Q_START MANUAL

DAT210/213

Digital Auto Tuning

Version V1a

MOUNTING

This manual covers a programmed DAT 210 (single phase mains) or DAT 213 (3 phase mains) inverter. The inverter is usually set up for a specific application and requires only installation wiring to operate correctly at startup. If the application is changed or flexible, refer to the section on tuning the inverter in this or the complete standard manual.

DAT means Digital Automatic Tuning that allows the inverter to maintain constant power into an ozone system load over changing gas pressures and flow rates. It does this by:

Automatically changing the frequency to seek resonance at the programmed power
Automatically changes the output voltage to compensate for mains voltage changes

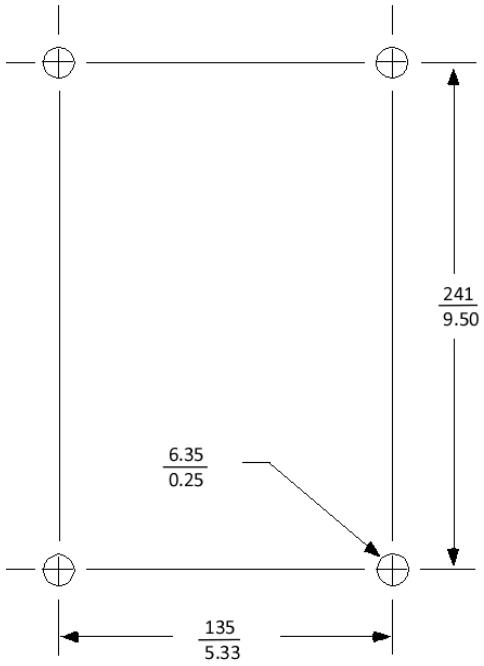
Mechanical Installation

Do not mount the inverter in a cabinet and then start drilling holes in the cabinet. Metal chips on the circuit board can destroy it.

Check that there is adequate clearance in front of the fan for adequate cooling.

The ambient air temperature should not exceed 40°C (104°F)

Hole pattern:



SSD110 Mounting Dimensions

ELECTRICAL INSTALLATION

Observe all wiring codes. Install wiring separating the control and low power wires from the high power mains or any high voltage wiring.

190 to 240 VAC operating voltage. **DO NOT** apply 480 VAC to this inverter.

Mains wiring

Power ratings (208 – 240 VAC):

Less than 2 KVA use a soft start relay circuit
The single phase effective power factor will be 0.6

