Plasma Technics, Inc.®

PTI

INSTALLATION & OPERATION MANUAL
Plasma Blo$_3$ck

10 - 20g

Section I COMPLETE PLATE INSTALLATION

1. Mount to allow O_2 flow meters to work for user feedback. The assembly contains a cooling fan which cools the transformer. Allow 1.25" to 1.5" clearance between the top of the fan and an enclosure surface.

2. Read the nameplate for operating line voltage and current adjustment levels. **Use copper conductors only.**

3. Apply only the line voltage indicated on the nameplate.

4. Ground the plate assembly to service green utilizing star washer. See installation drawing on page 14 for possible grounding locations and High Voltage safety considerations.

Mounting Environment

The block should be mounted in an environment that is free from the following:

!*Corrosive or volatile vapors. Dust and particles, Excessive moisture.*

!*Shock, Excessive vibration, Temperature extremes*!

The following environmental specifications apply:

Surrounding air ambient operating temperature: 32° to 104° F (0° to 40° C)

Relative humidity: 5 to 90%, non-condensing. Altitude (maximum): 3,310 ft (1,000 m), de-rating for altitude is 1% for every 300 ft (100m) above 1000m.

Wiring Standards and Codes

The installation person is responsible for following the wiring plan produced by the design engineer for the specific application.

All wiring must conform to the following standards:

National Electrical Code, Publication NFPA No. 70.

All local and national codes which apply. For motor usage; use appropriate NEMA relay for protection.

The supplier cannot assume responsibility for the compliance or noncompliance to any code governing the proper installation of this equipment.

Electrical Connection Wire Sizing and Fusing

The DAT300 input current ratings: 10g = 1.52 amps RMS / 20g = 3.0 amps RMS. Use branch circuit fuses suitable for use on a circuit capable of delivering not more than 25rms symmetrical amperes, 250 volts maximum. Refer to the National Electrical Code[NEC], Publication NFPA No. 70, Article 310, and any local codes that may apply for wire sizing and selection. Use 60/75°c wire min. and 25 amp input fuses of class K5 or RK5. Use copper conductors only.

Terminal connection max torque .5 newton meters[.369 inch lbs].

Case Ground

Each of the blocks must be connected to ground at their case ground terminal. A grounding electrode conductor or bonding jumper must be connected from the ground terminal to either a grounding electrode buried in the earth or a suitable plant ground with solid connections to earth ground. Refer to NFPA No. 70, Article 250, for details on grounding and grounding electrodes.

Safety Grounding

The case ground connections should be made at the ground terminals. The case ground of the various system components should be connected to the star grounding bus of the cabinet. A grounding electrode conductor or bonding jumper must be connected from the star grounding bus to either a grounding electrode buried in the earth or a suitable plant ground with solid connections to earth ground. Refer to NFPA No. 70, Article 250, for details on grounding and grounding electrodes.

5. Read section II for information regarding the individual components of the system.

6. Follow section III for field adjustment and/or verification: It is ***very important*** to at least ***verify*** that the ***system is set to the proper pressure*** and that the current values found in section III-6 agree with installed values. If current varies by more than ± .2A the adjustment procedure found in section VII must be conducted.

SECTION II COMPONENT INSTALLATION CONSIDERATIONS

A. BLO$_3$CK and Transformer Mounting and Connection Considerations:

1. Connect like primary wires to the same inverter terminals if multiple Blocks and transformers are used.

2. H-V Transformer should be spaced apart as far as practical. 6" or more.

3. Because of the magnetic field that surrounds the transformer, it's best to keep the coil portion of the transformer away from enclosure metal to minimize induction loses. The gray high voltage coil must be at least 1/2" away from metal to prevent corona from producing ozone in the enclosure. The most sensitive surface is the outside diameter of the gray coil.

4. The high voltage wire should be short (near the Plasma Block's high voltage entry).

5. NEVER dress the high voltage wire with other wires and keep it clear of metal surfaces. This will minimize the unwanted generation of ozone within the enclosure.

6. Follow the included connector diagram. While the coil system connection can be used for 120vac and 240vac power feeds, the inverter is usually configured for 120v operation only. Reference the label found on the inverter for limitation.

B. DAT300:

1. When AC power is applied, an inrush will occur - this is normal. A typical 2 Block system will require a 10-amp circuit breaker. If the inverter line voltage will be turned on frequently the relay or switch should be amply sized to prolong its life due to the high inrush current. A soft charge circuit is recommended in this case.
2. If the DAT300 is not fan equipped, the unit should be located so as to benefit from other cooling in the cabinet.

C. Plasma BLO_3CK:

1. The Plasma Block is built with aluminum and ceramic. While aluminum provides maximum safety for applications like water purification, it does react with nitric acid that would be produced if atmospheric air were to be used rather than a concentrate for gas feed. For this reason **ONLY a concentrator or O_2 can be used to provide the feed gas.** To maintain the warrantee the feed gas must be at least -60°F dew point and 93% O_2 or more.

2. **BEFORE** the system is energized for the first time the Plasma Block should pre-dried by flowing the above feed gas for 3 to 5 minutes. If the installed system will be dormant for long intervals then the control system should do a pre-purge to insure the system is dry before power is applied to the cell.

3. The best cell seasoning is accomplished with a concentrator. All cells have been factory seasoned but it is always a good idea to operate the finished system for a few hours prior to installation to allow all components to settle in.

4. When a system is off for an extended period, it is very important to prevent backflow of liquids and gasses through

the cell. Backflows void the cell warrantee. For example, systems which uses a venturi and concentrator must contain a solenoid valve to block gas flow if it is possible that the venturi will be active while the concentrator is off.

5. When the Block requires servicing, return it to the factory - DO NOT disassemble. The Plasma Block is fitted with a tamper label. If the label is broken, the warrantee is void.

6. **While it is possible to configure the system to accommodate negative pressures, negative pressures are problematic and tend to cause large power and ozone fluctuations. The most stable and predictable systems occur at positive pressures.**

7. The ozone outlet fitting mounted into the plasma block mates with other fittings inside of the unit and **must not be removed or changed** to another fitting type. Contact the factory if other sizes or styles are required.

SECTION III Operation and Tuning – BLO_3CK Systems

1. The plate-mounted system has been pre-configured for optimum performance for each customer's pressure circumstances, if they were specified. Typically the range will be 5 to 15 psi. If the pressure was not specified or requires changing, follow the power up instructions and subsequent tuning instructions. If the pressure is expected to fluctuate over a range then create the highest pressure condition and then tune the system.

2. Start gas flow, adjust to desired values and wait for several minutes.

3. Specific / manual / semi / auto instruction start on page 24.

Plasma Technics, Inc.®

PTI

OEM

10g & 20g @ 5% *Plasma* Blo$_3$ck® (Air-Cooled)

Doc : v4.0b, 08/22/08

Firmware: 10008.004

Feature List

- **10g**, 5%, **2 lpm**, 5 psi. **20g**, 5%, **4 lpm**, 5 psi. 10g and 20g models in the **same chassis**.
- **Full-Auto** and **Semi-Auto** modes hold power constant over the entire pressure range: **5 - 100 psi**. Go from package to process with no setup or adjustments required. Continuously tracks and automatically optimizes performance for changes in pressure, flow and line voltage.
- **Universal, world-class product**. **Constant ozone output** and cooling: 100 – 240vac, 50/60hz, power factor .94-.99 across the entire working voltage and power range. Power supply is UL / CSA / CE approved. NO line voltage configuration jumpers – any voltage, any frequency; same unit.
- **Efficient**, compact, silent (25khz), safe, rugged, reliable, advanced – all the normal traits of a PTI product. Same precise linear control, with turndown to 1%, as with all Plasma Block products.
- Maximum up time, durable, commercial / industrial solution the ozone industry requires.

- Possible **cell flooding** is identified followed by shut down and enunciation. No damage is caused to electronics, transformer and rarely the cell. Cell flushing and drying in the field is usually sufficient to restore full service.
- Extensive two tier fault enunciation **maximizes uptime** and simplifies service diagnostics. Latched fault indicators retain fault status until serviced.
- This Gen2 cell is a scaled down version of PTI's field proven 50g product, which is virtually impervious to extremes in temperature, vibration and pressure. **Major savings are had due to its low energy use, low oxygen volume needs and competitive pricing.**
- The control electronics is accomplished via Plasma Technics® new DAT300 microcontroller-based inverter board. This state of the art controller yields a simpler user interface and many new features intended to further increase uptime and **simplify installation** and troubleshooting.
- **Control connections** of the essential I/O functions are the **same** as in all other Plasma Block products.
- PDM, Voltage and Frequency potentiometers have their own jumper selection for onboard control, if desired.
- Complex and thorough onboard electronic short-circuit protection prevents nuisance circuit board failure due to accidental field wiring errors.
- Power and control connections are located at the rear of the product to enable integrators to construct 'plug & play' mounting.
- **Same mounting footprint and mounting hole centers** as the popular 50g Plasma Block. The 10/20g chassis is a miniature version of the 50g unit. This means that the general location for control connections, gas IN/OUT, cooling, etc. are the same.
- **Military grade conformal coating** eliminates problems associated with condensation and mold as well as greatly retards damage caused by accidental ozone exposure.
- Like all other Plasma Block products, the feed gas supply must be either PSA concentrator or oxygen.
- Directly installable by UL 508a panel house PENDING.

Firmware Version Info

Date ID only – Basic operational adjustments only, no LED status.

10008.001 – Added current window, PDM temperature control for cell and electronics with fault display, fan ramp, 100% fan ON select, fan controlled by time and temperature.

10008.002 – Added push button current adjustment, and power recording. Selectable Soft Fault output, 4/20ma selectable with shut down, improved fan ramp.

10008.003 - Added full automatic and semi-automatic tuning modes, Cell Fault diagnostics and enunciation. Changed J15 jumper assignment to select auto-tune.

10008.004 – Added 'Start' button functions: Power setting via LED window, extended tuning sweep. Recall of factory defaults via 'Op_OK' button. Manual control adjustment limits by product type.

