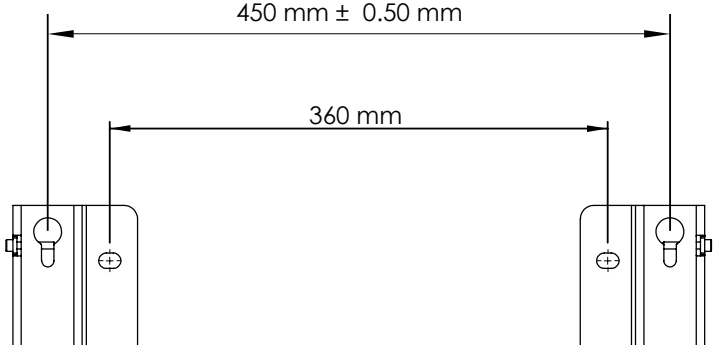


Figure 2 | *The distances between the mounting brackets.*

2. Hang the GM on the brackets using the four knobs on its back.
3. Secure the upper knobs of the GM to the bracket using the two included screws.

4. Remove the feet of the GM. Removing the GM feet will not affect the GM's IP class.

3.5 Installation of the Gas Line

3.5.1 General Instructions for Oxygen/ozone Gas-line Installation

- **In addition to the recommendations made by Primozone, use as few connectors as possible to prevent leakage.**
- Use **cone-shaped** and not cylinder-shaped male connectors (ISO-7).
- *Figure 3* ▶ 15 displays how PTFE seal tape should be applied to the connectors. The two innermost threads should be left unwrapped, to minimize the risk of PTFE tape entering the gas stream.
- It is recommended to install a valve at the GM inlet and one valve at the GM outlet, to simplify pressure measurements during maintenance.

Figure 3 | PTFE tape.

Conduct a leakage test after the gas line has been installed and pressurized.

WARNING: RISK OF LEAKAGE

Pressurized gas streams run the risk of leaking. Seal the connectors properly.

3.5.2 Upstream Installation

Technical specifications for the oxygen line are listed in 7.3 ▶ 37. A schematic of the upstream operations of a GM is displayed in *Figure 4* ▶ 16. Follow the instructions below regarding upstream equipment:

1. To ensure high inlet-oxygen quality, connect two filters between the oxygen source and the GM. It is required to use both a 0.10-µm and a 0.010-µm filter.
2. Install a pressure regulator after the filters and before the GM.
3. Install one valve near the GM inlet to allow for pressure tests. The pressure at this point should be 2.5 to 2.9 bar(g).
4. If pressure fluctuations of more than 1 bar (14 psig) occur, install an additional pressure regulator before the filters, as displayed in *Figure 4* ▶ 16.
5. If the system uses a Primozone® LOX Booster or other nitrogen blending equipment, its gas should enter the oxygen stream in a way to ensure that the gas passes through **both** filters.

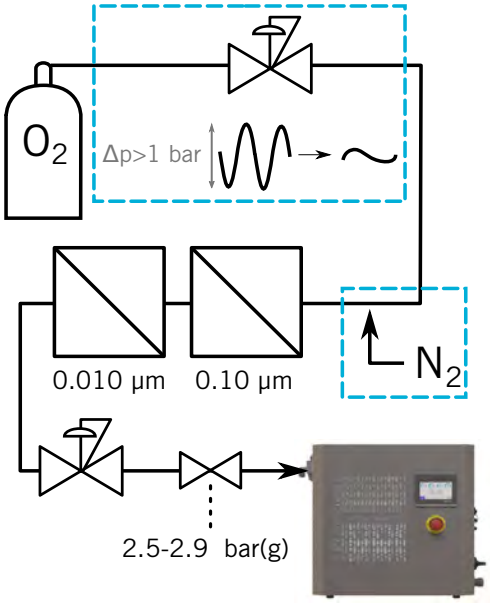


Figure 4 | Schematic overview of an oxygen line of a GM. The blue dashed lines signify optional or situational equipment.

3.5.3 Downstream Installation

- As in the case of the upstream line, it is recommended to position any valve for pressure tests close to the ozone outlet of the GM. Otherwise, use as few connectors as possible.
- If water is being treated, ensure that water cannot flow backward into the GM. See 3.8.3 ► 20 for more information.

3.5.4 Connecting Gas Lines to the GM

GM1-4 comes with a short piece of 8/6 mm hose, connected to the gas inlet and outlet. It is important that the GM **does not remain exposed** to the open atmosphere, because there is a risk that moisture and particles can enter the reactors. Hence, the O_2 and O_3 lines should be fully assembled before they are connected to the ports of the GM.

1. Assemble all necessary upstream accessories according to *Figure 4* ► 16.
2. Assemble all necessary downstream accessories.
3. **Purge the upstream line for a few seconds.** Ensure safe ventilation of oxygen during purging.

CAUTION: REACTOR DAMAGE
The ozone reactors are very sensitive to dust and moisture. Failing to purge the oxygen line before installation may result in serious damage to the ozone reactors.

4. After purging, immediately loosen the nuts from the gas connectors and discard the short piece of hosing.
5. Slip one nut onto the upstream hose.
6. Press the upstream hose onto the coupling on the connector labeled O2 IN. Fasten the nut.
7. Slip one nut onto the downstream hose.
8. Press the downstream hose onto the coupling on the connector labeled O3 OUT. Fasten the nut.
9. If needed, install ozone sampling (see 3.5.5 ► 17). Finally, pressurize the gas stream.

3.5.5 Ozone Sampling (Optional)

If continuous ozone concentration measurements are needed, it possible to connect a third 1/4" hose in between the IN and OUT connectors. The pressure at the O_3 sample connection is not regulated from the GM.

3.6 Coolant-line Installation

1. Follow the installation instructions for the cooling system.
2. Connect the inlet-water hose to the inlet-water line connector on the GM.
3. Connect the outlet-water hose to the outlet-water line connector on the GM.

IT IS VERY IMPORTANT THAT THE GAS LINE IS PURGED AND PRESSURIZED BEFORE THE COOLANT LINE IS FILLED, TO PREVENT CONDENSED WATER INSIDE THE CABINET.

4. Open the bleed valve near the inlet-coolant port, and fill the coolant line with an ethylene glycol/water mixture until no air bubbles remain. Coolant characteristics must meet the specifications listed in 7.6 ▶ 39.
5. Perform a leakage test to ensure that water cannot exit the coolant line.

If any part of the coolant line is located at a higher point than the bleed valve, an additional bleed valve must be installed at line's highest point as described in *Figure 5* ▶ 17. Failure to do so will lead to air bubbles in the coolant loop, which will in turn lead to reduced cooling performance.

