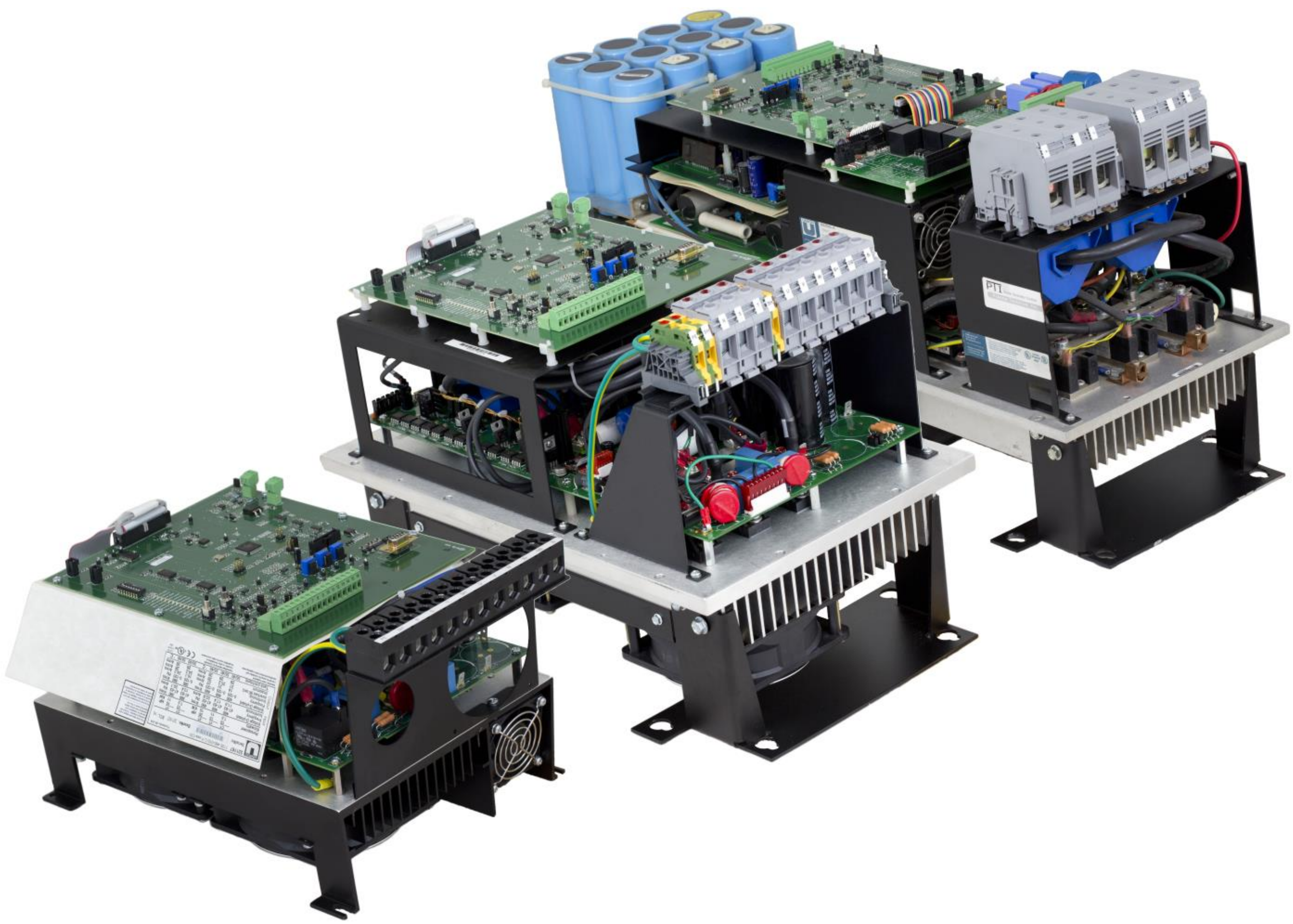
Plasma Technics, Inc.®

INSTALLATION AND OPERATION MANUAL

DAT 510 INVERTER

3 Phase Mains / 1 Phase Output (U-V)

Digital Auto Tuning



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NOTE:

THIS MANUAL COVERS THE DIGITAL AUTO TUNING DAT510 CONTROLLER FOR OZONE GENERATOR SERVICE. USED IN CONJUNCTION WITH Unico INVERTER.

The information contained in this manual is considered accurate to the best knowledge of the supplier at the time of publication. The manufacturer, however, assumes no liability for errors that may exist. The supplier reserves the right to change data and specifications without notice.

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PCB I.D. Label: 90329.001
PCM I.D. Label: 90447.000

Table of Contents:

1 Unpacking

1.1 *Verify delivery.*

Check that you received the inverter and optional equipment that was ordered. Verify that the part numbers match your purchase order and that the correct options have been installed. Report any discrepancies to your supplier.

1.2 *Inspect for damage.*

Inspect the inverter for damage that may have occurred during shipment. Visually examine the contents for obvious problems.
If damage is found, do not operate the inverter. Report the problem immediately to your supplier.

1.3 *After the initial inspection.*

Your inverter can be repacked and stored for future use. Choose a storage location that is clean and dry.
Do not store in ambient temperatures below 5° F or above 158° F (-15°C to 70° C)
Do not store in wet areas or areas of high condensation.
Do not store in corrosive environments.

2 Mechanical Mounting of DAT510 Controller

Proper mechanical installation of the DAT510 is necessary to ensure both reliable and efficient operation and ease of maintenance.

2.1 *Mounting Environment*

The inverter 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: 0° to 40° C (32° to 104° F)

Relative humidity: 5 to 90%, non-condensing.

Altitude (maximum): 1,000 M (3,310 ft), de-rating for altitude is 1% for every 100 M (300 ft) above 1000m.

2.2 *Mounting Considerations*

The following should be considered when planning the physical installation of your DAT510.

Leave enough clearance for access to all electrical connections.

Allow room for troubleshooting.

Allow at least 80 mm (3 inches) of clearance above and below the unit to permit adequate cooling airflow.

The DAT510 / Unico is fan cooled in order for the inverter to be run at full output power. Consult the factory for heat sink only de-ratings or fan placement. In the final installation the convection cooled DAT510 should be mounted with the cooling fins vertical so as to maximize the effects of normal convection cooling. The cooling fan can be mounted in any orientation. Allow a minimum clearance of 25 mm (1.0 in.) between units when mounted side by side. Separate conduit is required for line voltage and control wiring.

2.3 *How to Mount the Inverter*

Section 3 of the Unico manual shows the mechanical layout of the DAT510 / Unico inverter. Refer to this drawing when planning your layout. The inverter is an open type of equipment and should be mounted to a secure sub-panel or frame.

CAUTION:

Make sure the mounting rack is secure before mounting the inverter. Equipment damage could result from an improperly mounted rack or inverter. Electronic components and circuit boards may require temporary physical protection while maneuvering and mounting the heavy inverter assembly.

3 Electrical Installation

3.1 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.

3.2 Inverter Electrical Connection Wire Sizing and Fusing

The DAT510 3 phase input current rating is 12 amps/leg RMS, 525vac. Output current rating is 15amps RMS. 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.

Terminal connection max torque 0.6 newton meters (Nm) [5.3 inch lbs].

3.3 Case Ground

Each of the inverters 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.