Enhanced product features include

1. **Soft** and **Hard fault reporting**. **Soft fault** will signal that attention is required. The system is still functional; perhaps at a reduced ozone output level. A **Hard Fault** is signaled when the Plasma Block has disabled itself. In both cases fault LED's will continue to display the problem until serviced. Reset is accomplished simply by an OFF followed by an ON command.

2. **Constant temperature mode**. If for some reason the cell or electronics cooling is compromised, the processor will reduce PDM automatically to maintain a functionally high cell temperature, all the while generating a Soft Fault. This limp along mode will be at reduced ozone levels.

3. Optionally selectable **High / Low current** fault reporting. This enables a latched fault if the cell current excursion is beyond a normal operational window. PDM level has no effect on enunciation. The tolerance window is easily field set to one of three levels.

4. **Easy troubleshooting**. Extensive fault reporting and fault latching, even if the output is stopped by the user or internal stop, preserves the fault condition indefinitely as long as AC power is applied.

5. **Longer fan life**. Fan speed unaffected by line voltage changes, and is temperature and time controlled. When ozone is commanded off the fan cools down the cell and turns off automatically, thereby **saving energy and extending fan life.**

6. PDM start up ramp rate is automatically controlled by cell temperature to reduce the chance of inadvertent thermal shock under extreme cold temperature conditions.

7. Extended PDM control methods include: 0 – 10vdc via Pot or PLC, 0 / 20ma, 4 / 20ma (with OFF below 2ma). All PDM modes utilize dynamic slew rate limiting for smooth and stable control.

8. 0 – 5vdc analog output for **bus current** and **bus voltage** enables simple PLC monitoring of real power without expensive CT's and complex interfaces.

9. Plasma Block will **engage when AC power is applied** if continuous ON command is present and jumper 8 is installed, thereby simplifying restart in simple, controlled environments.

10. All established operational parameters are **permanently saved in memory** even if power is removed. **No backup power or batteries** are used. Future firmware will likely include histograms of important performance data. On board RS232 interface, for future direct computer data interface.

11. Power on LED marquee verifies LED operation and displays **firmware revision level**.

12. Operating firmware is fully **encrypted** and field **upgradable**.

Installation Instructions

Mounting can be in **any axis** via the same bracket used on the 50g unit.

Pressure and flow requirements are the same as all other Plasma Block® products. Connect oxygen feed gas to port labeled INLET. OUTLET should have a flow restriction control downstream to produce an operating pressure range of 5 to 100psi.

Allow 1" to 2" of space around the fan and areas which vent cooling air.

No heat inducing stray fields are to be present around the unit.

Line Voltage Connections

Terminal Strip Connections (Con13)

AC Line Power – 1 & 3. 100-240vac, 50/60Hz: presents .94 - .99 power factor, UL/CSA/CE approved supply.

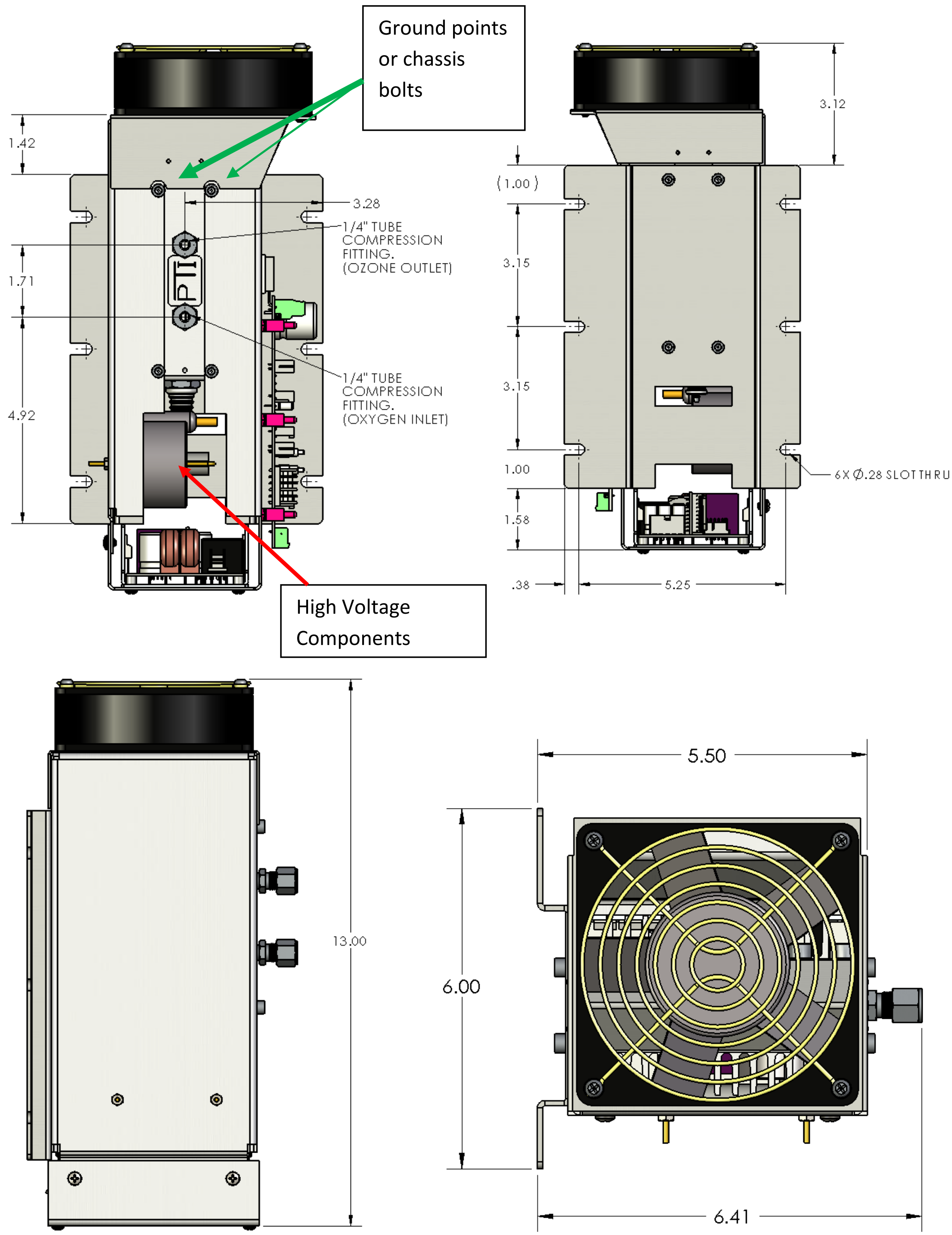
AC power is connected via the 3 pin connector. Use pins 1 and 3; polarity is irrelevant. Pin 2 is not connected and is used to provide proper electrical spacing only.

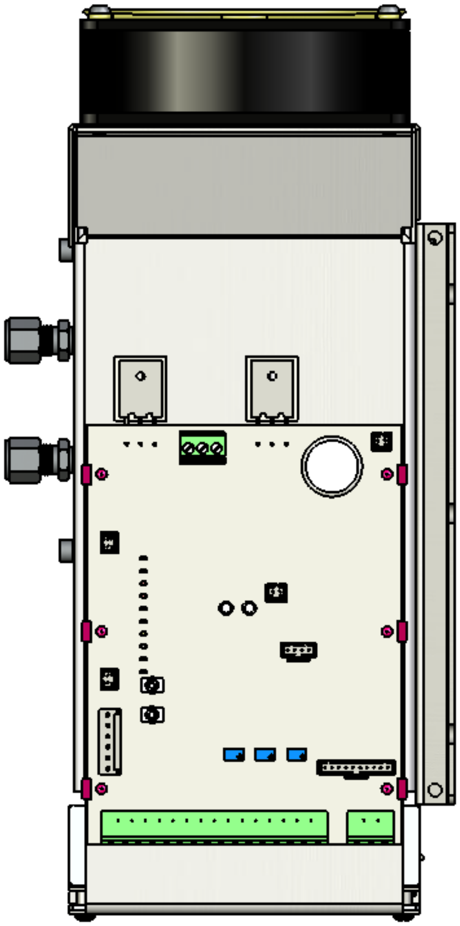
Connect a ground at any fastener that utilizes a star washer. A solid ground is essential to reduce electrical noise.

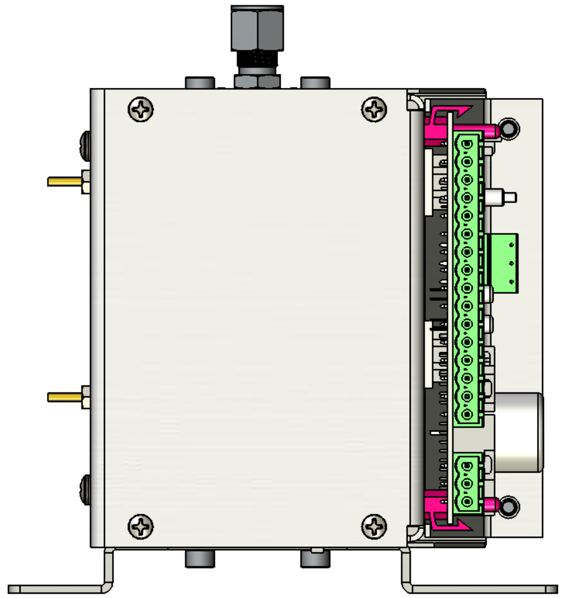
Product Start-up

1. Select jumpers appropriate to your needs. See tables and functional lists. Interface as needed.
2. Apply oxygen in the range of 5 to 100 psi at desired flow rate.
3. Apply AC power.
4. Apply 'ON' command.
5. The Plasma Block ships in the full auto-tune configuration. All tuning adjustments are continuously made by the processor to insure optimal constant power operation even if pressure and flow conditions change. It is suggested that once the unit operation has been verified, the '**OK**' button should be pushed. This provides the unit a reference for proper operational levels. Follow instructions labeled '**Programming current and operating power levels**'. This is recommended, but not required.
6. DONE! Go have some coffee.