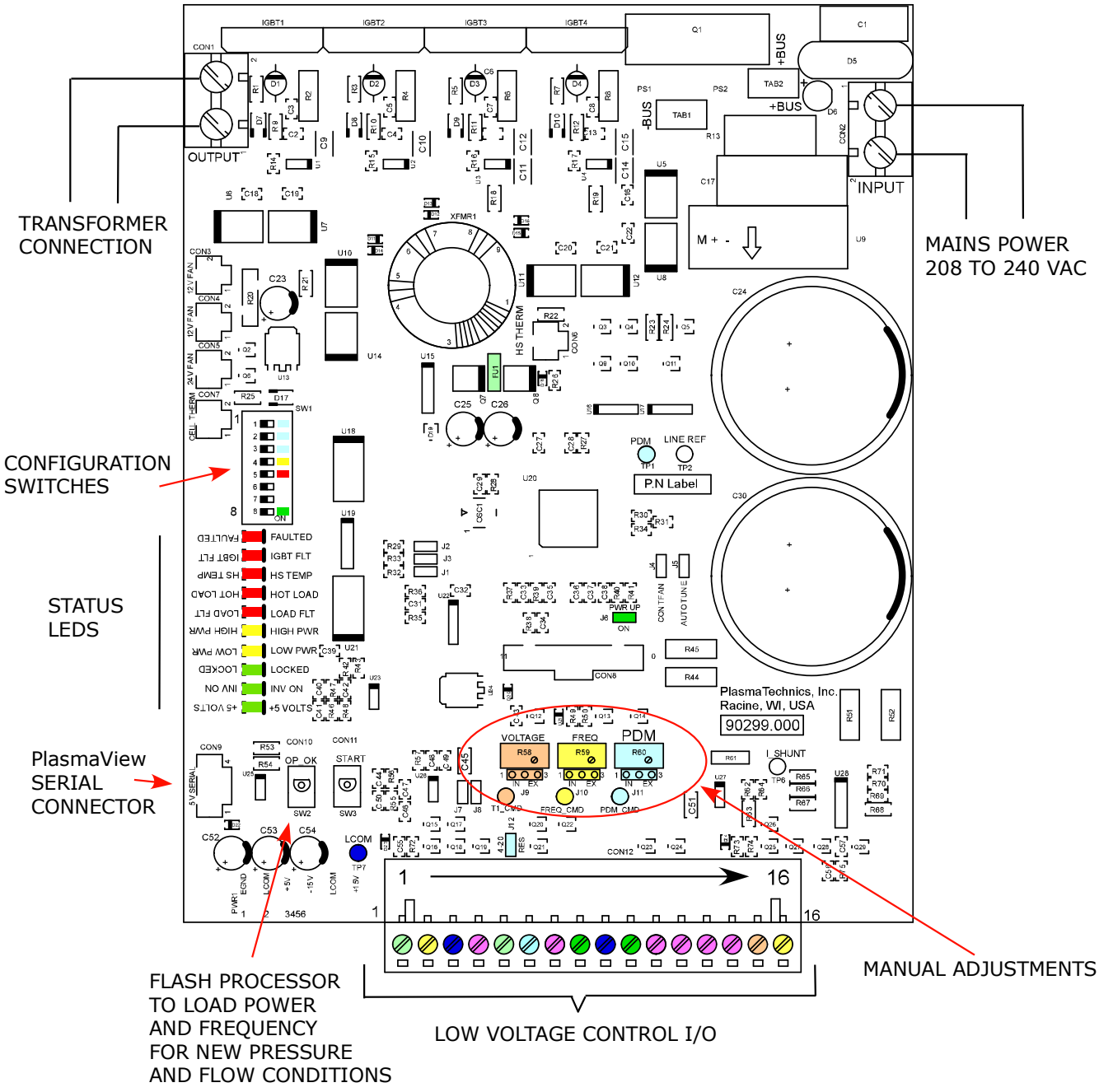
Greater than 2 KVA use 3 phase power – Use a soft start and link choke on the DC after the mains rectifier.
The three phase effective power factor will be 0.9

The soft start prevents high inrush currents due to filter capacitor charging when power is applied. The link choke reduces the ripple current in the filter capacitors (and mains 3rd harmonic) and improves the power factor from 0.6 to 0.9.

The inverter is capable of 25 Amps RMS 1.0 power factor mains current continuous. This means at 240 VAC mains, 6 KW is available with the voltage potentiometer turned full clockwise maximum. Take care so your equipment is not over powered.

For greater detail to help with system design and configuration refer to the complete manual.

DAT210


TRANSFORMER CONNECTION
MAINS POWER 208 TO 240 VAC
CONFIGURATION SWITCHES
STATUS LEDS
PlasmaView SERIAL CONNECTOR
FLASH PROCESSOR TO LOAD POWER AND FREQUENCY FOR NEW PRESSURE AND FLOW CONDITIONS
LOW VOLTAGE CONTROL I/O
MANUAL ADJUSTMENTS
OUTPUT
INPUT
PlasmaTechnics, Inc.
Racine, WI, USA
90299.000
P.N Label
VOLTAGE
FREQ
PDM

LOW POWER CONNECTIONS

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 DAT210 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 [Active low means that the terminal output is at 0V (Pin 3) when the alarm or other condition is present]. Terminal current is positive source only and is limited to 100 ma.