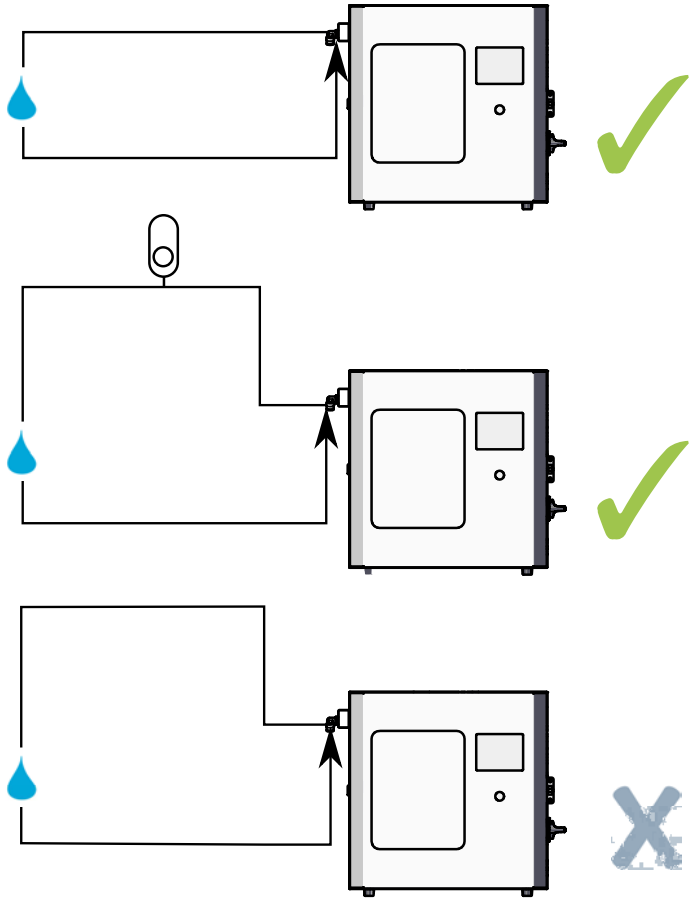


Figure 5 | The built-in bleed valve or an added bleed valve must be located at the highest point in the coolant line.

3.6.1 Important: Proper Treatments for Coolant

To ensure prolonged and reliable performance from your product, it is crucial to use appropriate coolant treatments. Primozone strongly recommends implementing the following measures to safeguard your investment and extend the lifespan of your Primozone equipment.

Filtration

The use of a high-efficiency filter in the cooling system helps remove particles and debris from the coolant. This reduces the risk of clogging in the system components and enhances overall system efficiency.

Corrosion Inhibitor

Add a corrosion inhibitor to the coolant to suppress corrosion and maintain optimal performance. Corrosion inhibitors protect the metal components of the cooling system, thereby extending the lifespan of the unit.

NOTE: Failure to use suitable filtration and corrosion protection can result in dirty coolant and corrosion, potentially causing damage to your Primozone equipment and reducing its effectiveness.

3.6.2 Water Valve

During periods when the GM is inactive, cold temperatures may cause water vapor to condense inside the cabinet of the GM. As a precaution, it is recommended to equip the cooling line with a water valve that opens only when the GM is active.

CAUTION: RISK OF CONDENSED WATER

Coolant should run through the GM **only** while ozone production is turned **on**. Otherwise, condensed water can enter the cabinet and cause severe internal damage.

The water valve is installed using an M12 five-pin male connector. The female connector is located on the right side of the GM and is labeled WV Port, from which the GM will constantly output a 24-V DC signal, when the coolant **should** be running.

3.7 Electrical Installation

All electrical installation must be carried out by authorized personnel and according to local regulations.

WARNING: ELECTRICAL HAZARD

The input voltage to the GM is 230 V AC. Physical contact with electrical parts can cause severe injury or death. If an accident occurs, seek medical assistance immediately. More electrical requirements can be found in 7.2 ▶ 37.

3.7.1 Overview of Electrical Components

A schematic diagram of the electrical installation is displayed in *Figure 6* ▶ 19. Power-supply details are listed in 7.2 ▶ 37.

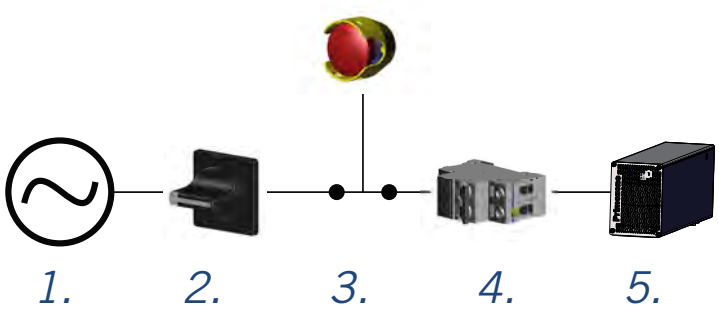


Figure 6 | Schematic diagram of the electrical components. 1. AC Power, 2. Lockable main power switch, 3. Built-in Safety Stop circuit, 4. Internal circuit breakers, 5. MiniSEPT.

3.7.2 Power Supply

Electrical specifications are listed in 7.2 ▶ 37.

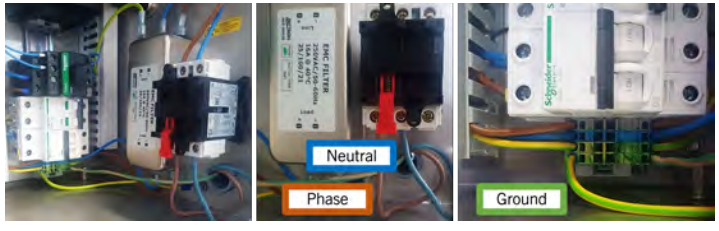


Figure 7 | The connection points of ground, phase and neutral wires (this example uses IEC 60446 color coding).

3.7.3 Lockable Main Power Switch

Lock the main switch in its OFF position during maintenance or installation.

3.7.4 Circuit for Safety Stop

In cases of fire, ozone leakage, or electrical failure, an active GM may pose a serious safety hazard. If such an event occurs, a Safety Stop can be activated by pressing the red button near the HMI.

3.7.5 Final Approval of Electrical Installation

Before the GM is turned on for the first time, the installation should be approved by a certified electrician according to local regulations.

3.8 Optional Cables

To use external I/O control, external Modbus TCP Control or BFP functionality in the GM, the GM must be configured by personnel who have completed Service or Commissioning training from Primozone.

3.8.1 Cable for External Modbus TCP Control

A network cable (not included) is needed if the ozone generator communicates with an overhead system via Modbus TCP Control. The port is located on the right side of the GM and is labeled RJ45 port.

Applies only to machines equipped with External I/O Control.

3.8.2 Cable for External I/O Control

If the GM is controlled using External I/O control, the control device is connected by using an M12 eight-pin male connector (not included).