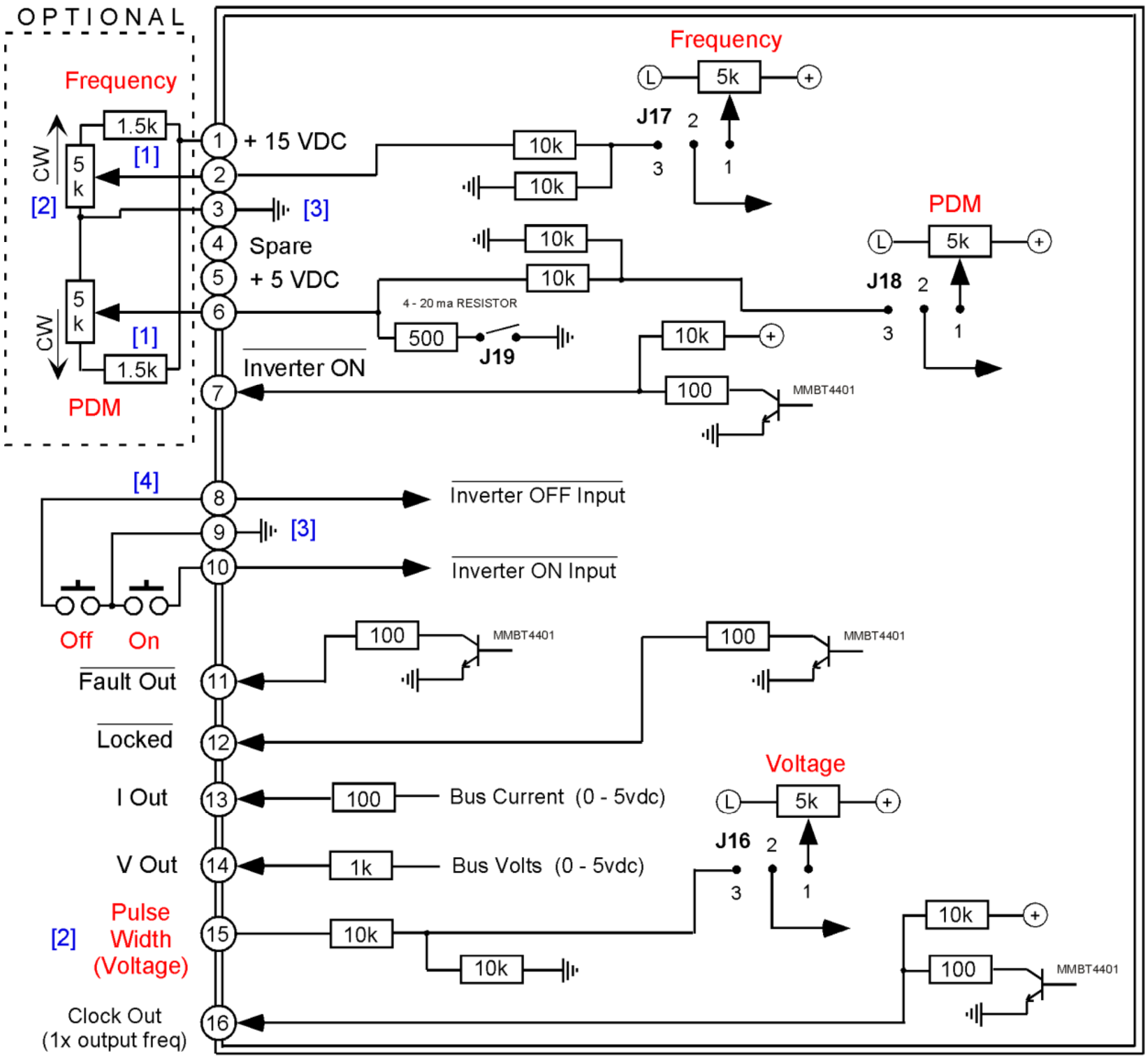
   If you feel the need to adjust something - read on. There are many powerful tools at your disposal.


Ground points or chassis bolts
1.42
3.28
1/4" TUBE COMPRESSION FITTING. (OZONE OUTLET)
1.71
4.92
1/4" TUBE COMPRESSION FITTING. (OXYGEN INLET)
High Voltage Components
3.12
(1.00)
3.15
3.15
1.00
1.58
.38
5.25
6X Ø.28 SLOT THRU
13.00
5.50
6.00
6.41





DAT300 Connections



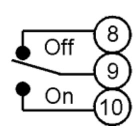
- Grounding either #3 or #9 is not necessary and usually controlled by PLC.
- External pots for frequency and voltage should be multi-turn, cermet substrate types for stability and precision. Rating of 1/4 watt.
- Shielded cable recommended for connection runs of 2' or more.

[1] Optional but recommended (1/4w) to obtain full use of potentiometer range.

[2] External pot 5k, 1500 ohm resistor recommended as per note 1.

[3] Ground symbol represents circuit board floating common, not earth grounded. Best to leave floating or allow PLC to establish the ground relationship.

[4] Optional SPDT toggle switch or relay.



Input / Output Connections (Con12)

Basic control connection for PDM, ON/OFF, Frequency, Voltage, Enable out, +15vdc, +5vdc are the same as all other Plasma Block products that have utilized the SSD111 control board. Note below that many new outputs are available and the enunciation outputs have been changed from 0-5v logic level types to open collector for easier interface to a wider variety of PLC's. The open collector outputs are all active low.

1. +15, aux use limit = 10ma.
2. Frequency Adjust (optional), selected by jumper J17, use 5k Ω pot, 0-10vdc only (10v= 100%), impedance 10k Ω.
3. **Signal Common**, tied to #9 internally.
4. Not used at this time. Was -15vdc on other Plasma Block products controlled by SSD111.
5. +5vdc, aux use limit = 12ma. **Recommend this be connected to PLC for power up validation.**
6. **PMD input** (optional), selected by jumper J18, use 5kΩ pot, 0-10vdc (10v= 100%), 4-20ma or 0-20ma, impedance 10k Ω. Select current input mode via jumper J19 (500Ω load from 3 to 6).
7. **Inverter Start,** output pulls low via open collector (MMBT4401) when inverter is engaged. Follows Inv_ON LED. 10k Ω pull-up to +5. 100Ω on board.
8. **Inverter OFF** when pulled low to terminal 9 via momentary or continuous. 10kΩ pull-up to +5v.
9. **Logic Common** for # 8 and 10.
10. **Inverter ON** when pulled low to terminal 9 via momentary or continuous. 10kΩ pull-up to +5v.
11. **FAULT OUT** pulls low via open collector (MMBT4401) when inverter faults due to: Operating cell current is above or below customer programmed set point. Over temp cell, over temp electronics, sustained instantaneous over current. 100Ω on board. (See jumper J4)
12. System LOCKED. Digital auto-tune feature has found and confirmed the proper operating point. If pressure changes cause significant re-tuning the LOCKED LED will flash. The locked LED will also flash during the initial tuning acquisition, which lasts for a few seconds.
13. Analog 0 – 5vdc, follows average DC bus current out. Direct op amp (MC33272AD) thru 100Ω resistor.
14. Analog 0 – 5vdc, follows DC bus voltage. Direct op amp (MC33272AD). 10kΩ series resistor.
15. Voltage Adjust input (optional), selected by jumper J16, use 5kΩ pot, 0-10vdc only(10v= 100%), impedance 10k Ω.
16. Clock Freq out (1x). Output pulls low via open collector (MMBT4401). 10kΩ pull-up to +5. 100Ω on board.

Jumpers

0. D **PDM Enable**, if installed. If PDM is remotely commanded, remove to test 100% output level. This is especially useful if the unit is hard wired to a PLC or ORP controller.

1. Alternate low PDM rate, if installed.

2. Alternate PDM method, if installed.

3. D **High / Low current** window detect and fault enabled, if installed.

4. S **Soft Fault** output enabled, if installed. Produces a wink in fault line #11, if one or more operational windows are beyond the factory limit. The system requires service attention but is still operational at a reduced level. Note: a Hard Fault can occur with or without this jumper.

5. Spare

6. Spare

7. S **4/20ma** (jumper IN), 0/20ma (jumper OUT). Controls input conditioning for #6, PDM input. In 4/20 mode (J7 installed), **0% output is reached at 4ma**. At the 2ma point the output is disabled and the INV_On LED will flash. If PDM command signal is increased above 3ma then the output is re-enabled.

   When J7 is removed, **0% occurs at 0 volts** (like Plasma Block products that use the SSD111 control board).

8. Inverter automatically engages output when AC line is applied if ON command is present, if installed. In other words; if a jumper is placed between screw terminals 9 and 10 (ON command), when line voltage is applied to the unit it will begin generating ozone after about 5 seconds, and stop when the power is turned off. Generally this is not recommended because an oxygen purge does not occur at start-up, and an ozone purge does not occur at shutdown.

9. 9-13, factory use.

14. Fan on continuous, if installed. Must power cycle AC line to activate.

15. D **Full Auto-Tune**, if installed (Voltage and Frequency pots are not observed). **Semi-Auto**, if un-installed (Voltage pot controls total power. System frequency is adjusted by the processor automatically. Frequency pot is not observed).

16. D **Voltage Control Pot.** 1 – 2 Internal, 2 – 3 external.

17. D **Frequency Control Pot.** 1 – 2 Internal, 2 – 3 external.

18. D **PDM Control Pot.** 1 – 2 Internal, 2 – 3 external.

19. S **4-20ma select.** Installing jumper applies a 500 Ω load across connections 3 and 6. If two or more DAT300's are to be controlled via one current loop: Wire all terminal 3's together, all terminal 6's together and **install J19 jumper on ONE DAT300** unit. Jumper is located behind and in line with #6. Note: Usually J7 should be installed if J19 is.

Factory jumper config:
D = Factory installed Default
S = Stow on one pin if needed.

Control Potentiometers (Pots)

PDM – The onboard Pulse Density Modulation control pot is primarily of use for simple applications running at a fixed turndown level. Also helpful for bench testing. Use jumper J18 to select on board (IN) or external terminal strip control (EX). Normally terminal #6 input delivers a voltage or current to the unit, which manages a closed loop process ozone level.