3.4 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.

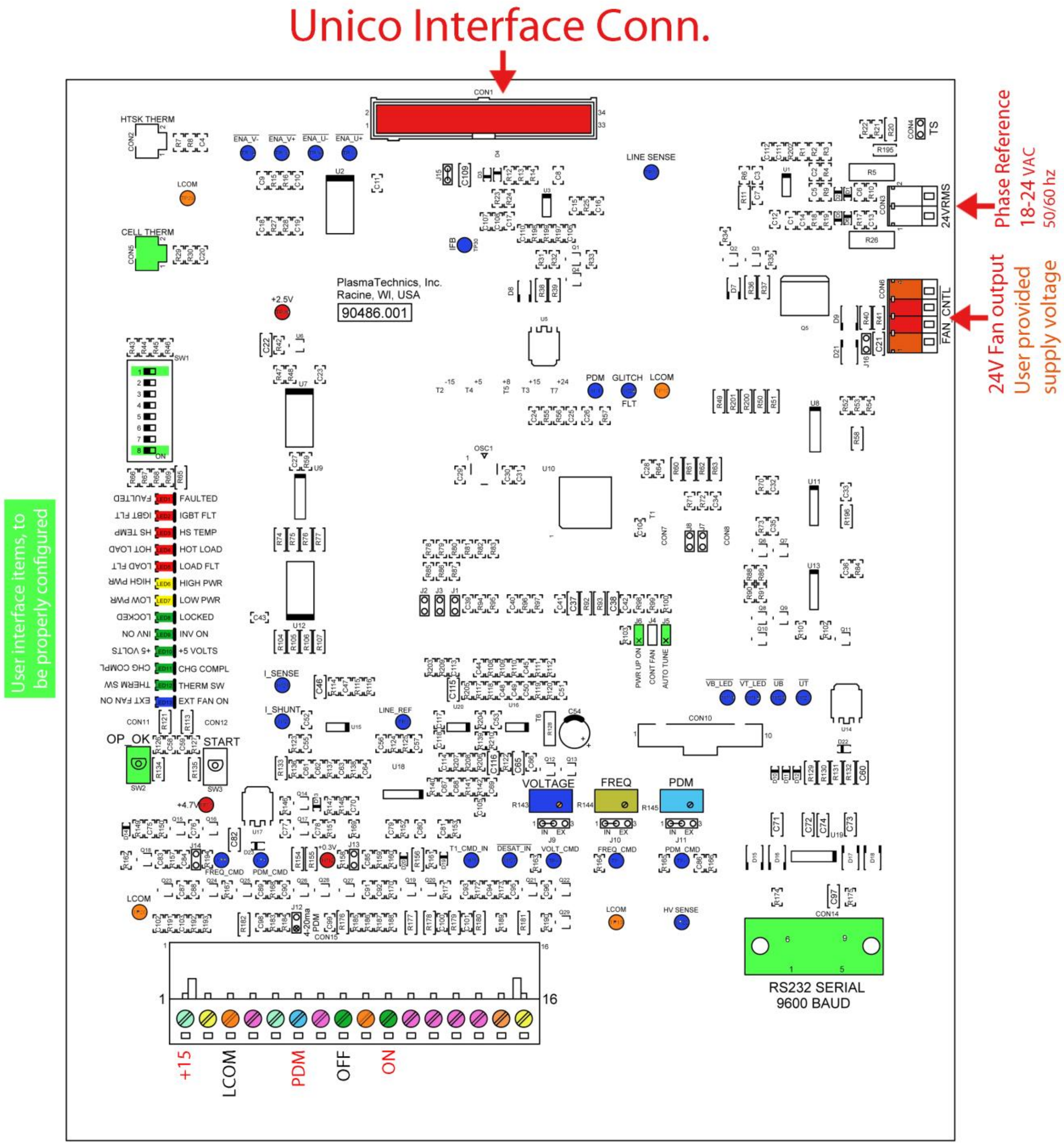
3.5 Soft Charge

The DAT510 and combined Unico Inverter provide completely managed soft charge. High input single cycle surge currents are limited and completely integrated with the Unico power platform. The soft charge procedure increases the bus capacitor life. The DAT510 is unique in that the soft charge event is completely processor managed and also includes instant response to transients and brown-out situations which release the unit from damaging surges and re-engage the DAT when stable power is restored. Adjustment to other standards like 380v / 50hz is automatic. Soft Charge completion is enunciated by LED labeled 'CHG COMPL'.. The processor automatically defers a run command until the soft charge is measured as complete, I.E: not a timed event.

3.6 Surge and Current Protection

Fusing is the customers responsibility, all else is Incorporated in Unico Power platform.

Figure 3.1 DAT510 Controller Layout



4 Inverter Output Calculations & Waveforms

4.1 Ratings and Measurements

It is very important to measure, evaluate and understand the electrical performance of the system. Calculations below presume PCM and 3 phase mains.

Wattage can be either measured or estimated using the generally accepted premise for DC supply devices. In this example the 3 - phase power line input to the Inverter is supplying 5 amps/leg:

Watts ≈ (Volts * current) * .9 (estimated power factor)

Equivalent single phase current: 5 amp/leg * 1.732 = 8.66a

∴ (480v * 8.66a) * .9 = 3741 Watts

The general rule for any type of transformer that determines the maximum primary amps ***regardless*** of applied primary volts is: **Nameplate VA / Configured Volts (not applied volts)**

Example: 5000va / 480v = 10.42a max or 3000va / 480v = 6.25a max.

Note that maximum primary amps is not related to applied volts. If the applied primary voltage is 50% of the rated value then the VA rating of the transformer has effectively been cut in half.

To continue with this example, if the expected ozone performance is being achieved with 50% of rated primary voltage then it is likely that the output voltage rating of the transformer is twice as high as it should be. Under these conditions the inverter input current could be well within its rating but the transformer could be at twice its rated primary current. This is why it is essential to also measure the transformer primary current. If a voltmeter is available rather than an amp meter then the primary current can be reasonably estimated by taking the inverter input watts and dividing it by the measured primary volts. For the purpose of this example 480vac is measured. Using the above numbers: 3741w / 640v = 5.85 adc.

You can see this 5.85a is nearly the rating of the transformer, which in this configuration is 12.5a.

Note: If the frequency control is going to be substantially increased it is recommended that the pulse width (voltage) control be reduced first.

4.2 Output Voltage Calculations

The RMS output line-to-line voltage (VLL) and its maximum value are partially determined by the input voltage. The Approximate maximum output voltage is calculated by using Equation 4.2.

Equation 4.2

Vo (RMS) Max = 1.1547*Vi (VRMS) or

Vo (RMS) Max = 1.1547*Vi (VDC)/ √(2)

The output voltage (VLL) is determined by the pulse width (Tp), at a selected Frequency (f). The pulse width (Tp) is set by a voltage from the voltage adjust to the micro-controller.

4.3 Pulse Density Modulation (PDM)

As shown in Figure 4.1, the high frequency is turned ON and OFF at a low frequency rate. Varying the percent ON time vs OFF time gives a very linear control of output power. The technique allows a high turndown ratio of at least 100:1 (1% to 100% output).