3.8.3 Back Flow Protector

When the GM is used to ozonate water (or other liquids), it is very important that water/liquid does not propagate back towards the GM. For this type of application, Primozone highly recommends the use of a Primozone Back Flow Protector (BFP).

The BFP is connected using an M12 five-pin male connector. The female connector is located on the right side of the GM and is labeled BFP Port.

The functionality of a BFP should be verified by unplugging and then immediately plugging in the BFP connector again. If a connection has been established, the HMI should display a BFP alarm. The alarm can then be acknowledged. For information on how to dismiss an alarm, see 5.1 ▶ 30.

3.9 Installation of External Gas Alarm

Because ozone poses a safety risk, detection of gas leaks is very important. Follow local regulations. Primozone recommends the following for the installation of an ozone alarm:

- The sensor should be installed max 0.5 m (1'8") above ground level.
- The sensor should be installed max 2 m (6'7") from the GM.
- The alarm should trigger an audible response.
- The alarm should trigger a visible response, such as a flashing light, which should be installed outside the room where the GM is located.
- If an external emergency stop has been installed, it is recommended that it is automatically triggered by a gas alarm. In addition, Primozone recommends installation of a valve at the GM to shut off oxygen flow when a gas alarm is triggered.

It is also recommended that an oxygen alarm is installed.

3.10 Installation Checklist

After installation has been completed, please make sure that the following actions have been carried out:

- The inlet hose for O_2 gas and the outlet hose for O_3 gas are **securely connected** to the ozone system, and two **particle filters and a pressure regulator** must be installed between the oxygen source and the ozone generator.
- The properties of the **oxygen gas** are according to the specifications in 7.3 ▶ 37.
- The inlet and outlet hoses for coolant are **securely connected** to the coolant system.
- The properties of the **coolant** fulfill the specifications in 7.6 ▶ 39.
- **Leakage tests** for gas flow and coolant flow have been carried out and approved.
- An **ozone alarm** should be installed with an ozone sensor at floor level.
- After 200 hours of operation, **leakage tests** are conducted to ensure the system is leak-proof.

4 Operation

4.1 Activating the HMI

After installation is completed, make sure that all requirements listed in 3.10 ▶ 20 are fulfilled.

The PLC will automatically boot. After booting, the Home screen will appear along with a screen selection field at the bottom. Press the **Left** 〈 and **Right** 〉 arrows to navigate between pages.

4.2 Home Screen

The *Home* screen contains basic information on process parameters. Some of the indicators display green or red pointers, which signify set values and alarm limits, respectively.

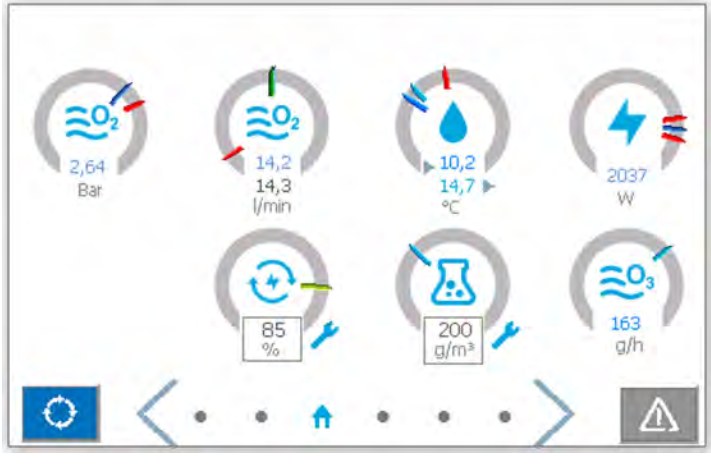


Figure 8 | The Home screen of the GM.

The symbols on the *Home* screen have the following functions:

Table 3 | The symbols on the Home screen.

	Name	Description
	Oxygen pressure Oxygen flow	Readings from the pressure and flow sensors at the GM gas inlet.
	Water temperature	Readings from the inlet and outlet water temperature sensors.
	Power	Power consumption of the GM.
	Remaining ramp-up time and remaining purge volume	The amount of remaining ramp-up time and gas volume of the current purge session. If purging is not ongoing, this indicator will be hidden.
	Capacity (button)	The set capacity of the GM
	Concentration (button)	The set ozone concentration of the GM.
	Gas flow (ODM mode)	(Only ODM mode) The current gas flow processed by the ODM.

4.3 Control Modes

By default, the GM uses Standard Mode to regulate ozone. In addition, the following modes can be activated by personnel who have completed Service or Commissioning training by Primozone.

- Direct Mode 4.3.2 ▶ 22
- I/O External Control (4.3.3 ▶ 22)
- Modbus TCP Control (4.3.4 ▶ 22)
- ODM Mode (4.3.5 ▶ 23)

4.3.1 Editing Values (Standard Mode)

In Standard Mode, a GM is controlled using the following two parameters:

- **Concentration**, which sets the ozone concentration measured in grams of ozone per cubic meter.
- **Capacity**, which scales the ozone productivity at the set concentration. Control ranges can be found in 7.5 ▶ 38.

To change these values, tap their respective icons.

Applies only to machines equipped with Direct Mode.

4.3.2 Editing Values (Direct Mode)

If Direct Mode has been activated in a GM, the Concentration and Capacity indicators will be replaced with:

- The **Power** setting, which sets the total power usage of all MiniSEPTs as a percentage ranging from 20 % to 100 %.
- The **Volume Flow** setting, which sets the flow of oxygen into the GM and is measured in liters per hour.

Direct Mode was previously called Traditional Mode.

Applies only to machines equipped with External I/O Control.

4.3.3 Editing Values (External I/O control)

If External I/O Control has been activated in a GM, the Capacity setting is controlled using only the external input signal, while Concentration can still be set from the HMI. For information on activating and deactivating External Control, see the settings page in 4.8 ▶ 27.

Applies only to machines equipped with Modbus TCP Control.

4.3.4 Editing Values (Modbus TCP Control)

If Modbus TCP Control has been activated in a GM, operation is controlled from the overhead system. In this case, the Home screen is used only for monitoring. For information on activating and deactivating External Control, see the settings page in 4.8 ▶ 27.

Applies only to machines equipped with an ODM.

4.3.5 Editing Values (ODM Mode)

GM units that use the Primozone Ozone Distribution Module (ODM) do not use the capacity setting because this parameter is automatically regulated by the GM. Therefore, if ODM Mode is activated, the **Concentration** gauge is the only parameter that is editable from this screen.

In ODM mode, the GM does not control the flow rate. The GM only detects the flow rate and adjusts the MiniSEPTs to achieve the correct concentration.

In ODM mode, the orange text below the gas flow symbol represents the maximum flow at which the set ozone concentration can be achieved. This limit is also represented by an orange pointer on the gas-flow symbol.

4.4 Basic Operation

The GM works continuously, and can run uninterrupted for as long as it is supplied with power, oxygen and coolant.