TERMINAL

1. +15, aux use limit = 1 Amp maximum.
2. Frequency Adjust (optional) external control, selected by jumper J10. Use 5k Ω pot, 0-10vdc only (10v= 100%). 10 volts can be derived with a 2.0 K resistor in series with the pot to +15 (Pin 1).
3. **Signal Common**, tied to #9 internally.
4. Flooded cell detector. (Current production inverter)
5. +5vdc, aux use limit = 3 Amps **The 5V can be used to drive a 5 V coil relay for input current pre-charge and for PLC use for low voltage power supply status. There is a 1 – 2 second delay before +5 V after application of mains voltage.**
6. **PDM input** (optional), selected by jumper J11, use 5kΩ pot, 0-10vdc (10v= 100%). 10 volts can be derived with a 2.0 K resistor in series with the pot to +15 (Pin 1). 0 – 10 volt control or 4 – 20 & 0 – 20 ma is selected with J12. All voltages/currents are with respect to Pin 3 (0V).
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 in series with the transistor for current limit.
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.

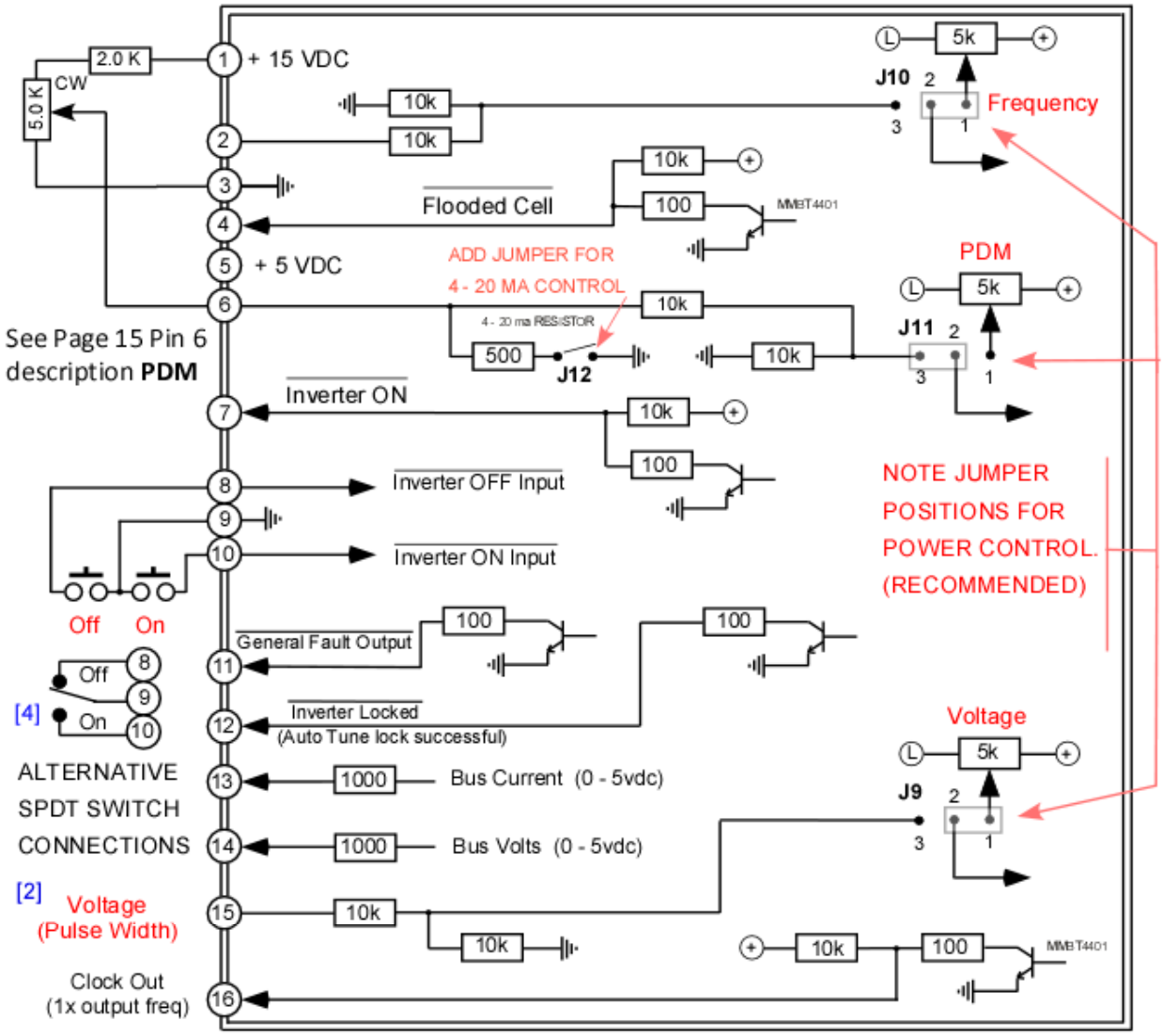
13. Analog 0 – 5vdc, follows average DC bus current out. Direct op amp (MC33272AD) thru 100Ω resistor.