Voltage – Adjusts voltage applied to cell. Use jumper J16 to select onboard (IN) or external terminal strip control (EX). This control is used to set the maximum power operating point for the unit while in the Semi-Auto mode, but is not observed in the Full-Auto mode. Remote operation is via terminal # 15. If external control is used, it must be a voltage from 0 to 10vdc, unless a 500 ohm resistor is added to terminals 3 and 15. No 4/20ma current control jumper provisions exist on the pcb.

Frequency – Adjusts cell frequency. This pot is factory set and not observed unless the unit is in the factory set-up configuration. Frequency is dynamically managed by the processor for both Semi and Full Auto modes. Provisions have been made for remote control via terminal # 2, in which case J17 should be in the (EX) location.

Push Buttons

Op_OK – This button has multiple uses.

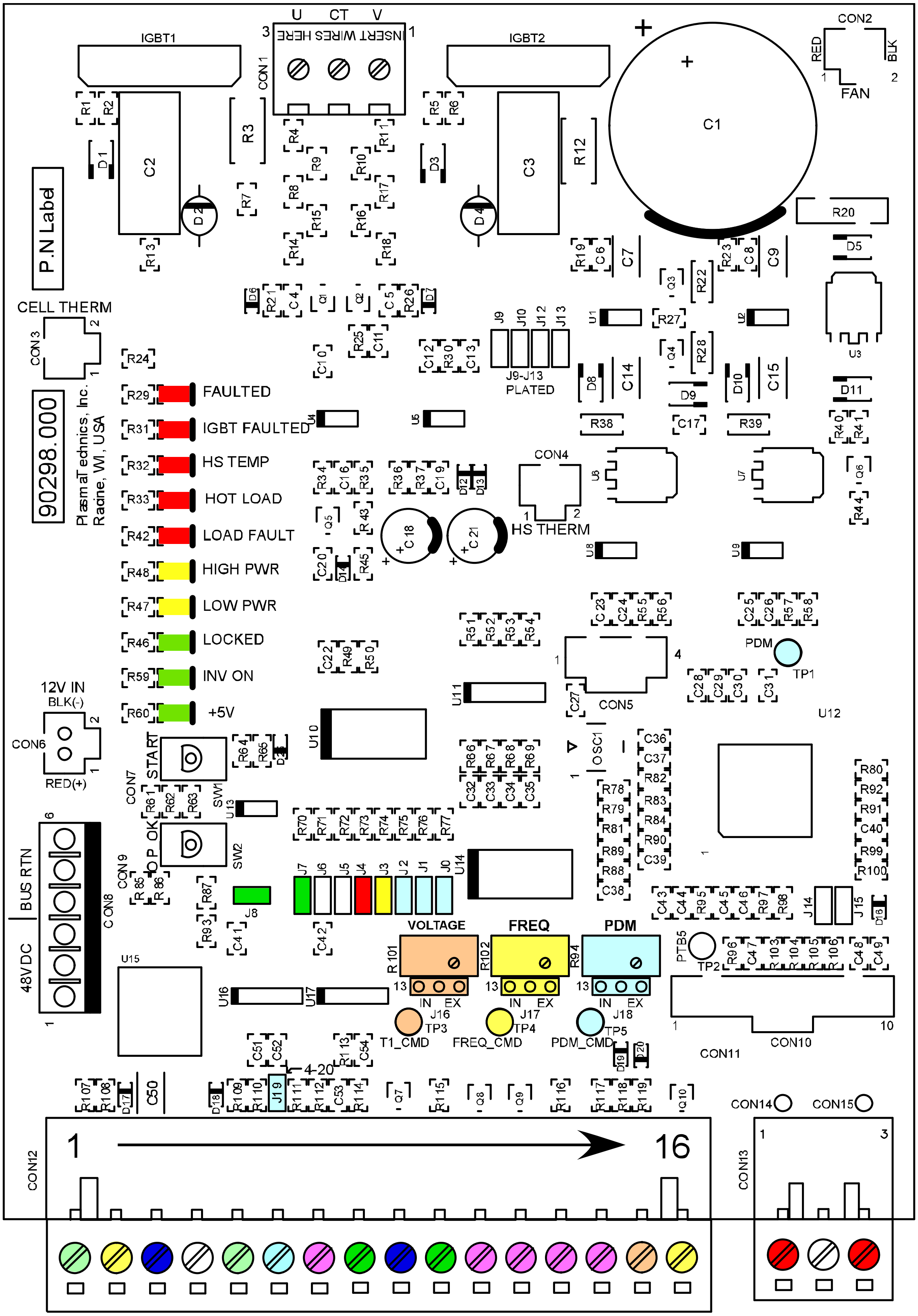
1. **Stores** the present running parameters as the norm, **when in the ON mode**. Selects and stores the presently configured acceptable current tolerance, power, voltage and frequency along with other internal configuration information available, as **proper field operation**. This information becomes the re-start information after a power cycle.

2. **Recalls** the factory set-up table to active memory, **when in the OFF mode**. The factory table is never overwritten and can be recalled as a last resort if the unit has been inadvertently maladjusted beyond recognition. If this happens, just follow the instructions in the 'Power Adjustment' section and you are painlessly back in operation.

Start – This button has multiple uses.

1. An **extended tuning sweep** is conducted if pushed for 2 - 4 seconds AND **J15 is installed**, which eliminates the possibility of tuning aliases. In other words, it allows the user to force an extended tuning adjustment and witness the results as a troubleshooting tool if needed. This type of operation also occurs automatically, but the user would be unaware of it. If either the power or current is different than the values found in the 'Power Level Table' below, store the new value by removing J15, adjusting the voltage pot (per 'Power Adjustment'), store the corrected running value (per above 'Op_OK'), and re-install J15.

2. A sensitive **manual power adjustment** of the 'Voltage' control if pushed for 2 – 4 seconds AND **J15 is removed**. While this same function can be performed without pressing the 'Start' button, this mode converts the High/Low LEDs into a sensitive meter which is centered around the stored value of the programmed power table in the processors' memory. In other words, you can **reset** the **power** level with extreme accuracy to the previous or factory value, **without** ever pulling your **amp meter** out of the tool box.



Plasma Technics, Inc. DAT300 (rev0)

Control I/O (low voltage)

AC Power Input

PTI 1900 William Street Racine, WI 53404-1875 Tele: (262) 637-7180
Fax: (262) 637-7157

Web Page: http://www.plasmatechnics.com
http://www.plasmablock.com
10g & 20g Plasma Block
E-Mail: sales@plasmatechnics.com

Status LED's

	+5vdc	Low voltage DC supplies are operational (line voltage applied to unit).

INV ON

On solid – Inverter output enabled. Ozone output per PDM command, if enabled.

Flash - Output enabled via ON command but disabled by PDM < 2ma (4/20). Output is re-enabled if PDM > 3ma, 'INV ON' LED on solid.

LOCKED

Flash – Semi-Automatic tuning is enabled when jumper J15 is removed. Frequency tuning occurs during flash interval. Search rate varies automatically: See Jumper J7. The Voltage pot is active and should be used to set the desired full power operating level. See: 'Start' button adjustment procedure.

ON solid – Occurs only in 'Auto-Tune mode when Jumper J15 is installed and signals that the proper operating point has been established and 'locked'. The indicator is ON continuous, and only winks off momentarily while a new scan of the operating parameters is conducted.

LOW POWER

Flash – Output current is slightly below the programmed tolerance window. A service request enunciation is placed via the soft fault if jumper J4 is in place. No disabling action is taken in this state. If the current continues to drop, the flash will transition to an on steady (solid) mode – see ON solid, below.

Note: It is normal for the LOW POWER LED to flash for a few seconds when a large incremental <u>increase</u> in PDM is commanded. This can be helpful in that it will provide a visual indication that the PDM control input is being stimulated. No enunciation action is taken.

ON solid – Output current to the ozone cell is lower than the allowable programmed window. If sustained, a hard fault will be generated in 32 seconds, which disables ozone production when FAULTED LED is ON solid. This LED will be latched on indefinitely to provide service diagnostics. The latched fault is cleared by either an OFF / ON transition (includes 4/20 off as well) or power cycle.

HIGH POWER

Flash – Output current is slightly above the programmed tolerance window. A service request enunciation is placed via the soft fault if jumper J4 is in place.

No disabling action is taken in this state. If the current continues to increase, the flash will transition to an on steady (solid) mode – see ON solid, below.

Note: It is normal for the LOW POWER LED to flash for a few seconds when a large incremental decrease in PDM is commanded. This can be helpful in that it will provide a visual indication that the PDM control input is being stimulated. No enunciation action is taken.

ON solid – Output current to the ozone cell is higher than the allowable programmed window. If sustained, a hard fault will be generated in 32 seconds, which disables ozone production when FAULTED LED is ON solid. This LED will be latched on indefinitely to provide service diagnostics. The latched fault is cleared by either an OFF / ON transition (includes 4/20 off as well) or power cycle.

LOAD FAULT

ON solid – Possible flooded cell, shorted cell or open transformer connection.

HOT LOAD

Wink – Cell temperature is slightly above programmed limit. No disabling action is taken in this state. If the temperature continues to increase, the wink will transition to a flash (longer duty cycle than wink) – see below. During this mode the processor is reducing the PDM level automatically in an effort to lower the cell temperature. This of course also reduces ozone output.

Flash – Cell temperature continues to rise. PDM is controlling power to hold cell temperature constant in an effort to produce some ozone and remain online. This elevated temperature will not damage the cell. A service request enunciation is placed via the soft fault if jumper J4 is in place. No disabling action is taken in this state. If the temperature continues to rise, the flash will transition to an on steady (solid) mode – see ON solid, below.

ON solid – The ozone cell temperature is higher than the allowable programmed window. If sustained, a hard fault will be generated in 32 seconds, which disables ozone production when FAULTED LED is ON solid. This LED will be latched on indefinitely to provide service diagnostics. The latched fault is cleared by either an OFF / ON transition (includes 4/20 off as well) or a power cycle.