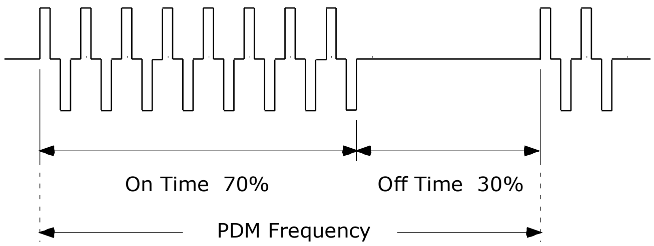


Figure 4.1

The normal method is with an external potentiometer or PLC. The voltage on terminal 6 controls the PDM ozone output. If J5 is OUT, the input is 0 – 10 VDC. If J5 is IN, the input is 4 – 20 ma or 0 – 20 ma. with ozone production starting at about 4.1 ma.

4.4 Output Frequency and Voltage Adjustment

The external voltage applied to the micro-controller can control the output frequency if PlasmaVIEW soft jumper is selected to external and a voltage source is applied to terminal 15.

With PlasmaVIEW soft jumper selected to INT position, the voltage is controlled with the PC board potentiometer. (DEF)

Normally there is no need for these adjustments as they are controlled by the firmware automatically. Automatic frequency adjustment is necessary to automatically compensate for minor gas flow and pressure variances.

4.5 Output Rate of Change Calculations

The output frequency, if controlled by the frequency potentiometer ramps down from a high frequency to the established expected frequency for control. Normally there is no need for this adjustment as it is controlled by the firmware automatically.

5 Low Voltage Control Connections

Input / Output Connections (Con17), Principal User Interface

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 DAT210/310/410/510 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]. Voltage polarity at the enunciation terminal must be positive and limited to 100 max., less than 50ma. preferred.

TERMINAL

1. **+15vdc**, aux use limit = 50 ma maximum.
2. **Frequency Adjust** (optional) external control is selected by PlasmaVIEW soft jumper found in PlasmaVIEW Status Tab. Use 5k Ω pot, 0-10vdc only (10v= 100%). 10 volts can be derived with a 1.5k resistor in series with the pot to +15 (Pin 1). Also can be used for **ORP or Dew Point** and graphed in PlasmaVIEW. Use PlasmaVIEW Status Tab to select input type, voltage range and device. Doesn't affect the use of on board Freq. Pot… both can be in use simultaneously.

   External Power feedback (optional) via 4/20ma (5v or 10v selectable via PlasmaVIEW). The DAT510 in combination with a Unico power platform is capable of maintaining a constant volt-amp product but not constant power (watts). This works just fine if Oxygen pressure is fairly constant but if variations greater than 25% occur a remote panel mounted power analyzer similar to AccuEnery, AcuVim II with 4/20ma output representing power can polish power stability. This product is an excellent value and can be monitored via AccuEnergy Portal. https://www.accuenergy.com/products/acuvim-ii-power-energy-submeter/ also add AMX-IO2 I/O module and any others like WEB2 perhaps. This is an excellent and inexpensive upgrade. To enable this DAT510 function, select 'Enable pin#2' in PlasmaVIEW Factory1 Tab and calibrate using 'Start' button (see Start button description).

3. **Signal Common**, tied to #9 internally.
4. **Flooded Cell** detected enunciation follows LED. 10k Ω pull-up to +5. 100Ω in series with the transistor for current limit. 100ma Max, design with 50ma limit. ***10k pull-up resistor (to +5vdc) is NOT present unless desired by installing J14. DAT210, 310, 410 have 10k pull-up present.***
5. **+5vdc**, aux use limit = 50 ma **The 5v can be used to drive such things as a 5 V coil relays, panel lights, PLC monitoring low voltage power supply status, etc.. There is a 1 – 2 second delay before +5 v after application of mains voltage.**

6. **PDM input** (optional), use 5kΩ pot, 0-10vdc (10v= 100%). 10 volts can be derived with a 1.5k resistor in series with the 5k pot to +15 (Pin 1). 0 – 10 volts control or 4 – 20 & 0 – 20 ma is selected via J7 500Ω and DIP Switch #8. All voltages/currents are with respect to Pin 3 (0V). Unlike other DAT controllers, No pot is present on PCB. If no #6 command is available, switch DIP Switch #1 OFF to obtain 100% output.

7. **Inverter Run Confirmation,** 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. 100ma Max, design with 50ma limit. ***10k pull-up resistor (to +5vdc) is NOT present unless desired by installing J13. DAT210, 310, 410 have 10k pull-up.***

8. **Inverter OFF** when pulled low to terminal 9 via momentary or continuous. 10kΩ pull-up to +5v. OFF prevails even if ON is present.

9. **Logic Common** for # 8 and 10. Connected internally to #3 common.

10. **Inverter ON** when pulled low to terminal 9 via momentary or continuous. 10kΩ pull-up to +5v. If pulses in 50-60hz ranges present, PDM will phase lock to this input. ON control input still responds normally to Run/Stop commands.

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, no pull up present. 100ma Max, design with 50ma limit.

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. 100Ω in series with the transistor for current limit. 100ma Max, design with 50ma limit.

13. Analog 0 – 5vdc, follows average **AC load current out (U,V)**. Direct op amp (MC33272AD) 1kΩ series resistor. Scaled by digital gain select. Lower nibble of memory location m108. *Unlike other DAT controllers, AC output can't be used to calculate Power.*

14. Analog 0 – 5vdc, follows **DC bus voltage out**. Direct op amp (MC33272AD). 1kΩ series resistor.

15. **Voltage Adjust** input (optional), use 5kΩ pot or voltage or current source, 0-10vdc or 0–20ma only (10v= 100%), impedance 10k Ω. Insert J8 for 500Ω termination. Use PlasmaVIEW Status Tab to select External rather than default Internal Pot.

16. **Clock Freq** out (1x). Output pulls low via open collector (MMBT4401). 100Ω series protection resistor. 100ma Max, design with 50ma limit.

Output Connections, Soft Charge

1) Unlike the DAT210, 410 inverters, the DAT510 control board doesn't have an external interface. The control is internally directed to the selected Unico power platform.

External Fan

2) The power platform fans are completely managed by the Unico unit itself. External fan control, if desired, is available via Con6. Connect fan BLACK (-) to #3 and RED (+) to #2. If the fan is **24v** simply install jumper J16 to use the on board 24v supply. If an external supply is needed or wanted, connect the negative (-) to #4 and the supply positive (+) to #1. Supply voltage can be anything up to and including 48vdc (examples: 5, 6, 12, 24, 48). External supply should be sized to comfortably handle remote fans and fused if supply current can exceed 5a. The fan output will be managed like other DAT controllers… ON when commanded to run and continue for 2 minutes after stop command.

Input Connections (Con3), AC Phase Reference for PDM synchronization with Mains

a) Connect 18 - 24vac to terminals 1 & 2. The current is minuscule. The output should be floating and independent of other power supplies that may be present. It can energize with the inverter mains or be left on continuously if most convenient. PTI provides a transformer that should be on an appropriately fused circuit. Input is 120/208/240 to 24 vac.