14. Analog 0 – 5vdc, follows DC bus voltage. Direct op amp (MC33272AD). 10kΩ series resistor.

15. Voltage Adjust input (optional), selected by jumper J9, 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 series protection resistor.

DAT210 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, 2000 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.

DAT 210 JUMPER CHART

SWITCH SW1	SWITCH POSITION	NAME	FUNCTION IF INSTALLED
S1	ON	PDM Enable	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.
S2	OFF	LOW PDM	Lower PDM period than 30 Hz
S3	OFF		Not implemented
S4	ON	HIGH/LOW current fault	A window of normal operating current. This will cause a fault if either the LOW or HIGH value is exceeded.
S5	OFF	Soft fault	Produces a wink in fault line #11 if one or more operational windows are exceeded beyond the factory limit. Will not shut down the inverter like a hard fault but attention is needed. The fault is being managed by the inverter processor.
S6	OFF	PDM Ramp	Default – 5 sec. for inverter to ramp from 0 – 100% power. Switch ON is immediate ramp to 100% inverter power.
S7	OFF		Spare
S8	OFF	4/20 ma.	Configuration for 4 - 20 ma. control 0 - 100% ozone output. At 2 ma the INV_ON LED will flash. At 3 ma. The output is reinabled. If the jumper is removed, 0 - 10 (0 - 100%) volts controls the ozone output. If the command is for zero ozone, the inverter will be in standby.

JUMPER	INSTALLED DEFAULT		
J101	OUT	ON with power up	ON-OFF command change. The inverter will turn ON 5 seconds after power is applied and turned OFF when power is removed. This is not recommended because it eliminates gas purge.
J1, J2			Alternate methods of inverter startup. See Pages 17 – 19.
J3	OUT	SEMI-AUTO Tune	J5 out, voltage pot active to set maximum power. Frequency control is automatic.
J4	OUT	Manual fan	Fan goes on when power is applied and off when removed.
J5	IN	Full AUTO-TUNE	Voltage and frequency pots are not active. These parameters are controlled automatically. In SEMI-AUTO mode, the voltage pot controls total power but frequency control is automatic.
J9	IN	Voltage control pot	1 - 2 jumper = internal control. 2 - 3 = external
J10	IN	Frequency control pot	1 - 2 jumper = internal control. 2 - 3 = external
J11	IN	PDM control pot	1 - 2 jumper = internal control. 2 - 3 = external
J12	*Stow	Installed = 4/20 ma. Or 0/20 ma. OUT = 0 - 10 VDC	Adds 500 ohm resistor to control input. If two or more DAT 210s are to be controlled via one current loop, wire all Connector CON12 term. 3 together and all term. 6 together and install J12 on one DAT 210 inverter. Usually S8 ON and J12 jumper are used together.

*Jumpers that are available for customer needs are stored on one pin.

TUNING THE INVERTER

Safety Considerations

DANGEROUS VOLTAGES ARE ON THIS CIRCUIT BOARD

To avoid injury to personnel and/or damage to equipment only qualified personnel should perform the procedures outlined in this chapter. This person must understand both the electrical and mechanical components associated with the application.