HS TEMP

Wink – Heat sink temperature (electronics) is slightly above programmed limit. No disabling action is taken in this state. If the temperature continues to increase, the wink will transition to a flash (longer duty cycle than wink) – see below. During this mode the processor is reducing the PDM level automatically in an effort to lower the heat sink temperature. This, of course, also reduces ozone output.

Flash – Heat sink temperature continues to rise. PDM is controlling power to hold cell temperature constant in an effort to produce some ozone and remain on line. This elevated temperature will not damage the cell. A service request enunciation is placed via the soft fault if jumper J4 is in place. No disabling action is taken in this state. If the temperature continues to rise, the flash will transition to an on, steady (solid) mode – see ON solid, below.

ON solid – The heat sink temperature is higher than the allowable programmed window. If sustained, a hard fault will be generated in 32 seconds, which disables ozone production when FAULTED LED is ON solid. This LED will be latched on indefinitely to provide service diagnostics. The latched fault is cleared by either an OFF / ON transition (includes 4/20 off as well) or power cycle.

IGBT FAULTED

If a short-circuit is present on the inverter output, sophisticated electronic circuits instantly disable the effected power section. If this occurs over too many cycles, the output is disabled and a fault is enunciated.

FAULTED

Rapid Flash – signals a **SOFT FAULT** via open collector to terminal #11. **Jumper J4 must be installed for this mode to be active**. A soft fault up to 32 seconds in length can be produced by any one of the following: cell operational current signature, high or low current, high instantaneous current in the output power section, over temp in the electronics or cell. A hard fault will **not** be latched or reported as a hard fault if the fault self-corrects within 32 seconds.

Both cell and electronics over temp conditions invoke an automatic closed loop turndown control of the PDM function that results in a constant, but elevated, cell temp. This condition can be sustained indefinitely. If the system can manage the event, no hard fault is delivered. The soft fault is continuous. **This is a summons for service.** Ozone production is curtailed, but not disabled.

On solid - signals a **HARD FAULT** via terminal #11 (pulls low). Ozone production is OFF; the nature of the fault is latched and enunciated.

Power Adjustment

By altering the 'Voltage' setting, you can easily modify the full power operational point if need be. Remember that the purpose of the PDM control is to provide a turndown from the 100% power set-point established by the 'Voltage' pot. Adjustment is very easy and would likely be desired if it is determined that the Plasma Block has much more ozone output than the application requires. You would know this if, for example, the closed loop control from an ORP unit always had the PDM adjusted to a very low value of current, like 6-10ma. For the sake of discussion, let's say we would like to adjust the 10g product from its normal 130w level down to 100w.

1. **Apply a current clip** to one of the AC power wires, terminals 1 or 3 of Con13.
2. **Pull jumper J0**. This forces 100% output.
3. **Verify current** level at factory setting, which at 120vac should be per table: about 1.1a. If this does not agree try another amp meter, or better yet, a power analyzer. An inexpensive and surprisingly accurate power meter can be purchased for $25-$35: UPM model EM100 or Kill-A-Watt from P3 International.
4. **Pull jumper J4**: fault enable. This will prevent any faults, such as current out of window, from shutting down the unit while it's being adjusted.
5. **Pull jumper J15**, which will select the Semi-Auto mode and allow the 'Voltage' pot to be observed.
6. **Adjust 'Voltage' pot** to desired value using the table below as a guide (J16 set to IN). Ozone levels alone can also be used if they are lower. FYI – the processor continues to optimize other aspects of the tuning process as indicated by the **occasional wink** of the 'Locked' LED. Additionally, the processor will not allow excessive levels to be commanded if that may endanger any of the unit's components. If the 'Voltage' control is increased excessively, and a safety limit is reached, the '**HS temp' and 'HOT load'** LEDs will **flash rapidly** in an alternating manor. Simply **reduce** (CCW) the **control** to an acceptable level of current and the LEDs will extinguish.
7. Lock in the new set-point by **pushing the 'Op_OK' button** per the description found in the section titled 'programming current and operating power level'. This permanently stores the new parameters in the processors memory and causes a reboot of the unit.
8. Re-install jumpers: J0, J4 and J15. Re-enable by cycling to OFF and ON.

You should now observe that the PDM level being commanded from the ORP unit is much greater, hence making the control loop more stable.

Power Level Table:

		120/60	208/60	240/60	220/50	
Model	Watts	Amps	Amps	Amps	Amps	
10g	100	.86	.52	.47	.48	
10g	115	.98	.58	.52	.56	
10g	130	1.10	.65	.58	.62	**DEFAULT**
20g	235	1.97	1.16	1.02	1.10	
20g	250	2.10	1.22	1.08	1.17	**DEFAULT**
20g	265	2.22	1.30	1.13	1.22	Must be in a cool environment

<u>Saving current and operating power level</u> - the details

Method of setting "expected power" value and "tolerance" value (for running the "high power and low power" fault detection) is as follows:

Have inverter off for around 4 seconds, to allow "offsets" filters to stabilize.

Turn inverter on, tune it up, making sure PDM duty cycle is at least 67%. A 100% PDM duty cycle is best, if the system can tolerate the resulting power level.

Allow inverter to run at desired operating point for at least 4 seconds.

Push "OP OKAY" button, and see two yellow LEDS come on. (This LED display pattern will remain, as long as you hold the button in for less than 5 seconds.) Release the button, and the two yellow LEDs blink slowly, indicating a loose tolerance of 40% on "expected power" for high-power and low-power detection.

Push "OP OK" button a second time, until you see the two yellow LEDS being on together. Release button, and blinking rate is medium, indicating medium tolerance of 20% for "hi/low detection."

Push "OP OK" button a third time, until you see the two yellow LEDs on together. Release button, and blinking rate is fast, indicating tight tolerance of 10% for "hi/low detection."

Push "OP OK" button a fourth time, until you see the two yellow LEDs being on together. Release button, and blinking rate is slow, indicating we're back to the "loose" tolerance level of 40%.

Select the desired band by the above process. 20% is the recommended default.

Now push "OP OK" button, and hold it in for more than 5 seconds, and you'll see two RED LEDs come on. Release the button, and all of the LEDs come on --> the inverter has computed an 'expected power' value, a 'tolerance' value, and has stored the values in on-chip FLASH, then did a power-down / power-up sequence.

If you held in the "OP OK" button for more than 5 seconds (so you get the two RED LEDs), and then released it, but you DON'T see the "power-up" flashing pattern of lights, then the software did not modify either the "expected power" nor "tolerance" data values. Try again.

Safety issues in the software:

1. If inverter is off, you can get the "two yellow LEDs" and "two RED LEDs" display patterns (by pushing the button "less than 5 seconds" or "more than 5 seconds"), but then nothing happens when you release the button. (Neither the "expected power" value nor the "tolerance" value is modified.)
2. If inverter is on, and you've set up a "tolerance" level (with a "less than 5 seconds" button push), but then don't do any follow-up button pushing, the whole "set up average power" stuff goes back to "idle" after a 60-second time-out.
3. If the inverter is on, and you did not first set up a tolerance value (with a "less than 5 seconds" button push), and then you try setting "expected power" (with a "more than 5 seconds" button push), the software will not modify any "expected power" or "tolerance" values.
4. If the PDM is set to something less than 100%, the "expected power" is computed by scaling the observed power level by 1/(PDM duty cycle). In other words, if duty cycle is 80% when the OKAY button

is held in for more than 5 seconds, the "expected power at 100% PDM" would be computed as expected power = (observed power at 80% PDM) x 1.25. But if the PDM duty cycle is less than 66%, the extrapolation might start to give bad values for "expected power at 100% PDM" and then the inverter's "expected power" values are not modified at low PDM settings.

5. If, when accounting for the PDM duty cycle, the software thinks that the computed "expected power" value would be higher than 0xFF (i.e., larger than what an 8-bit byte can hold), the maximum allowable power supply value will be substituted for expected power.

<u>Setting the power level without a meter, via the 'Start' button</u> - the details

1. Check that J15 is removed. (This is the jumper plug that is most distant from the two pushbuttons.) Note: If J15 is installed, the inverter is set up to run "fully automatic" mode, not "semi-automatic".
2. Check that the jumper plug near the "T1_CMD test point" is in the proper position for your "voltage" command level. For instance, if using the "T1" potentiometer on the board, the jumper should be in the INT position. If using an external potentiometer or PLC, the jumper should be in the EX position.
3. Check that your system can tolerate having the inverter operate at full power for several minutes (PDM will be at 100% duty cycle).
4. Turn the inverter on. Look for the "INV ON" LED to be lit. Note: This procedure will not work unless the HS TEMP indicator is blinking.
5. Push the START button for a time interval between 2 and 4 seconds. (During this push, the HIGH PWR, LOW PWR, and LOCKED lights will all light up in a flashing pattern.)
6. When you release the START button, the "HS TEMP" indicator will blink once per second. Note: This setting procedure will only work if the HS TEMP indicator is blinking.
7. If the LOW PWR indicator is lit up, turn the T1 command "up" slightly. Then wait for 5 seconds to see how things stabilize. If using the T1 potentiometer, turn it CW 1/2 turn, then wait 5 seconds. If the LOW PWR indicator continues to be lit (or blink), continue to turn the T1 up slightly, and wait 5 seconds after each change, until the LOW PWR indicator goes dark.
8. If the HIGH PWR indicator is lit up, turn the T1 command "down" slightly. Then wait for 5 seconds to see how things stabilize. If using the T1 potentiometer, turn it CCW 1/2 turn, then wait 5 seconds. If the HIGH PWR indicator continues to be lit (or blink), continue to turn the T1 down slightly, and wait 5 seconds after each change, until the HIGH PWR indicator goes dark.
9. When you are "close" to the proper point, both the HIGH PWR and LOW PWR indicators will be dark. Turn the T1 control "up" slightly, until the HIGH PWR indicator starts to blink. Note the control's setting (or the screwdriver position). Turn the T1 control "down" slightly, until the LOW PWR indicator starts to blink. Note the control's setting (or the screwdriver position). Put the T1 command setting midway between the "HIGH PWR blink" and "LOW PWR blink" positions. This will be very close to the proper power level.
10. Push the START button for approximately 2 to 4 seconds. (The HIGH PWR, LOW PWR, and LOCKED lights will all light up in a flashing pattern.) The "HS TEMP" indicator will stop blinking. If you don't do this step, then when 2 minutes elapsed since the last time you adjusted the T1 command, the "HS TEMP" indicator will stop blinking on its own. This confirms that the unit is operating at the proper frequency.