4.4.1 Start-up, Pre-purge, and Ramp-up

To start ozone production, press the green **START/STOP** button in the lower left corner. Make sure that all necessary manual shut-off valves for gas or coolant are open.

Before commencing ozone production, the GM needs to be free from moisture. To achieve this, the GM will begin pre-purging by flushing a stream of oxygen through the reactors without powering the MiniSEPTs. The volume needed for pre-purging is displayed below the time symbol on the *Home* screen and is dependent on the GM size, as well as how long the GM has not been used. During pre-purging, the Start/Stop button will flash in green. If the GM has never been used to produce ozone on-site, the GM will start the process using 300 liters of oxygen per reactor.

After pre-purging has finished, the MiniSEPTs will slowly reach their set power over the course of up to two minutes (ramp-up). During this time, the **START/STOP** button will flash in blue (when in local mode, not in remote mode).

4.4.2 Ozone Production

The **START/STOP** button will display rotating arrows on a blue background (when in local mode, not in remote mode) during ozone production. The control parameters for ozone production are further detailed in 4.2 ▶ 21.

4.5 Stopping Ozone Production

Ozone production can be stopped in three different ways:

- Normal shut-down
- Quick stop (in cases when ozone production needs to stop without waiting for post-purging to finish)
- Safety Stop (in cases of emergency)

4.5.1 Normal Shut-down

To stop ozone production, press the **START/STOP** button in the lower left corner, and when a prompt appears, press the check mark symbol . This will cause the GM to enter the post-purging step, during which any remaining ozone is flushed out of the system. The time needed for post-purge is displayed below the timer symbol . During this step, the **START/STOP** button will flash in green .

4.5.2 Quick Stop

In cases when ozone production needs to be shut off quickly, thereby skipping the post-purge step, it is possible to issue a command to shut off the MiniSEPTs immediately.

1. Press the **START/STOP** button.
2. A new window appears. Press the **STOP** button in the lower left corner, as displayed in *4.5.2* ▶ 24.
3. Another window appears, prompting the user to confirm that ozone production should be stopped, which can be done by pressing the check mark symbol .
4. The MiniSEPTs will shut off and the GM will go into standby, skipping the post-purge step. Hence, it is very important to allow the GM to purge as soon as the issue has been remedied. Restart ozone production, as described in 4.4.1 ▶ 23.

Figure 9 | The location of the Quick Stop button.

CAUTION: STAGNANT OZONE

Ozone remains inside the ozone reactors and outlet hoses after a Stopping Alarm, Quick Stop or Safety Stop. Make sure to purge the system as soon as possible.

4.5.3 Safety Stop

The red safety stop (see the example in *Figure 10* ▶ 25) on the GM cuts power to the MiniSEPTs and stops ozone production immediately. Before the ozone generator is restarted after a safety stop, ensure that the cause of the stop has been addressed and rectified.

Figure 10 | Safety stop

USE THE SAFETY STOP ONLY IF THERE IS RISK OF INJURY TO PERSONNEL OR DAMAGE TO THE EQUIPMENT.
DO NOT USE THE SAFETY STOP FOR NORMAL SHUTDOWN.

4.6 Process Screen

The *Process* screen of the HMI contains information about the flows entering and exiting the GM.

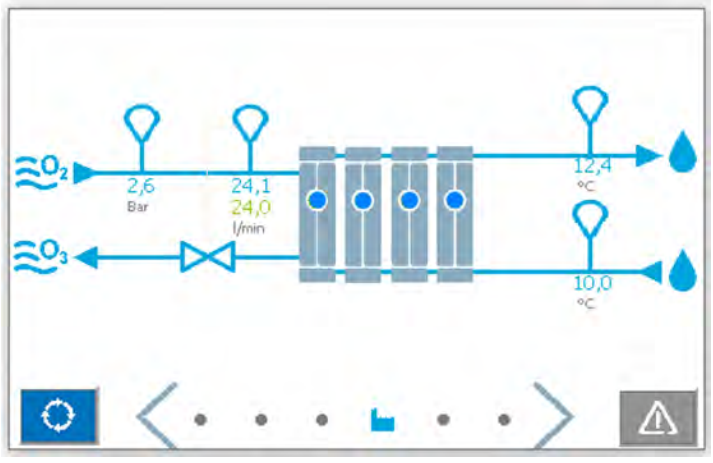


Figure 11 | The Process screen.

The interactive icons on this screen allow the following actions:

- Press any MiniSEPT + reactor to display the unit's technical data.

In addition, the screen contains a number of process indicators:

- The water droplets symbolize the outlet and inlet coolant streams, respectively. These are accompanied by indicators which display their temperature readings. If a water valve is connected (see 3.6.2 ▶ 18), it will be displayed as a second valve symbol ⋈ on the coolant line.

- The inlet pressure and flow for oxygen are displayed in the upper left part of the screen.
- The statuses of the MiniSEPTs are displayed by the colored indicators in the middle of the screen, as displayed in *Figure 12* ▶ 26.
- If a MiniSEPT displays a yellow light, it has encountered an internal error or a communication error. Press the icon of the affected MiniSEPT for more information, or visit the *Alarms* screen.

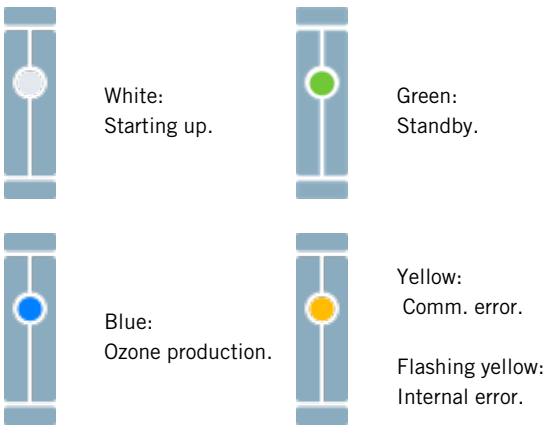


Figure 12 | The colored indicators of the MiniSEPTs.

4.7 Trends Screen

The *Trends* screen of the HMI displays a trend curve for physical parameters.

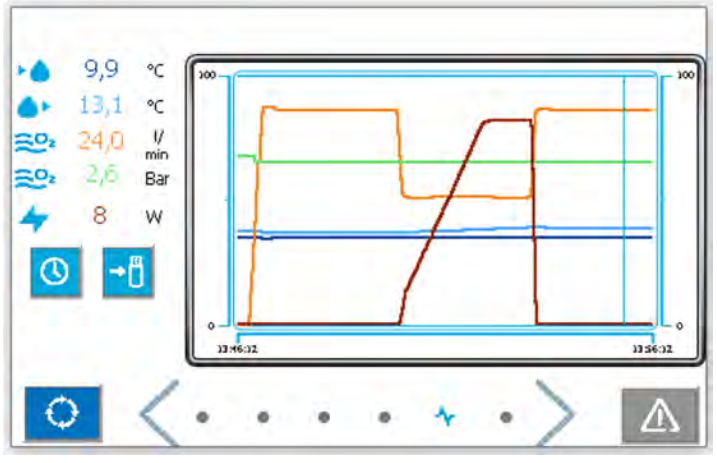


Figure 13 | The Trends screen.