Output LOAD Connections , Transformer / Inductor

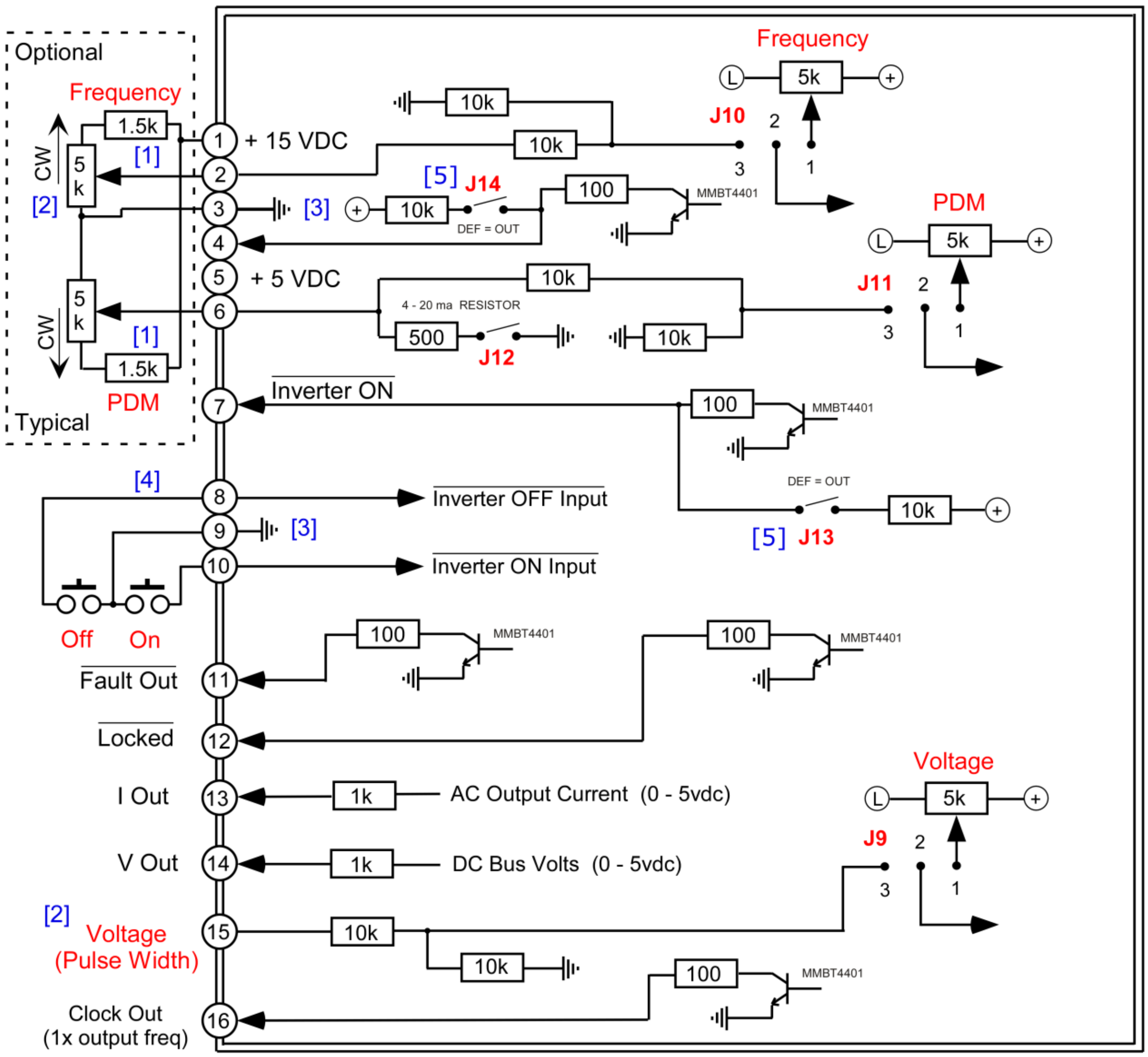
UNICO output terminals U & V only

DATA Port (Con14), RS232

1. RS232 (DB9) connector contains the components normally found in the PTI dongle. Simply connect the USB to RS232 cable directly to interfaces with PlasmaVIEW or managed by a PLC like other DAT controllers.

5.1 16 Pin I/O Connections

DAT510 Connections



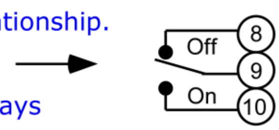
- Grounding either #3 or #9 is not necessary and usually controlled by PLC.
- External pots for frequency and voltage should be multi-turn, cermet substrate types for stability and precision. Rating of 1/4 watt.
- Shielded cable recommended for connection runs of 2' or more.

[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.

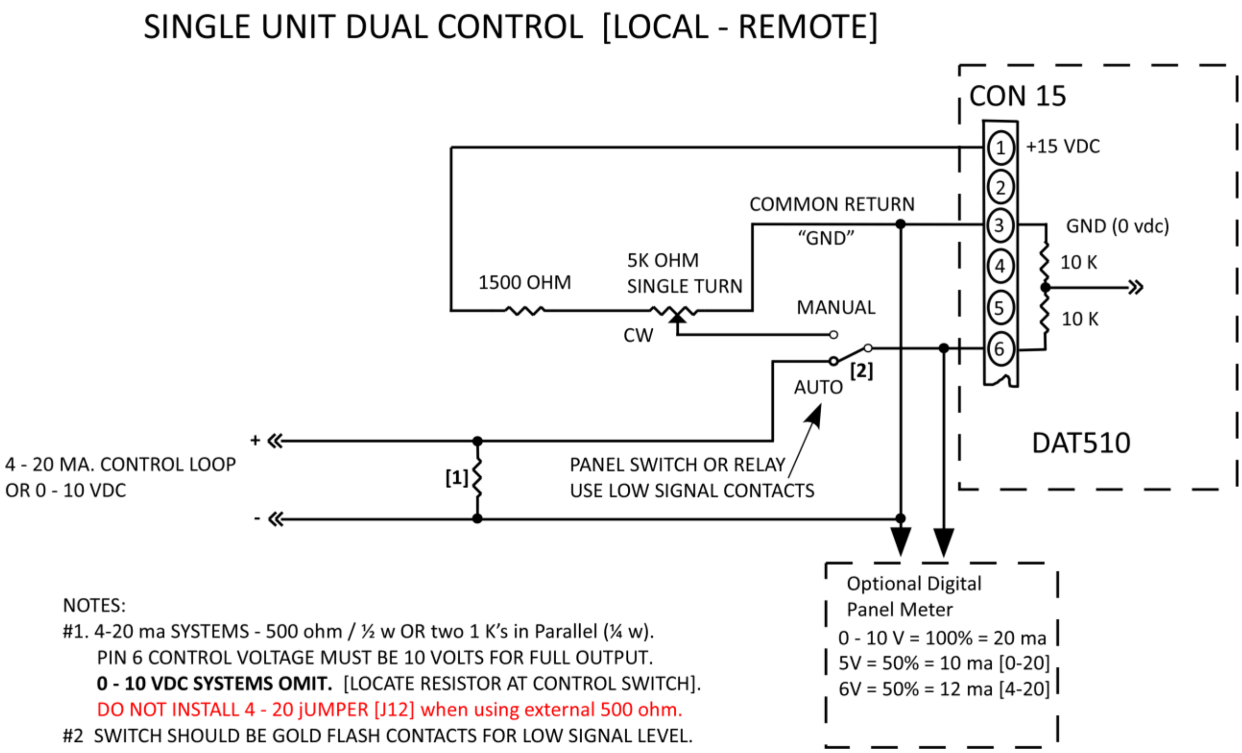
[3] Ground symbol represents circuit board floating common, not earth grounded. Best to leave floating or allow PLC to establish the ground relationship.