Ozone Performance Measurement

PTI's flow bench utilizes tank supplied oxygen, delivered through pressure regulators. Our customer's most often use oxygen concentrators and their feedback confirms the notion that ozone production is equal to or better than PTI's published data using pure oxygen. We use bottled oxygen because many customers require products set to pressures in the range of 20 to 100 psi.

Flow is measured at the cell inlet via both Rotameter and mass flow. **Inlet flow devices** are on the oxygen side at **test pressure,** which implies the Rotameter must be corrected to standard LPM for proper sizing of the concentrator. PTI's mass flow meter corrects for 100% oxygen as well as gas pressure and temperature.

All pressure readings are psig and are measured at the distribution manifold outlet and inlet to minimize any pressure drop errors caused by higher flow rates.

Ozone flows from the Plasma Block under test into the flow bench, and has its flow rate controlled by precision needle valves. From this point on, ozone is essentially at atmospheric pressure. An ozone side stream is encouraged to travel into the analyzer at a rate of about 1 lpm, but is still at atmospheric pressure. A filter is also in-line with the analyzer inlet to prevent any possibility of fouling. All ozone leaves the flow bench at atmospheric pressure.

PTI has chosen the simple Rotameter method of performance presentation in the hope of simplifying the total process. Once a one-time correction is accounted for and the concentrator is sized, the actual running system will agree with PTI's published data, because virtually all installations use simple, inexpensive, air-calibrated Rotameters.

Equipment List:
Power by one of the following: Yokogawa WT110, Magtrol 5100, Fluke 43B, Fluke 41B.
Flow: Key Instruments Rotameters, Mass Flow TSI 4043 (with gas temp and absolute pressure display)
Pressure: mechanical pressure gauges, all $100+
Ozone: InUsa Mini Hicon (g/nm^3)

Compensation equation for PSA concentrator feed gas flow rate:

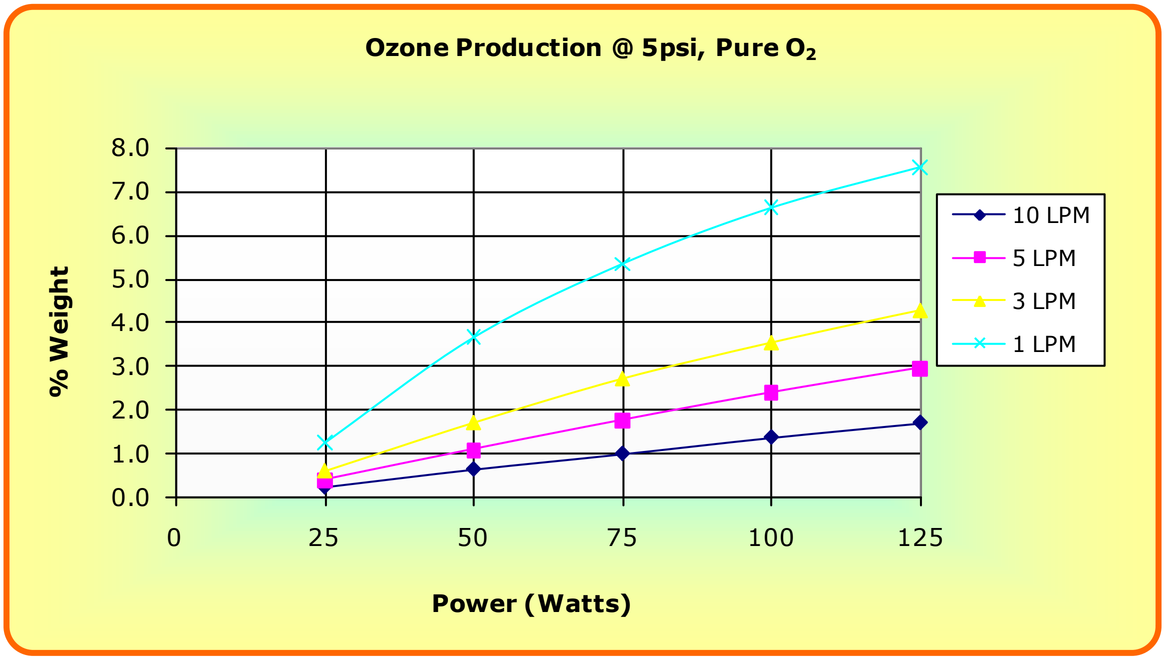
Actual **S**tandard **L**iters/**M**inute ≅ Rotameter flow * (Air to Oxygen flow meter coefficient) * √(14.7+psi)/14.7

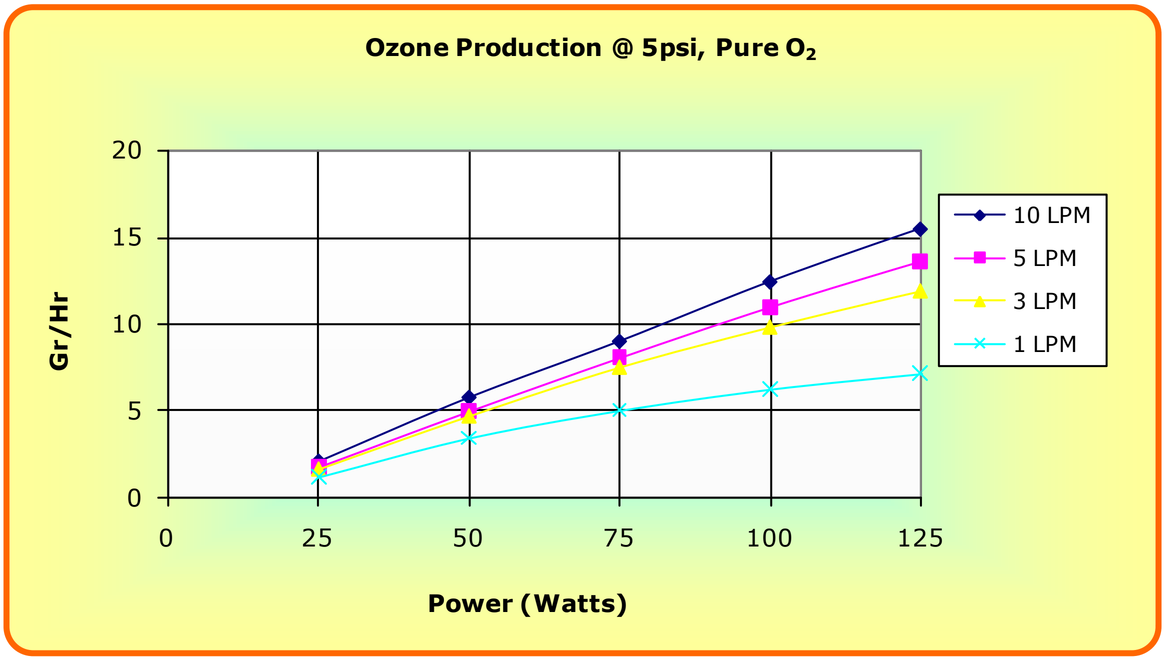
Example: Inlet pressure = **10 psi**; Rotameter flow from test system or performance curves = **12 lpm**

Actual standard Liters/Min ≅ 12 * .95 * √(14.7+10)/14.7
≅ 11.4 * √ 1.68
≅ **14.78 lpm**

Note that temperature correction is generally neglected at typical room temperatures.