The process parameters displayed in the graph are listed at the upper left, and represent inlet water temperature, outlet water temperature, inlet oxygen flow, inlet oxygen pressure, and total power, respectively.

It is possible to save a log of process data by using the memory symbol. For more information, see 4.7.2 ▶ 27.

4.7.1 Using the Trends Screen

- Press the clock symbol to toggle between displays of current values and historical values.

- While Trends history is active, use the two blue arrow buttons to move in the time line in the current view.

4.7.2 Exporting Process Data

It is possible to save a log file of process data that has been recorded by the GM, as well as a list of logged alarms.

WARNING: HIGH VOLTAGE

To export process data, only the controller unit will need attention. Do not touch any other electrical components.

1. Open the GM and locate the USB slot on the controller unit.
2. Insert a FAT32-formatted USB stick into the slot. If the stick is not formatted as FAT32, it will not be detected by the GM.
3. Press the memory card button to manually record process and alarm log data.
4. Two CSV-formatted log files will be created.

4.8 Settings Screen

The Settings screen of the HMI allows adjustment of various settings (see the example in *Figure 14* ▶ 27).

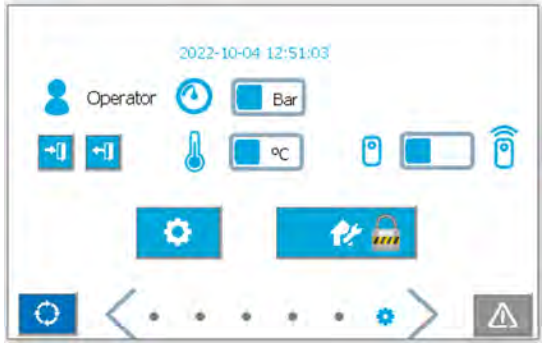


Figure 14 | Settings screen (example image). NOTE: the remote/local toggle ( ) appears only when a remote control mode is selected.

The Settings screen contains the following features:

	Name	Description
	Log in	Leads to a password screen. If valid credentials are entered, Service settings may be accessed.
	Log out	Returns to the default operator credentials.
	Temperature unit	Switch between displaying temperatures in °C or °F.

	Name	Description
	Pressure unit	Switch between displaying pressures in bar or psi(g).
	Toggle Remote Mode	If toggled, ozone amount is controlled from either Modbus TCP Control or External I/O Control.
	Toggle Local Mode	If toggled, ozone amount is controlled from the local HMI.
	Add-ons	Views in which add-ons are activated.

4.9 Force Output Screen

If certain automatic process operations need to be adjusted manually, the user may do so from the *Force output* screen, which is accessed by pressing the oxygen flow ⋈ icons on the *Process* screen.

Forced values will remain active only as long as the *Force output* screen is open.

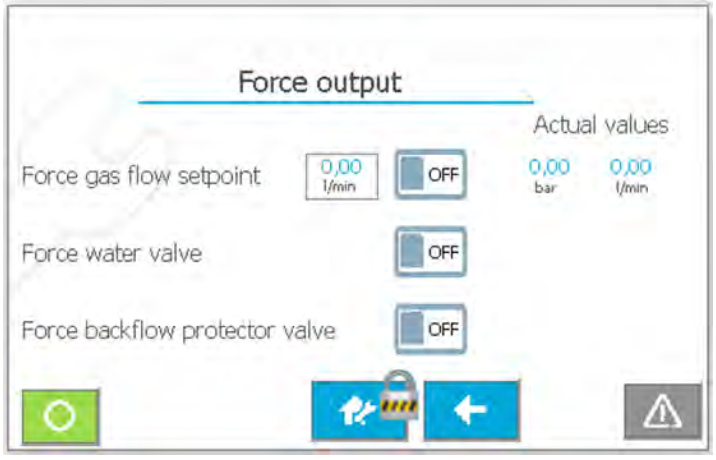


Figure 15 | The Force Output screen.

4.9.1 Forcing the Gas Flow

Force gas flow setpoint may be used to let oxygen flow through the GM without generating ozone. This operation may be used to purge the ozone reactors manually, **which should be done for 90 minutes the first time the GM is started**.

Forcing the gas flow is possible only while ozone production is in standby.

4.9.2 Forcing Open the Water Valve

Force water valve will open the water valve, even if ozone production is in standby.

CAUTION: RISK OF CONDENSED WATER
Coolant should run through the GM **only** while ozone production is turned **on**. Otherwise, condensed water can enter the cabinet and cause severe internal damage.

Note: If the ozone system is not equipped with a water valve/BFP solution, these selections will not be available in the display.

4.9.3 Forcing Open the BFP

Force backflow protector valve will open the BFP valve. This operation should be used only when there is no risk of water entering the GM.

Note: If the ozone system is not equipped with a water valve/BFP solution, these selections will not be available in the display.

5 Software Alarms and Error Handling

The GM uses a series of software alarms that activate when the GM needs special attention. These alarms are visible from the *Home*, *Process* and *Trends* screens in the form of a rectangle in the lower right corner of these screens.

Figure 16 | The location of the alarm symbol.

No alarm is active.

Warning alarm, which should be investigated and corrected.

Stopping alarm, which should be **immediately** investigated and corrected. It is important to note that stopping alarms will immediately stop the gas flow through the ozone reactors, causing ozone to become stagnant inside. Because of this, a stopping alarm must be quickly remedied, and the reactors must then be purged by re-starting ozone production. Failure to do so may cause irreparable damage to the GM.

CAUTION: STAGNANT OZONE

Ozone remains inside the ozone reactors and outlet hoses after a Stopping Alarm, Quick Stop or Safety Stop. Make sure to purge the system as soon as possible.

5.1 Alarm Screen

To view a list of currently active alarms, press the Alarms symbol in the lower right corner of the HMI.

The Alarm screen is illustrated in *Figure 17* ▶ 30.