[4] Optional SPDT toggle switch or relay.



[5] Installing J13, J14 adds 10k pull-up resistor which always present with DAT210, DAT310 control boards.

The most commonly used control wiring for: 0 – 10v, 4-20ma or both mixed.



NOTES:

#1. 4-20 ma SYSTEMS - 500 ohm / ½ w OR two 1 K's in Parallel (¼ w).
PIN 6 CONTROL VOLTAGE MUST BE 10 VOLTS FOR FULL OUTPUT.
0 - 10 VDC SYSTEMS OMIT. [LOCATE RESISTOR AT CONTROL SWITCH].
DO NOT INSTALL 4 - 20 jUMPER [J12] when using external 500 ohm.

#2 SWITCH SHOULD BE GOLD FLASH CONTACTS FOR LOW SIGNAL LEVEL.

5.2 Dip Switch & Jumpers

DAT 510 DIP SWITCH CHART

SWITCH SW1	DEFAULT 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	SSD110 Output Logic	Inverts output status signal Pin# 7 [Inv ON]
S3	OFF	SSD Emulation Mode	Useful when transformer step-up ratio is greater than necessary. This mode enables PDM turn down linearity when T1 is less than 10%
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. Do **NOT** turn ON for Ozone systems, no startup ramp can easily damage an ozone cell.
S7	ON	Drop Back Mode	Detects load fault in multi-cell units and drops the power back to allow continuous ozone production, unless a fault is detected in two or more cells. If too many cells are faulted then unit will shut off ozone like a normal load fault condition. OFF also detects partial load failure but STOPS inverter.
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 re-enabled. 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.

DAT 510 JUMPER CHART

JUMPER	DEFAULT	NAME	FUNCTION IF INSTALLED
J1, J2	OUT	ON-OFF Configs	Alternate methods of inverter startup. See Section 5.4
J3	OUT	Full Manual Mode	Completely manual, like SSD110
J4	IN	Auto Fan	Fan on when RUN and is speed controlled based on cell and device temp. If OUT, max speed when RUN.
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.
J6	*Stow	ON with Mains power up if installed	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 Ozone gas purge.
J7, J8	Not Present	Factory	
J9	IN	Voltage control pot	1 - 2 jumper = internal control, 2 - 3 = external, **#15**
J10	IN	Frequency control pot	1 - 2 jumper = internal control 2 - 3 = external, **#2**
J11	IN	**PDM** control pot	1 - 2 jumper = internal control, 2 - 3 = external, **#6**
J12	*Stow	**IN** = 4/20 ma. Or 0/20 ma. **OUT** = 0 - 10 vdc	Adds **500Ω** resistor to **PDM** control input. Usually S8 ON and J7 jumper are used together. If two or more DAT510s are to be controlled via one current loop, wire all Connectors CON17 term #3 together and all term #6 together and install J7 on one DAT510 inverter. For precise control use a resistor > 500 and omit J7.
J13	*Stow	**IN** = 10k pull up	Adds **10kΩ** resistor to +5, **#7 INV-ON-OUT**, Con15, to create same control impedance as DAT210, 310, 410.
J14	*Stow	**IN** = 10k pull up	Adds **10kΩ** resistor to +5, **#4 FLOODED-CELL**, Con15, to create same control impedance as DAT210, 310, 410.
J15	IN	Factory	Default, installed, DC/AC current sense coupling.
J16	IN	IN = 24vdc	Applies on board 24vdc to fan circuit. If out, customer must supply fan voltage to Con6, **#1&4**. 5, 6, 12, 24, 48v acceptable; ie: any voltage up to 48vdc.

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

5.3 Pots & Buttons

Control Potentiometers (Pots), No On Board INT/EXT Jumper Selectors

PDM – Normally terminal #6 input delivers a voltage or current to the unit, which manages a closed loop process ozone level. Power and hence ozone level is easily and instantaneously managed. 10v= 100%, 5v= 50%, and so on. The PDM input is always observed unless SW1 is OFF.

Voltage – Adjusts voltage applied to cell. 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. Use 5kΩ pot with 1.5k wing resistor or voltage or current source, 0-10vdc or 0–20ma only (10v= 100%), impedance 10k Ω. Insert J8 for 500Ω termination. Use PlasmaVIEW Status Tab to select External rather than default Internal Pot..

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. External control is selected by PlasmaVIEW soft jumper found in PlasmaVIEW Status Tab. Use 5k Ω pot, 0-10vdc only (10v= 100%). 10 volts can be derived with a 1.5k resistor in series with the pot to +15.

Buttons

Op_Ok – This button has two uses. Additional information is available in the detailed description.

[1] When the inverter is ON and AutoTune **J5** is OUT, stores the present running parameters of voltage, frequency range, current tolerance along with other internal configuration information available, as **normal** field operation. This information becomes the re-start information after an OFF - ON power cycle. A soft button also exists in PlasmaVIEW. PTI web site has narrated video in SUPPORT tab.

[2] Recalls the factory set-up table to active memory when the inverter is powered up but OFF. The factory table is never overwritten and can be recalled as a last resort if the unit has been improperly adjusted beyond recognition. If the table value operating point isn't acceptable, refer to the detailed description. If this happens, just follow the instructions in the 'Power Adjustment' section.

Start – This switch has two uses: to find a new operating frequency and Auto Scale power selection.

[1] A **discovery tuning sweep** is conducted if pushed for 2 - 4 seconds <u>AND</u> **J5** is uninstalled AND in normal Resonant Mode via PlasmaVIEW. This should eliminate the possibility of tuning aliases and make new system start-ups easier. 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 **J5**, adjusting the voltage pot (per 'Power Adjustment'), store the corrected running value (per above 'Op_Ok'), and re-install J5.

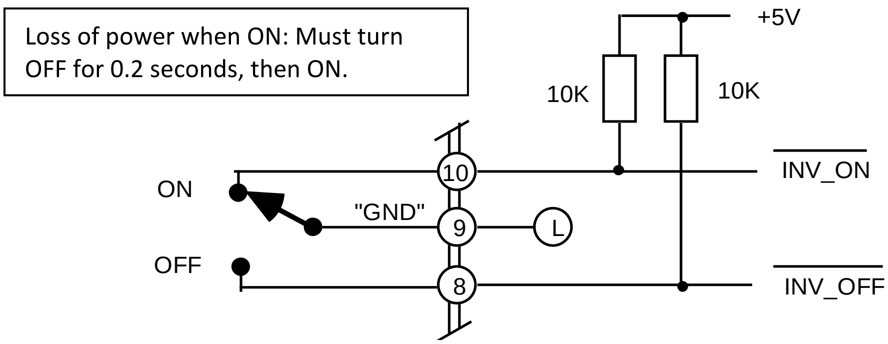
Once the inverter finds resonance as its operating point, normally it makes only minor adjustments to compensate for minor pressure and flow changes.