10g Plasma Block®

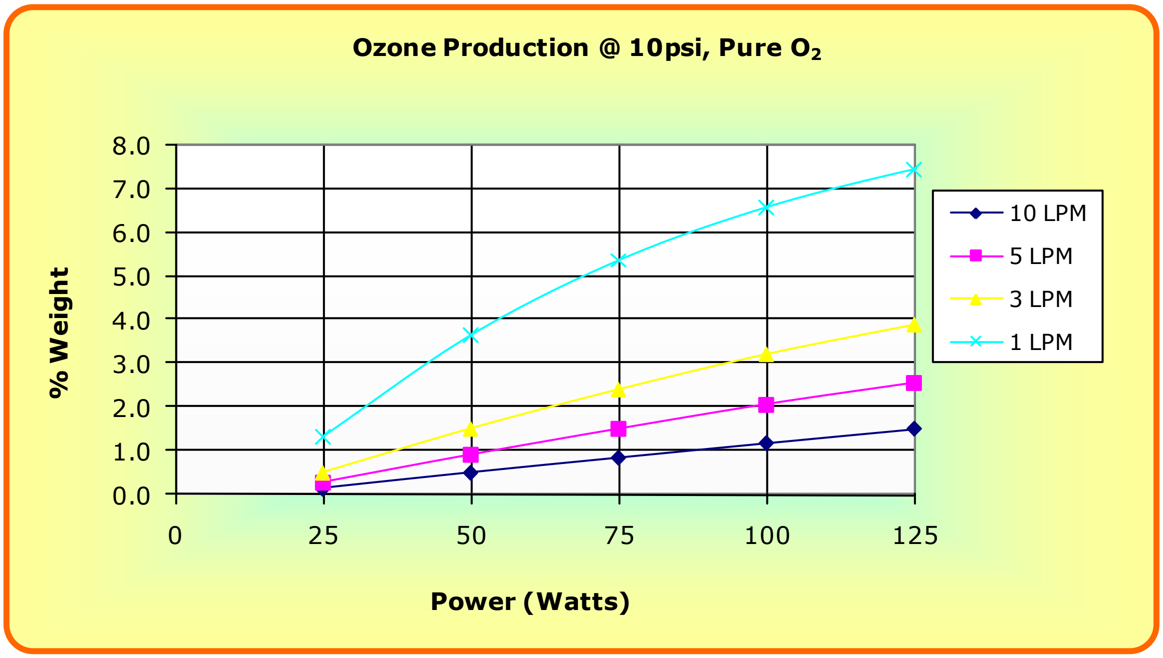


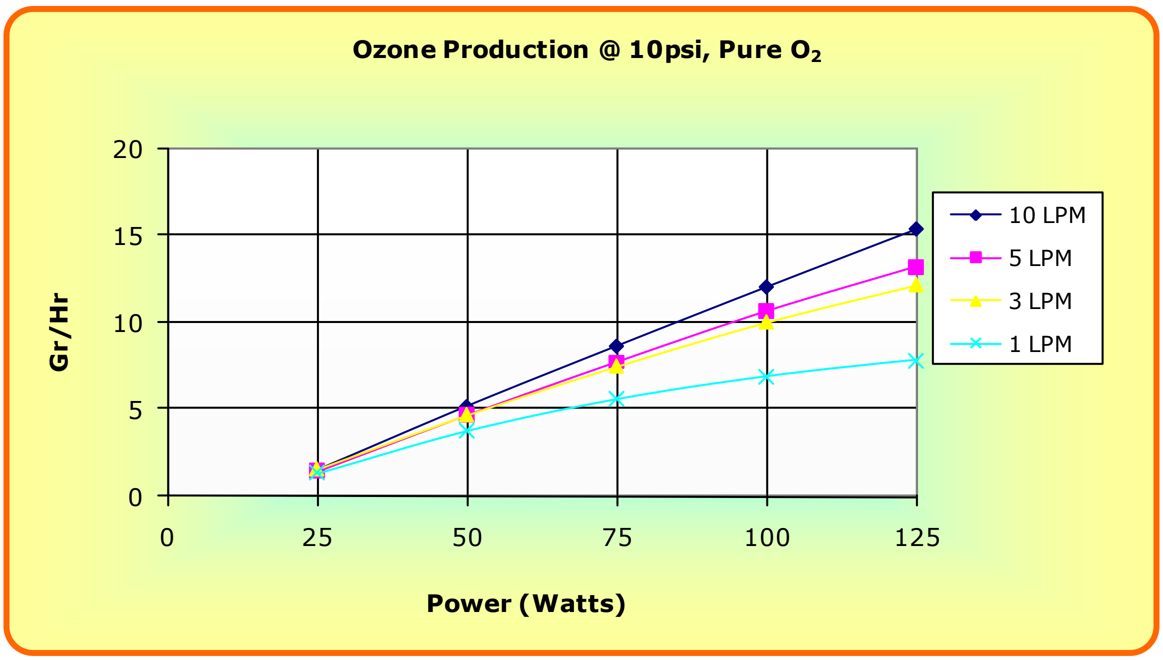


Normal factory POWER set point: 125 watts at FULL PDM (10vdc or 20ma).

Published production-ozone output level (10gr/hr) based on 5% concentration.
Tests conducted at 72°F, 700' MSL: all pressure readings in psig. Ozone in g/nm^3.
Flow measured in **LPM** via **uncorrected** Rotameter at inlet port. Ozone at 0 psi from side stream.
Fan and power supply burden of 17 watts is included in above chart.
Extrapolate lines below 25w for low power ozone output.

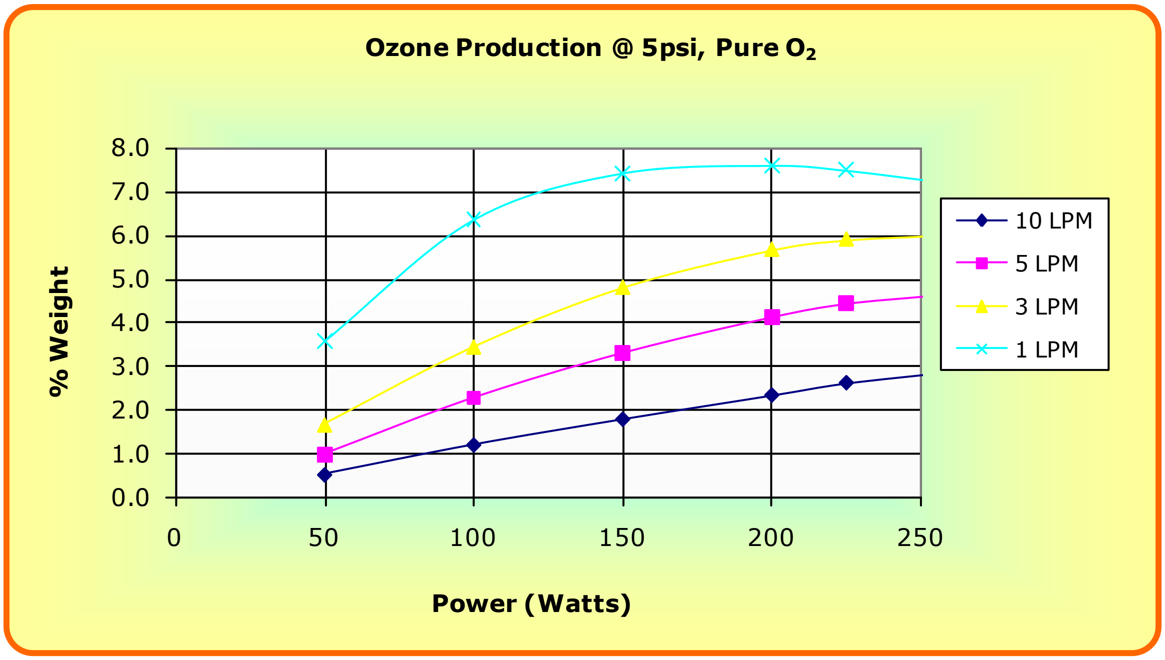
10g Plasma Block®

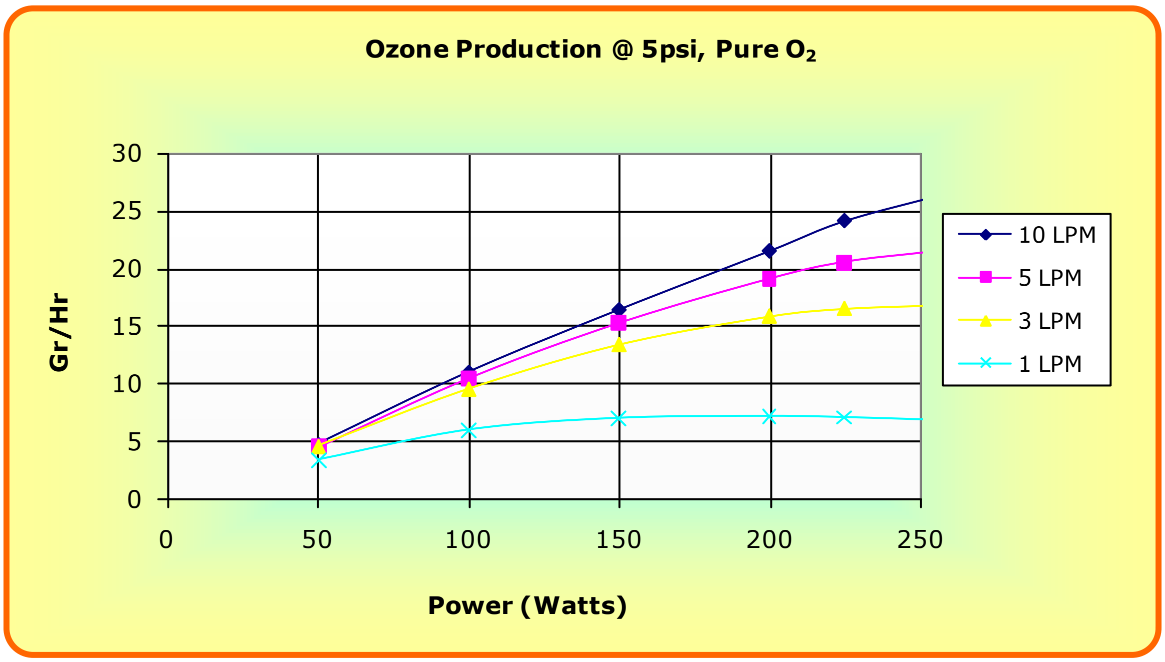




Normal factory POWER set point: 125 watts at FULL PDM (10vdc or 20ma).

Published production-ozone output level (10gr/hr) based on 5% concentration.
Tests conducted at 72°F, 700' MSL: all pressure readings in psig. Ozone in g/nm^3.
Flow measured in **LPM** via **uncorrected** Rotameter at inlet port. Ozone at 0 psi from side stream.
Fan and power supply burden of 17 watts is included in above chart.
Extrapolate lines below 25w for low power ozone output.