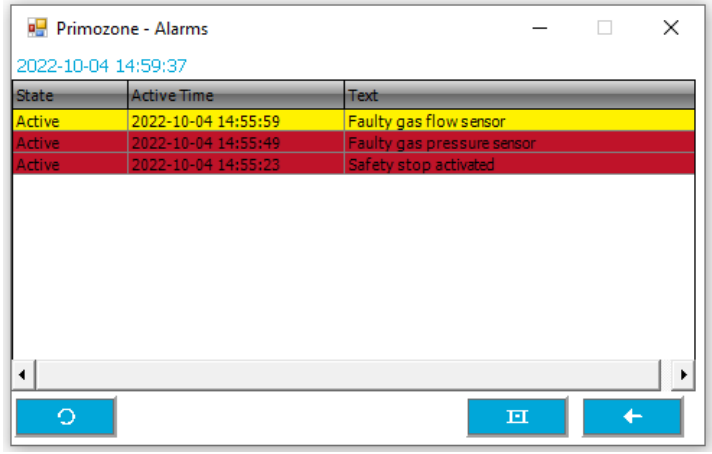


Figure 17 | The Alarm screen.

- The **Reset** button removes all active alarms from the list. If the underlying issue is still present, alarms will reappear.

- The **Back** button exits the Alarm screen.
- The **Alarm history** button toggles between displays of active alarms and the history of alarms.
    - The **Delete All** button deletes all alarms from the history (if Service credentials are active).
    - The **Back** button exits the History screen.

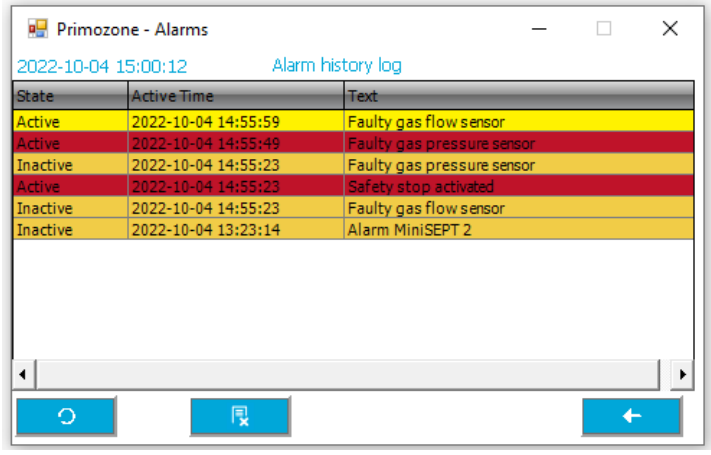


Figure 18 | The Alarm history screen.

5.2 Alarm List

Table 4 | Alarms which generate a stopping alarm.

Alarm	Cause and solution
Water in Back Flow Protector	? Water has entered a BFP, or the GM has encountered a communication error with the BFP. ! Empty the BFP. ! Make sure that the signal cable is securely connected.
Faulty in/out temperature sensor	? The temperature sensor has encountered an error. ! Make sure that the signal cable is securely connected. ! Check the temperature sensor for errors.
High gas pressure	? The inlet gas pressure is higher than 3 bar(g) or 36 psig. ! Make sure that the set point of the pressure regulator is less than the allowed maximum. ! Perform a leakage test after an alarm is triggered for high gas pressure. ! Go to the *Force output* screen and set the *Force gas flow set value* trigger to **On**, to allow the oxygen to flow until the pressure has stabilized.
High water temperature	? Inlet or outlet water temperature is higher than 30 °C. ! Make sure that the cooling system is working correctly.
Safety stop activated	? The Safety Stop button has been pressed. ! Correct any underlying issue and **then purge the GM**. The reactors will begin to suffer damage if left with ozone inside for more than 3 hours.
Faulty gas pressure sensor	? The gas pressure sensor has encountered an error. ! Make sure that the signal cable is securely connected. ! Replace the transmitter.

USE THE SAFETY STOP ONLY IF THERE IS RISK OF INJURY TO PERSONNEL OR DAMAGE TO THE EQUIPMENT.

DO NOT USE THE SAFETY STOP FOR NORMAL SHUTDOWN.

Table 5 | Alarms that generate a Warning Alarm.

Alarm	Cause and solution
Gas flow regulation	? The measured gas flow has failed to reach the set point for more than 2 minutes. ! Check the upstream and downstream gas line for leaks or irregularities.
Low gas flow	? The gas flow is less than 8 % of the max capacity of the GM. This causes the PLC to cut the power to the MiniSEPTs. ! Check to see whether the gas supply is working correctly.
Power deviates from set point	? The GM has failed to achieve the set power level for 120 seconds or more. ! Stop ozone production, then reboot the GM. ! Replace any non-functional MiniSEPTs.
Alarm MiniSEPT	? One of the MiniSEPTs has encountered an internal error. ! Go to the Process screen (see 4.6 ▶ 25) and press the icon for the affected MiniSEPT to check its current status.
Communication error MiniSEPT	? The GM has lost communication with one of its MiniSEPTs. ! Turn off the power and check whether the affected MiniSEPT and its neighbors are connected. ! If the MiniSEPT has been recently installed, make sure that it is properly addressed. Instructions for addressing MiniSEPTs are described in the GM Maintenance manual.
Faulty gas flow sensor	? The MFC has encountered an error. ! Make sure that the signal cable is securely connected.
High ODM gas flow to maint. conc.	? The set ozone concentration cannot be achieved at the current gas flow. ! Decrease the gas flow.

Table 6 | Alarms that can generate different types of alarms depending on preferences.

Alarm	Cause and solution
Communication error with overhead system - or - **Signal error external I/O (mA)**	? The GM has lost contact with its overhead control system or contact has not yet been established. See the "External Communications Manual". ! If the GM is not meant to use an overhead control system, set to Local Mode ( ) in *Settings*. ! Make sure that the signal cable is securely connected. ! Make sure that the overhead control system is active. See the "External Communications Manual".

6 Miscellaneous

6.1 Inspection

6.1.1 Condensation Check

Once per day, check for condensed water inside the GM. If water is present, review the environmental requirements listed in *Table 2* ▶ 13, and make sure that they are followed.

If the GM is inactive, and if no automatic water valves are installed, it is important to turn off the water flow during generator inactivity.

NOTE: If condensation is detected, contact your Primozone Local Service Partner immediately.

6.1.2 Coolant Temperature Check

Once per day, ensure that the coolant temperature fulfills specifications. See 7.6 ▶ 39 for coolant details.

6.1.3 MiniSEPT LED Indicators

During ozone production, all MiniSEPT LED indicators should emit a steady blue light. If not, refer to the MiniSEPT alarms in "5.2 Alarm List" ▶ 32.

6.1.4 Discoloration of GM Cabinet/Components

Discoloration is a sign of internal leakage. Check regularly for any discoloration on the cabinet or its components (inspect interior components by shining a flashlight or similar through the plastic front in the GM door).

NOTE: If discoloration is detected, contact your Primozone Local Service Partner immediately.

6.1.5 Annual Leakage Test

At the end of each 12-month period of operation, perform a leakage test on the GM. Perform the test more frequently if leakage is suspected.

NOTE: If leakage is detected, contact your Primozone Local Service Partner immediately.