Thoroughly read and understand the following procedures before beginning the start-up process. The following specific safety procedures must be observed when performing any maintenance or adjustments on the amplifier.

Always turn off and lock out AC power at the main machine disconnects switch. Do this before touching any electrical or mechanical components.

High voltage may be present even with all electrical power supplies disconnected.

Use an appropriate meter to verify that all DC bus capacitor banks have been discharged before working on any equipment. Do not rely exclusively on high voltage RED LED indicator for bus voltage, as dangerous voltage levels may remain even when the indicator is off.

Follow industry recognized safety procedures. Use only one hand to hold test equipment probes, wear approved eye protection, etc. Before energizing the inverter, make sure that device(s) connected to the output of the inverter will not result in injury or damage to equipment. Keep unnecessary personnel out of the immediate work area. Never leave an inverter cabinet open and unattended.

Start-up Checklist

To ensure a complete checkout and test, check off each step as it is completed. If the proper event does not occur while performing this start-up procedure, do not continue. Take the appropriate action to correct the malfunction before proceeding.

- Ensure the main disconnect switch is locked off. High voltage may be present even with all electrical power supplies are disconnected. Use an appropriate meter to verify that all DC bus capacitor banks have been discharged before working on any equipment. Do not rely exclusively on RED LED indicator of bus voltage, as dangerous voltage levels may remain even when indicator is off.
- Verify that the inverter mounting has been performed in accordance with the guidelines listed in
- Chapter 2.
- Inspect the inverter to verify that all optional modules have been selected and installed according to the system drawings and documentation.
- Verify that all wiring has been installed according to the wiring plan produced by the design engineer and according to the guidelines listed in Chapter 3 for proper connection, grounding, wire size, labeling, routing and applicable codes. The DAT 210 does not have internal fusing. Install input and output (optional) fusing per suggestions Page 23.
- Verify that all electrical terminals, screws, nuts, and bolts are securely fastened.
- Apply high voltage DC or single-phase AC power to the inverter as specified.
- Check to make sure that the RED Bus voltage LED is on, indicating bus voltage.

START-UP PROCEDURE POWER ADJUSTMENT

1. For PlasmaBlocks®

Reasons for changing the factory setup:

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. The goals are 1) Maximum power and 2) Current High/Low limits. Adjustment is very easy.

If it is determined that the Plasma Block® has much more ozone output than the application requires. You would know this if, for example, if the closed loop control from an ORP unit always had the PDM adjusted to a very low value of current, like 6-10ma.
OR
A PlasmaBlock® is going to be applied at pressure and flow range that is different from the factory setup.
OR
If the inverter was purchased to be used with a PTI resonating inductor and transformer set to drive a new cell or changed cell configuration, the inverter would have to be tuned.

REMOVE POWER FROM THE INVERTER FOR SET UP

1. **Install a true RMS current clamp-on meter** to one of the mains AC power wires. A power meter could also be used.
   Note: An inexpensive and surprisingly accurate power meter can be purchased for $25-$35: UPM model EM100 or Kill-A-Watt from P3 International.
2. **PDM should be set at 100%.** Another method of turning the PDM to full ON if it is more convenient is to turn **Switch S1** OFF. This forces the PDM at 100%.
3. **Verify Switch S4 and S5 OFF**: fault enable. This will prevent any faults, current exceeding the High/Low limits for example, from shutting down the unit while it's being adjusted.
   Note: Maximum power safety is now OFF. It is possible to damage the ozone cell.
4. **Pull jumper J5 AUTO**, which will select the **Semi-Auto** mode and allow the **VOLTAGE** pot (potentiometer) to be manual active. The frequency will still be automatically adjusted for resonance.
5. **Turn the VOLTAGE pot counterclockwise (CCW)** until clicking sound indicates minimum.