[2] The DAT510 and 510 have a new feature to simplify load matching. This feature greatly simplifies the first startup with unknown components. A 1 second button push will automatically determine the proper internal software scalers which allow the inverter to be applied outside of its indicated power levels if necessary and assures optimum gain balances resulting in the best possible load matching. It also will zero internal references if pushed when in Standby (OFF). **See section 8 for detailed instructions.**

5.4 Methods of ON – OFF Control

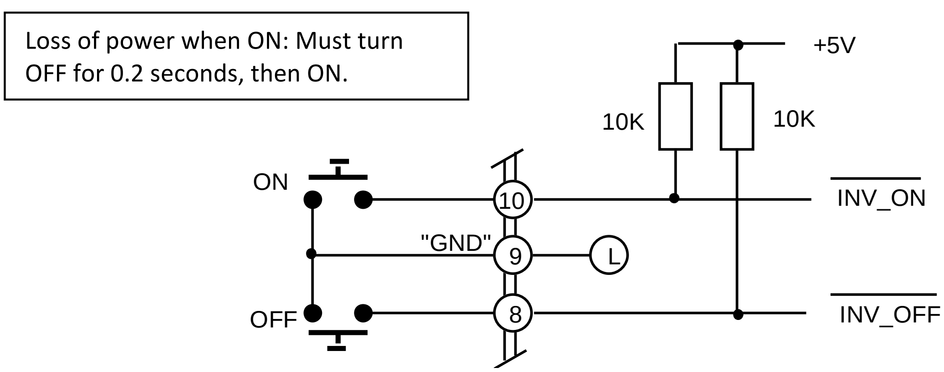
JUMPER numbers refer to **Soft** Jumper #'s in PlasmaVIEW not physical PCB Jumpers

SPDT RELAY OR SWITCH



FUNCTION	PWR_UP	J1	J2	J3
To start the inverter the switch must first be in the OFF position, then moved to the ON position for ozone to start.	OMIT	OMIT	X	X
To start the inverter the switch must first be in the ON position, then power is applied to produce ozone. The inverter will start after the "LED banner flash".	IN	OMIT	X	X
X = Don't care condition.				

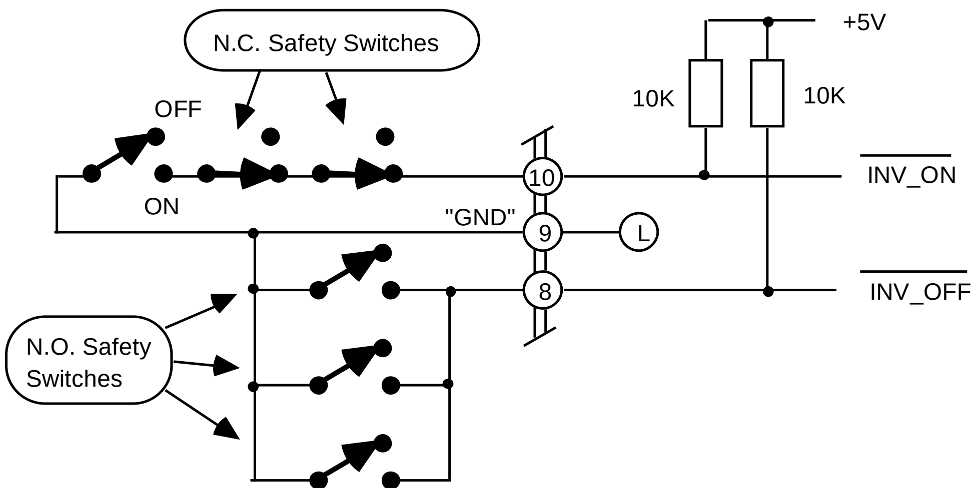
ON – OFF PUSHBUTTONS



JUMPER CONFIGURATION AND FUNCTION

FUNCTION	PWR_UP	J1	J2	J3
Push ON and push OFF to start ozone production. If both pushbuttons are actuated simultaneously, the inverter will stay OFF.	X	OMIT	X	X
X = Don't care condition.				

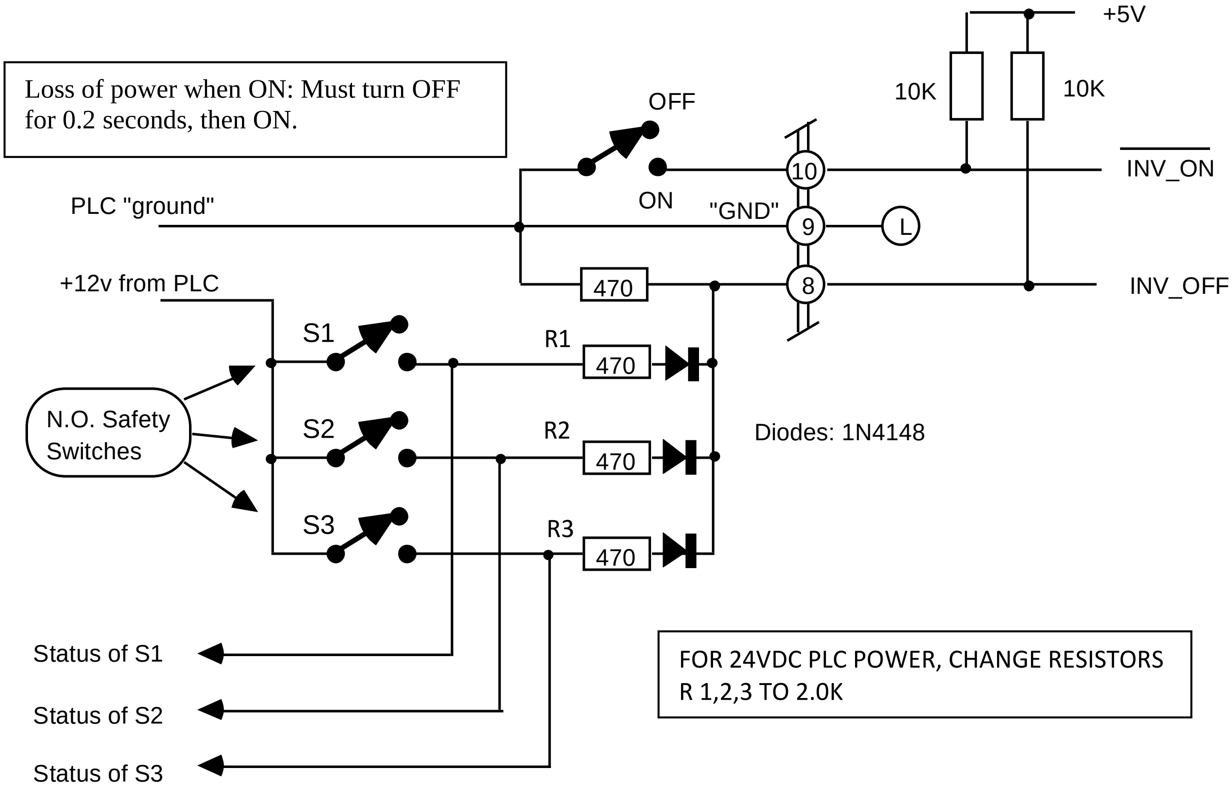
SAFETY SWITCH INVERTER CONTROL CIRCUITS



Loss of power when ON: Must turn OFF for 0.2 seconds, then ON.