6.2 Storage and Transportation

If the GM is stored but not in use, or if it is transported, please follow the below guidelines:

- The GM may not be tilted.
- The GM must be completely drained from coolant.
- No hoses may be connected.
- All water and gas ports must be plugged.
- The GM must be stored in a location that complies with the ambient environment guidelines in *Table 2* ▶ 13. These guidelines also apply to any spare reactors or MiniSEPTs stored outside the GM.

When the GM is started for the first time after having been stored for one week or longer, the reactors should be manually purged as described in 4.9.1 ▶ 28.

6.3 Disposal

The GM contains no parts or chemicals that need special attention upon disposal.

Please follow local laws and guidelines when disposing of the GM.
Recycle any materials if possible.

7 Technical Specifications

7.1 Dimensions

Detailed diagrams with dimensions are displayed in "7.12 Mechanical Drawings" ▶ 42.

	GM1	GM2	GM3	GM4
Weight	36 kg, 79 lbs	45 kg, 99 lbs	52 kg, 110 lbs	60 kg, 130 lbs
Height	517 mm/20.4"			
Width	603 mm/23.7"			
Depth	437 mm/17.2"			
Ingress Protection	IP65: Dust tight and protected against water jets.			

7.2 Electrical Data

	GM1	GM2	GM3	GM4
Power (at 100 %)	0.6 kW	1.2 kW	1.8 kW	2.4 kW
Max fuse	6 A	10 A	10 A	16 A
Power supply	1×230 V + N + PE, AC 50/60 Hz			
Circuit breaker type for power supply	C-characteristic			

7.3 Oxygen Gas Supply

Maximum gas pressure at inlet	Less than 3 bar(g), 43.5 psig
Oxygen purity	> 94%
Oxygen dew point	< - 70 °C, < -94 °F
Recommended gas pressure at inlet	2.5 bar(g), 36 psig
Oxygen connector	8/6 mm push-on fitting

7.4 Maximum Oxygen Consumption

Numbers indicate gas properties at 100 % capacity, 0 °C (32 °F) and normal atmospheric pressure. If a PSA system is utilized for the ozone production system, please be aware of its maximum capacity and do not overload it.

	GM1	GM2	GM3	GM4
Oxygen consumption	0.41 m³/h 14 Ft³/h	0.81 m³/h 29 Ft³/h	1.2 m³/h 43 Ft³/h	1.6 m³/h 57 Ft³/h

The proportional valve of the GM1-4 can process up to 1.7 m^3/h of gas.

7.5 Ozone Gas

7.5.1 Ozone Gas-line Specifications

	GM1	GM2	GM3	GM4
Ozone pressure (depends on pressure and flow of incoming oxygen)	Up to 2.9 bar(g) Up to 42 psig Pressure drops are negligible.			
Ozone connector	8/6 mm push-on fitting			

7.5.2 Ozone Gas Productivity

Figures are within a standard deviation of 4.8 %. Ozone productivity will be lower if the coolant recommendations listed in 7.7 ▶ 40 are not met.

O_3 Productivity	GM1	GM2	GM3	GM4
150 g/m³ (10 $\%_{wt}$)	6.0 g/h - 60 g/h 0.32 lbs/day - 3.2 lbs/day	12 g/h - 120 g/h 0.63 lbs/day - 6.3 lbs/day	18 g/h - 180 g/h 0.95 lbs/day - 9.5 lbs/day	24 g/h - 240 g/h 1.3 lbs/day - 13 lbs/day
200 g/m³ (13 $\%_{wt}$)	5.0 g/h - 50 g/h 0.26 lbs/day - 2.6 lbs/day	10 g/h - 100 g/h 0.53 lbs/day - 5.3 lbs/day	15 g/h - 150 g/h 0.79 lbs/day - 7.9 lbs/day	20 g/h - 200 g/h 1.1 lbs/day - 11 lbs/day
250 g/m³ (17 $\%_{wt}$)	4.0 g/h - 40 g/h 0.21 lbs/day - 2.1 lbs/day	8.0 g/h - 80 g/h 0.42 lbs/day - 4.2 lbs/day	12 g/h - 120 g/h 0.63 lbs/day - 6.3 lbs/day	16 g/h - 160 g/h 0.85 lbs/day - 8.5 lbs/day
300 g/m³ (20 $\%_{wt}$)	4.1 g/h - 27 g/h 0.21 lbs/day - 1.4 lbs/day	5.4 g/h - 54 g/h 0.29 lbs/day - 2.9 lbs/day	8.1 g/h - 81 g/h 0.43 lbs/day - 4.3 lbs/day	11 g/h - 110 g/h 0.57 lbs/day - 5.7 lbs/day

7.6 Coolant

Coolant composition	~30 % ethylene glycol, ~70 % water
Water hardness	< 10° dH to avoid lime scaling
Water quality	Drinking water (98/83/EC) or turbidity maximum 0.2 NTU.
Cooling-loop type	Primozone advises using a closed-loop cooling system. An open-loop system will require frequent rinsing to prevent residue inside the GM.
Temperature alarm limits (GM)	3–30 °C / 37–86 °F on inlet coolant 3–30 °C / 37–86 °F on outlet coolant
Target temperature in the ozone generator	10 °C on inlet , 15 °C on outlet 50 °F on inlet, 59 °F on outlet
Coolant, max pressure	6 bar(g), 87 psig
Coolant, pressure drops (at minimum coolant flow)	Up to 0.4 bar(g), 5.8 psig
Coolant connector	12/10 mm push-in fittings

7.7 Minimum Coolant Flow

The following figures apply under the condition that the temperature of the coolant increases by 5 °C between the inlet and the outlet temperature sensors. A smaller temperature difference requires a higher coolant flow.

	GM1	GM2	GM3	GM4
Minimum coolant flow	0.11 m³/h 0.48 GPM	0.21 m³/h 0.92 GPM	0.32 m³/h 1.4 GPM	0.42 m³/h 1.8 GPM

7.8 Noise

The generator emits less than 55 dB.