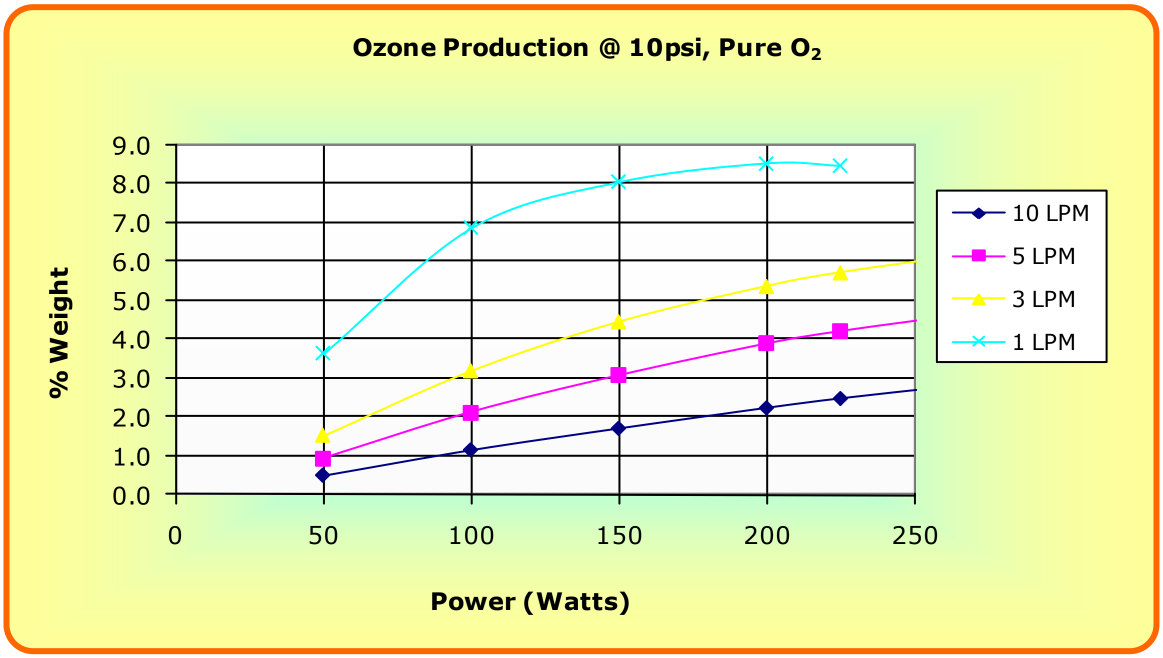


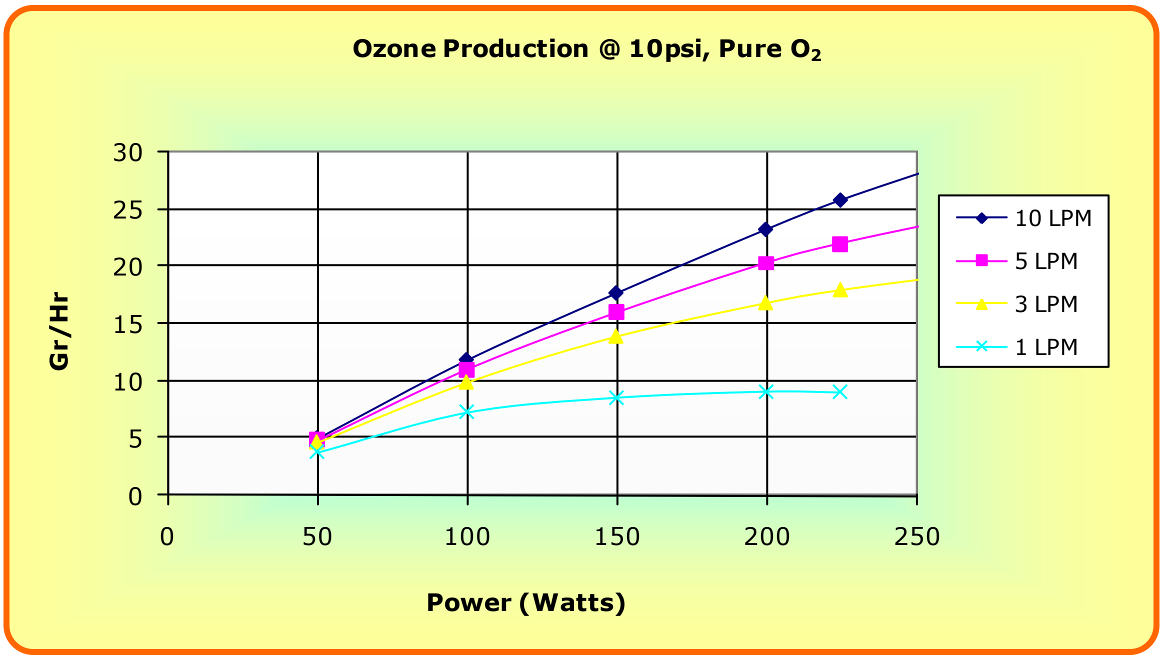


Normal factory POWER set point: 250 watts at FULL PDM (10vdc or 20ma).

Published production-ozone output level (20gr/hr) based on 5% concentration.
Tests conducted at 72°F, 700’ MSL: all pressure readings in psig. Ozone in g/nm^3.
Flow measured in **LPM** via **uncorrected** Rotameter at inlet port. Ozone at 0 psi from side stream.
Fan and power supply burden of 20 watts is included in above chart.
Extrapolate lines below 50w for low power ozone output.

20g Plasma Block®



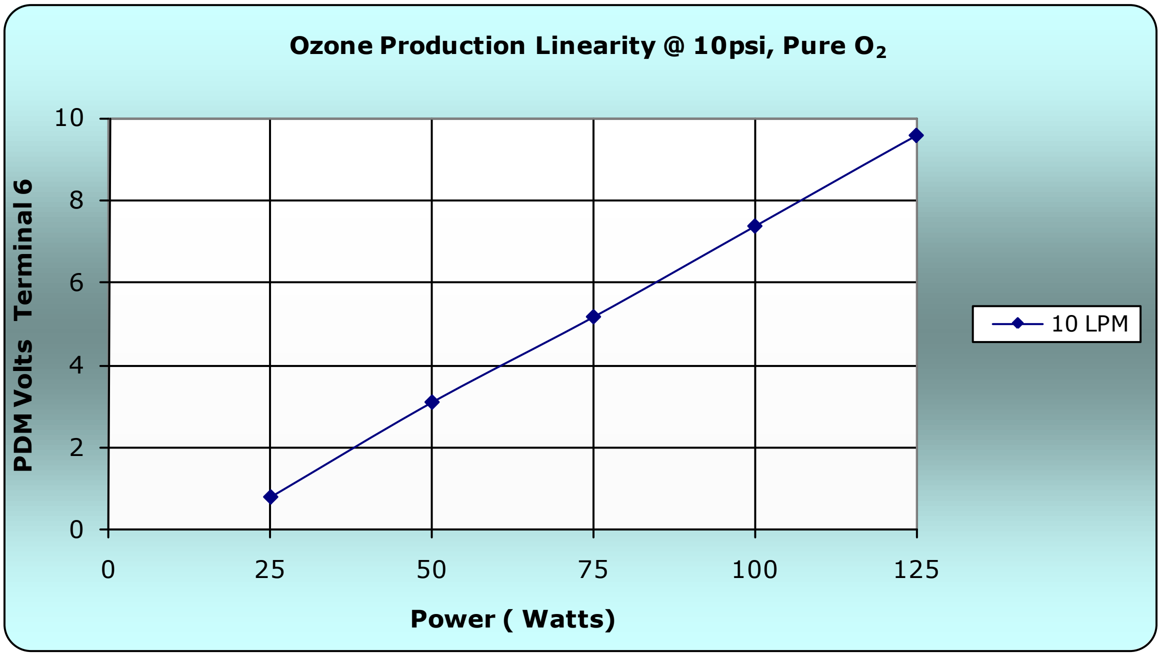


Normal factory POWER set point: 250 watts at FULL PDM (10vdc or 20ma).

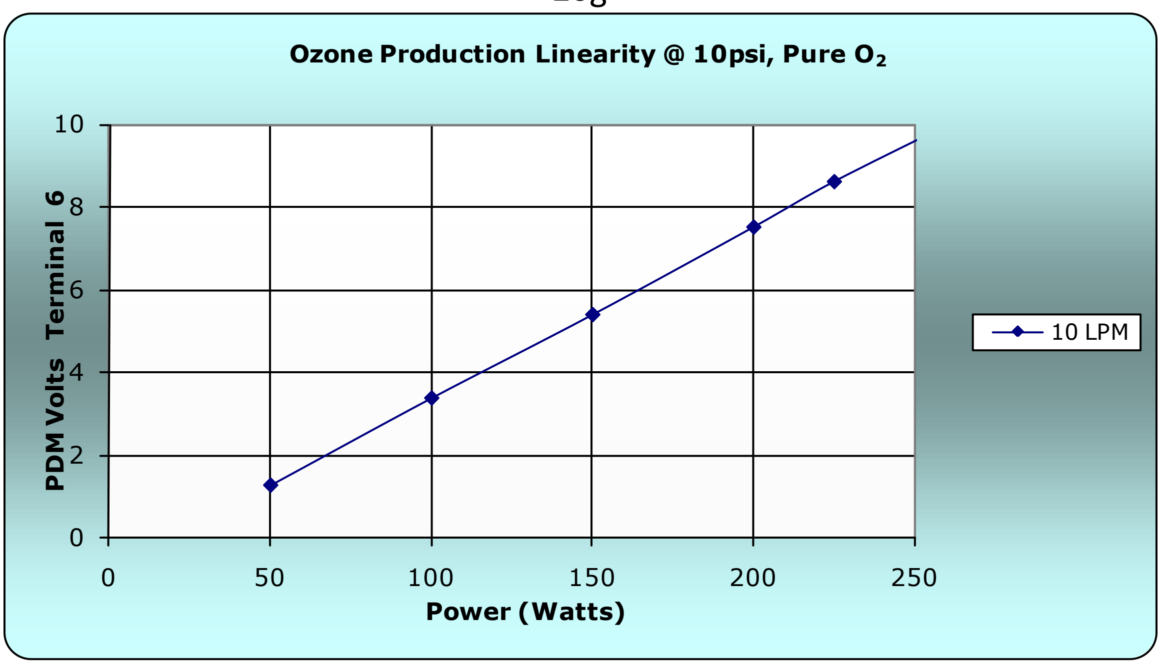
Published production-ozone output level (20gr/hr) based on 5% concentration.
Tests conducted at 72°F, 700' MSL, Gas: 'Standard' In; 'Normal' Out.
Tests conducted at 72°F, 700' MSL: all pressure readings in psig. Ozone in g/nm^3.
Flow measured in **LPM** via **uncorrected** Rotameter at inlet port. Ozone at 0 psi from side stream.
Extrapolate lines below 50w for low power ozone output.

Ozone Linearity vs PDM Command Signal

10g



20g



1900 William Street Racine, WI 53404-1875 Tele: (262) 637-7180

Fax: (262) 637-7157
Web Page: http://www.plasmatechnics.com
http://www.plasmablock.com

E-Mail: sales@plasmatechnics.com