FUNCTION	PWR_UP	J1	J2	J3
To start the inverter the switch must first be in the OFF position, then moved to the ON position for ozone to start.	OMIT	IN	OMIT	X
To start the inverter the switch must first be in the ON position, then power is applied to produce ozone. The inverter will start after the "LED banner flash".	IN	IN	OMIT	X
X = Don't care condition.				
If any of the normally open (N.O.) safety switches goes closed then ozone production cannot start or will cease if operating.				

PLC POWERED SAFETY SWITCHES WITH STATUS REPORTING



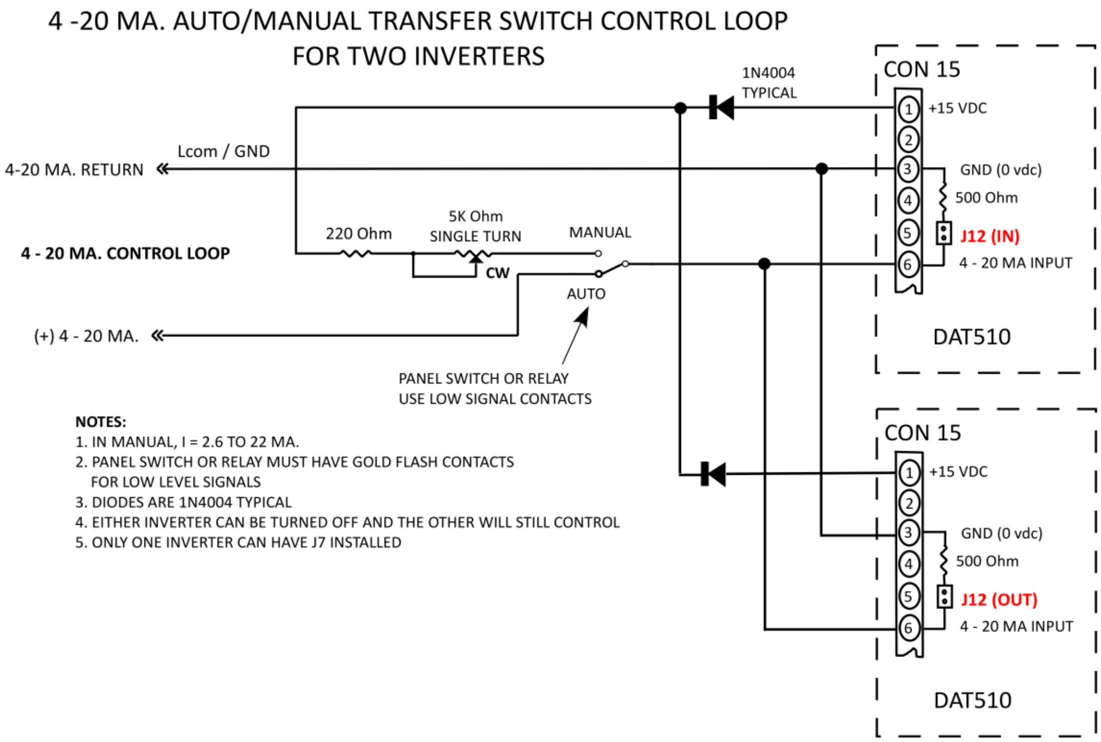
FUNCTION	PWR_UP	J1	J2	J3
To start the inverter the switch must first be in the OFF position, then moved to the ON position for ozone to start.	OMIT	IN	IN	X
To start the inverter the switch must first be in the ON position, then power is applied to produce ozone. The inverter will start after the "LED banner flash".	IN	IN	IN	X
X = Don't care condition.				
If any of the normally open (N.O.) safety switches goes closed then ozone production cannot start or will cease if operating. This circuit allows the PLC to monitor the switch status.				

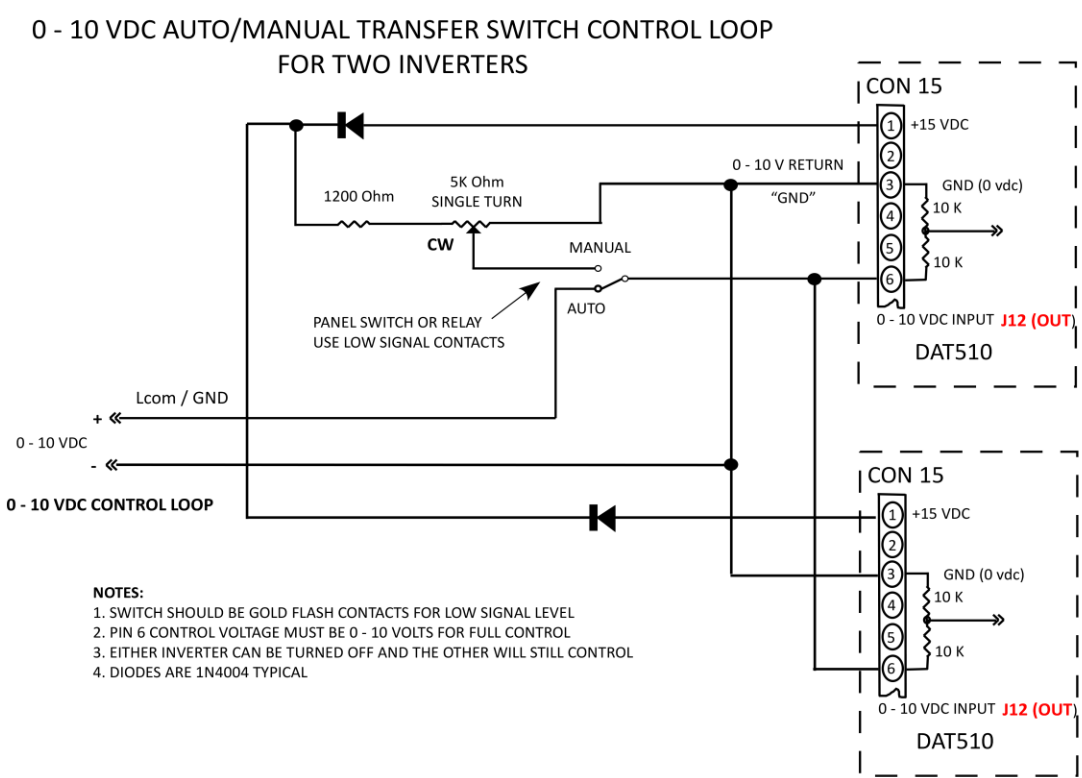
Note: The processor scans J1, J2, J3 only on power up. Changing the jumpers will not be immediately recognized unless the inverter is shut OFF – then ON.

5.5 Multi-Unit Control

Two user wiring options are shown. If an Auto/Manual front panel switch is desired to control one or two inverters, use the schematic shown. This also allows a single control input to control both inverters with either inverter powered down.

DAT510 PLASMA TECHNICS SUGGESTED OPTIONS





6 Operating Status LEDs

DAT510 Status LED description

LED		Description
Ext Fan ON	New	**ON** – when external fan voltage active, speed per temp sensors.
THERM SW	New	**ON** when power platform thermal switch temperature Ok.
Soft CHG	New	Soft Charge process complete, relay engaged, DAT will accept RUN.

+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 — **OFF, Winks ON** – Semi-Automatic tuning is enabled when jumper J5 is removed. Frequency tuning occurs during wink interval. Search rate varies automatically. The Voltage pot is active and should be used to set the desired full power operating level. See: 'Start' button adjustment procedure.