APPLY POWER TO THE INVERTER – TURN THE INVERTER ON

6. **Adjust the VOLTAGE pot CW** to the desired maximum current (power) level permissible. Ozone levels alone can also be used to establish maximum power if satisfactory at a lower current (power). The processor continues to optimize other aspects of the tuning process as indicated by the occasional 'wink' of the **LOCKED** (resonant frequency found) LED. If the **VOLTAGE** control is increased excessively (pot CW), and a safety limit is reached, the pair of Red LEDs will **flash rapidly** in an alternating manor. This will not damage the ozone cell. Simply **reduce** (CCW) the voltage **control** to an acceptable level of current (power) and the LEDs will extinguish.
7. **Set the High/Low power limits.**
   Push the **OP_OK** push switch once (1 to 5 seconds). Two Yellow LEDS will come on and blink slowly. This is the +/- 40% power fault tolerance limits.
   Push **OP_OK** once again. The Yellow LEDS will flash faster. This is the +/- 20% limit.
   Push **OP_OK** once again. The Yellow LED will flash even faster. This is the +/- 10% limit.
   Keep pushing **OP_OK** and the cycle repeats.
   The normal factory recommended limit is +/- 20% (40% total).

8. Lock in the new operating point by **pushing and hold the 'Op_OK' button until the Red LEDs come ON**. Then release it. Then ALL the LEDs will come ON (except FAULT) momentarily to acknowledge your input and the inverter will turn OFF. This action permanently stores the new parameters in the processors memory and causes a reboot of the unit.
9. Set Switches **S1, S4** and **S5** to ON. Reinstall **J5** (AUTO_Tune). Re-enable by cycling the inverter OFF and ON.
10. Now observe the inverter gradually increase power to the new programmed level automatically at 100% PDM. Frequency control is automatic and the **LOCKED** LED will cycle indicating frequency lock. The inverter PDM can now control power from 1% to the 100% new programmed value.

You should now observe that the PDM level (power control) being commanded from the ORP unit is much greater, for example, hence making the control loop more stable.
OR
The inverter is now properly configured for the new ozone cell components
OR
The inverter is now properly configured for new pressure or flow ranges.

2. For other manufacturer's generator cells or other applications

Make sure the inverter has the correct code for the frequency range of interest. Either the factory has or will set this up before shipment or you will need a PC in terminal mode connected via USB to RS-232 to the inverter board. Call the factory for the correct codes and instructions.

Monitor the line current with a true RMS ammeter. The following assumes power factor correcting components are installed. See the 700250 inverter assembly.

It will be necessary to configure the inverter for a manual mode of operation.

S1 OFF	Forces PDM to 100% maximum for tuning purposes
S5 OFF	Disables alarms and power limits. **It is possible to apply too much power**
Jumper J3 IN	Enables Manual operation of frequency and voltage
Jumper J5 OUT	Disables full Auto-Tune

Turn the FREQUENCY pot full clockwise until clicking sound is heard

Turn the Voltage pot full counterclockwise (minimum) until clicking sound is heard then CW 3 turns

Procedure:

1. Observe the current or power meter and reduce the frequency by turning the Frequency pot CCW.
   The power will peak at a lower power because the Voltage pot is turned down.
   If the frequency is lowered too far (CCW) the power will reduce. You want the peak.
2. Increase the voltage at the current (power) peak until ½ of the maximum desired current per leg (power) is reached.
3. Readjust the frequency slightly to find the current peak.
4. Increase the voltage until the current reaches 90% of the expected maximum power.
5. Verify the frequency is still at peak with the frequency pot.
6. Increase the voltage pot CW to reach 100% expected power.
7. Set the High/Low power limits.

Push the **OP_OK** push switch once (1 to 5 seconds). Two Yellow LEDS will come on and blink slowly. This is the +/- 40% power fault tolerance limits.
Push **OP_OK** once again. The Yellow LEDS will flash faster. This is the +/- 20% limit.
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10. Now observe the inverter gradually increase power to the new programmed level automatically at 100% PDM. Frequency control is automatic and the **LOCKED** LED will cycle indicating frequency lock. The inverter PDM can now control power from 1% to the 100% new programmed value.