7.9 Electromagnetic Compatibility

	GM1	GM2	GM3	GM4
Compliance level (EN55011)	B	A	A	A
Date of approval	2020	2020	2020	2020

7.10 Additional Power-supply Information

The MiniSEPT unit contains the following functions:

SMPS incorporating a Short-circuit-proof safety isolating transformer (inherently or non-inherently)

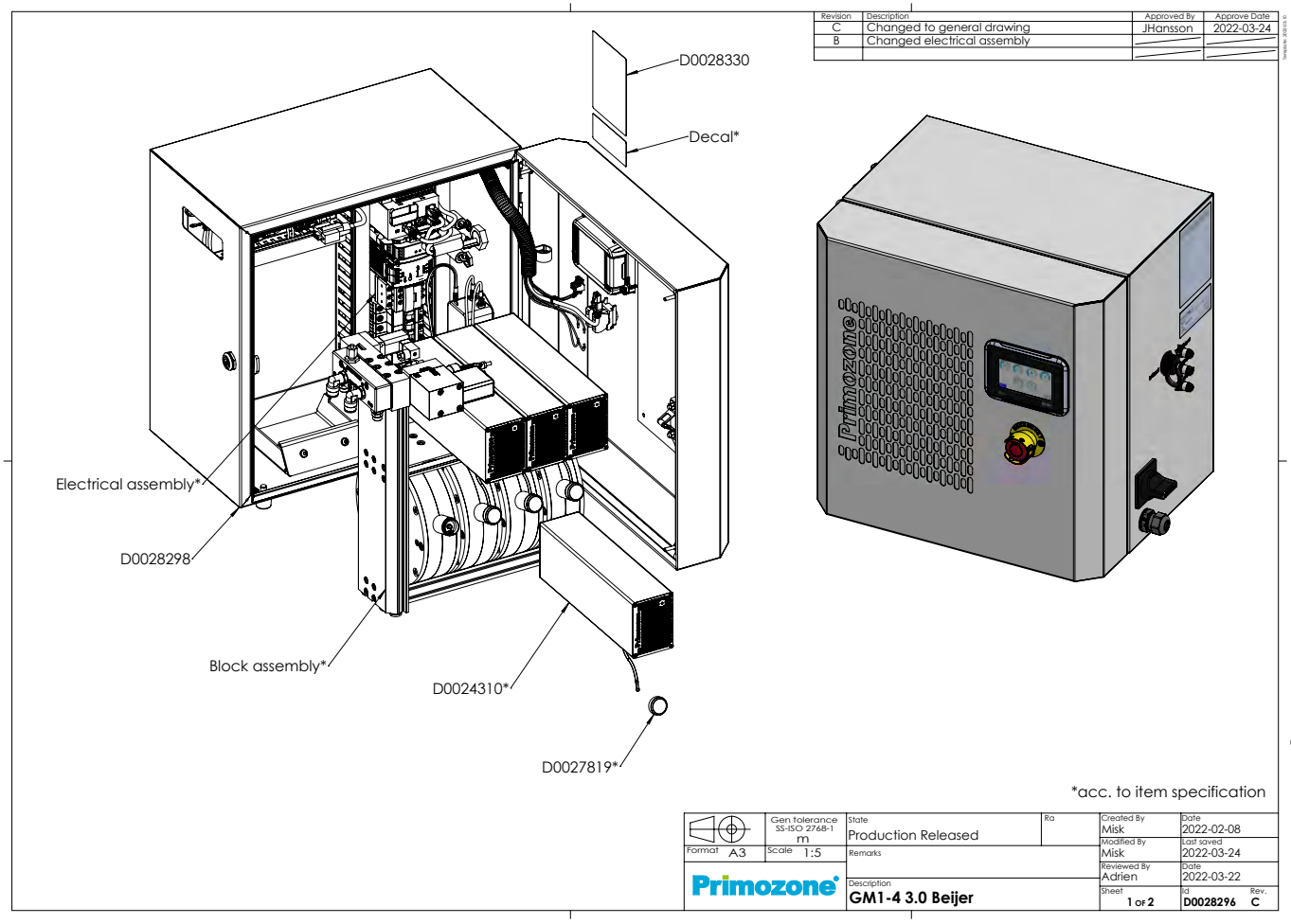
SMPS (Switch mode power supply unit)

Single-phase AC

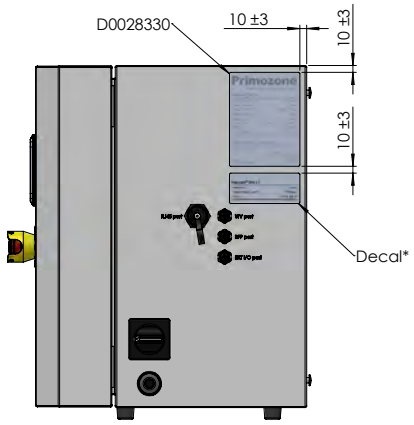
7.11 FIFRA Information

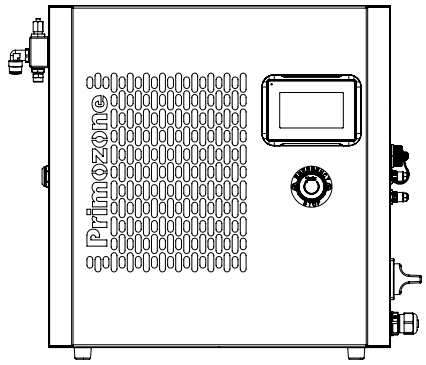
US EPA establishment number: 95235-SWE-1

7.12 Mechanical Drawings



Revision	Description	Approved By	Approve Date
C	Changed to general drawing		
B	Changed electrical assembly		





*acc. to item specification

Gen tolerance SS-ISO 2768-1 m	State: Production Released	Ra	Created By: Misk	Date: 2022-02-08	
Format: A3	Scale: 1:5	Remarks	Modified By: Misk	Last saved: 2022-03-24	
Primozone	Description: **GM1-4 3.0 Beijer**		Reviewed By	Date	
			Sheet: **2 of 2**	Id: **D0028296**	Rev.: **C**

8 Version History

Hardware version	Date	Author	Changes
3.0	May 2023	PEOS	Initial version.
3.0	Dec 2023	PEOS	• Added information about condensation and leakage tests. • Minor updates.
3.0	Jan 2024	PEOS	• Updated term from "cooling water" to "coolant". • Minor updates.

9 Glossary List

%wt

Weight percentage

bar(g)

bar – gauge (measured in relation to atmospheric pressure)

BFP

Back Flow Protector - A Primozone product which is used to prevent water from the site of dissolution from propagating back into the GM.

DEXF7

Destructor Excluding Fan (7 m^3/h)

°dH

Water hardness

GM

Generator Module

HMI

Human Machine Interface

ICSC

International Chemical Safety Cards

LOX Booster

A product by Primozone which is used to "boost" the ozone production by mixing the oxygen stream with a small amount of nitrogen into oxygen which originates from a liquid oxygen (LOX) source.

MiniSEPT

Mini Self-regulating Electronic Power Transformer

O_2

Oxygen

O_3

Ozone

ODM

Ozone Distribution Module – A Primozone product which is installed downstream from the GM and is used to regulate the flow of ozone into two or more dissolution sites.

Ozone capacity

The amount of ozone produced as a percentage of the maximum of the GM.

Ozone concentration

The volumetric concentration of ozone, often measured in grams per cubic meter

Ozone productivity

The amount of ozone produced in a timespan, often measured in grams per hour

ppm

parts per million (by weight)

psig

psi – gauge (measured in relation to atmospheric pressure)

SC

System Controller – a Primozone product which is used to monitor and regulate the ozone production and its peripheral devices.