If during the manual portion of the tuning effort it is not possible to reach the current peak, then call the factory to help diagnose the reason. It may be that the load is very insensitive to the frequency and that Auto-Tune is not feasible. In that case, expect the inverter to be left in the manual mode.

TROUBLESHOOTING

PROBLEM	STEP	VERIFY	NEXT STEP
ON - OFF switch/PLC control - nothing happens	1	Is there power to the inverter?	No - troubleshoot elsewhere. Yes - Get a voltmeter and do Step 2
	2	Was there 5 seconds between applying power and the ON command?	No - increase the timing between application of power and the ON command. See Section 6 p.18 & 19. Yes - Step 3
	3	+5 VDC between Terminals 5(+) and 3 on CON12 and +5 green LED ON?	No - Check connector seating, broken wires to the small power supply inside the generator toward the rear. Replace supply if necessary. Yes - There is power to the inverter. Step 4.
	4	Is the "INV ON" light on? Measure voltage terminals 3 & 5 on Connector 12. Verify if the external command output power setting is at zero? Verify 4/20 or 0 - 10 VDC control as set by Switch 8 on the inverter board.	No - Step 5 Yes - Increase the ozone output control voltage/current.
	5	If you have gone through steps 1 - 4 without results, it is possible that the inverter board has failed.	Replace the inverter circuit board. Refer to the instruction sent with the replacement to ensure reliable operation.

FAULT indicators on the circuit board are illuminated.

ALL LEDS flashing	1	Low voltage power supply cycling on and off	Problem with a broken wire, mis-wiring or shorted circuits in the inverter electronics. Look for metal drilling chips caused by contractor drilling. If there, vacuum the electronics thoroughly and retry. If this is not the problem, go to 2.
	2	If there are no other shorts in the system or the system is mis-wired, the low voltage power supply may be defective.	Replace the low voltage power supply.
FAULTED light - Flashing = soft fault temporary condition	1	Caused by: High or Low cell current, high instantaneous current in power section, over temperature in the electronics or cell.	Usually this fault is a result of improper tuning of the inverter beyond factory limits. Go to Step 2
	2	Is the ambient temperature greater than 40 C (104 F)?	Yes - Improve ambient air flow. Inverter will eventually compensate by running at reduced power. No - Go to Step 3
	3	Retune the inverter using the procedure in Section 7. Review Section 4.	This should solve the problem if flashing. Flashing is a "call for service" with reduced ozone output.
FAULTED light - On solid = Hard fault condition and the inverter is locked OFF	1	Look at other fault lights to diagnose the problem. Ozone production is turned OFF.	Go to step 2.

IGBT FAULTED	2	Is IGBT faulted light ON?	Yes - There is a short in the inverter output section that has exceeded the allowable event limit. Look for damaged or loose wires, metal chips, water corrosion or anything that could cause a short. No - Go to step 3
HS TEMP	3	Is HS TEMP faulted light ON?	Yes - Review Status LED description for detail No - Go to Step 4
HOT LOAD	4	Is HOT LOAD faulted light ON	Yes - Review Status LED description Section 6 for detail. No - Go to Step 5
LOAD FAULT	5	Is LOAD FAULT light ON?	Yes - Possible water flooded cell due to the process entering the cell. If the process water is clean, empty the water out of the cell and flush with DI water or 91% alcohol. EMPTY FLUSH WATER FROM CELL! Then dry with very dry oil free air or oxygen for several minutes. Try to operate again. Do not disassemble the cell. Call the factory. No - Go to Step 6.
HIGH POWER	6	Is HIGH POWER light ON?	Yes - Review Status LED description Section 6 for detail.
LOW POWER	1	Is LOW POWER flashing?	Yes - This is non-critical indication that the power is less than the programmed window. No - Go to Step 2
	2	Is LOW POWER ON steady?	Yes - Output current is too low than the programmed window. If this condition remains for more than 32 seconds, a hard fault will shut off ozone and turn on the fault LEDs for diagnostics. Review Status LED description in Section 7 for more detail.