ON, Winks OFF – Occurs only in 'Auto-Tune mode when Jumper J5 is installed and signals that the proper operating point has been established and 'locked'. The indicator is ON mostly continuously, and only winks off momentarily while a new scan of the operating parameters is validated.

LOW POWER — **Flash** – Output current is slightly below the programmed tolerance window. A service request enunciation is placed via the soft fault if switch S5 is ON. 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 increase 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 switch S5 is ON. 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 switch S5 is ON. 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. **Switch S5 must be ON 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. **This is a summons for service.** Ozone production is reduced, 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.

7 Applications

7.1 Retrofit transformer types that can be used with the DAT510

The 200-HSHI04803/D230, for example, is rated for 240v or 480v operation, 8KVA at 1.2 KHz. While this transformer can be operated at 600 Hz one must be very careful to reduce the input voltage in half so as to prevent overheating and burn out. This reduction will also reduce the power available for said transformer to 4800 VA. Increasing the frequency above 1.2 KHz is no problem either as long as the case temp limits are observed.

The HSH series transformers will operate from 1 to 10 KHz.. This transformer can easily be driven to power levels beyond its means by the inverter. The HSH series is used with a matching choke to form a tuned circuit, which are intrinsically self-protecting for mis-tuning.
The same general rules also apply to the 100-HLHxx302/D230, which is rated at 3kva at 1.2khz. It has a primary of either 230 or 460v. This transformer is a better match for the capacity of the DAT 210.

PTI has several voltage output levels available in the 3kva Case100 series. If you are uncertain as to the proper high voltage level needed in your application it is recommended that the transformer be strapped for 460 V operation while the inverter has 230 applied. This will reduce the output high voltage by 50%. I.E. A 10kv transformer would produce 5kv and is also de-rated in power from 3 KVA to 1.5 KVA. The need for this test configuration is mandated by the measurement of rated or nearly rated inverter input current while having a relatively low transformer primary voltage measurement, 200-300 V (460 Vac inverter input).

It is recommended to contact PTI before attempting to match a transformer to a load. PTI's experience can solve application problems before the problem becomes more critical.

8 Start up

8.1 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.

8.2 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 Sections 2, 3, and 12 Unico Appendix.
- 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 DAT510 does not have internal fusing. Install input and output (optional) fusing per suggestions in Section 3 and 12 Unico Appendix Tables 4-11.
- 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.

8.3 Start-Up Procedure Power Adjustment

Note: Green highlighted boxes such as Numeric1 refer to 'Tabs' in PlasmaVIEW.

New Outline, reminder form for the those familiar

First system config, abbreviated reminder

1) Factory1, Select N.R. mode, trans=1, select freq range, Numeric1 (100% break point which is **Standard Legacy PDM chopping**, ramp3, Select Primary or Secondary inductor, freq tune offset=0)

2) T1=10%, freq=max.

3) Reduce freq and increase T1 as need to achieve desired power as measured by EXTERNAL power meter. If IGBT fault at full power disable OVC. Never increase T1 more than 5% at one time without dithering frequency to peak current.

4) Observe Hex current on Numeric, after 30sec of stable power push 'Start' for 1 sec, observe Hex for 80 – A0, Temp blinks, Flash.

5) Fine tune if necessary and Flash again.

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 PlasmaBlock® 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 4-10ma… **(Use Method 1)**

OR

A PlasmaBlock® is going to be applied at pressure and flow range that is different from the factory setup but the system is familiar… **(Use Method 1)**

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… **(Use Method 2)**

NEW control MODES available via PlasmaVIEW… implemented in DAT510 & DAT410 :

The DAT510 is always combined with a Unico power platform and measures current differently than all other DAT inverter/controller boards. All other DATs measure internal DC bus current to calculate power. The DAT510 measures AC output current to the transformer. For this reason the 510 actually can only maintain a constant VA. Power polishing input information can be found in Section 5, #2 (Page12) and Section 8.4 (page 33).

< SIMPLE procedural summary reminder if familiar with calibration steps >

REMOTE POWER INPUT PIN # 2 SELECTIVILY ACTIVATED via Factory1 tab

1. Configure PlasmaVIEW/current clip / DC voltmeter on pin #13 (#3 always common reference).

2. Set oxygen pressure/ flow and sustain for interval to ensure dry gas and cells, preferably no water cooling that would condense internals of cells. Critical on first run… may be overnight.

3. **SW1 OFF**, AutoTune jumper out, output ON, set **Power or Current** via 'Voltage Pot' (T1) if required.

4. If firmware version is v1.7 or greater, 'Start' button can be pushed ~ 1 second to initiate automatic calibration and scaling of DAT510 control board. **Power must be stable for 30 seconds before pushing 'Start' button.** A High Temp LED begins to wink as a reminder to "Flash" via 'OP OK'.

5. 'Flash' processor by momentarily pushing the 'OP OK' for .5 to 1 sec. to select fault tolerance. Complete 'Flash' by push and HOLD 'OP OK' until first **2 red** LEDs are on **STEADY** (~10 seconds), then release.

PlasmaVIEW Displays and Operation Unique to DAT510

1. **Power measurement** is fundamentally different in that AC Output current is measured rather than DC bus current. In all other DAT boards, DC bus voltage is measured. The Unico power platforms provide these analog signals via the bridging ribbon cable. This means wattage is not calculated. An accurate AC output amps must have a scaler inserted which can be calculated by PlasmaVIEW if the user measures the AC amps with a highspeed Hall Effect current clip and True RMS multimeter. Once measured the value can be **saved** and **recalled** in the 'Current Scale Factor' located on the left side of the Numeric tab. This will then display in the Numeric tab Digital Data table as Amps (AC out). This value is combined with DC volts to create an ESTIMATED KVA (not Watts). **The scaler value must be recalled or manually entered… it does NOT automatically load when PlamaVIEW starts.**

Detailed procedure METHOD 1

REMOVE POWER FROM THE INVERTER FOR SET UP

- **Install a true RMS current clamp-on meter** to one of the mains AC power wires, terminals R, S, T. A power meter could also be used as can PlasmaVIEW software.
- **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% and ignores #6 input.
- **Verify Switch S4 and S5 OFF**: Power fault disable. This will inhibit any current faults which exceed the High/Low limits, 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.**
- **Pull jumper J5 AUTO**, which will select the **Semi-Auto** mode and allow the **VOLTAGE** pot (potentiometer) to be active. The frequency will still be automatically adjusted for resonance. If desired PlasmaVIEW, Factory1 Tab 'Non-Resonant' mode can be selected which locks frequency to adjustments made manually via "Frequency' pot. This might simplify finding the operating point with new unknown components. Once the proper operating point is ascertained, a fixed frequency is only recommended (for normal operation) if oxygen pressure varies only a small amount. Large Muni systems are fine in Non-Resonant mode.
- **Turn the VOLTAGE pot counterclockwise (CCW)** until clicking sound indicates minimum.

APPLY POWER TO THE INVERTER – TURN THE INVERTER ON

- **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.
- **Set the High/Low power limits.**

  The normal factory recommended limit is +/- 20%. Systems with large fluctuations in gas pressure and/or line voltage should use 40%, which is the most common field choice.

  Push the **OP_OK** push button once (~1 second). 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.
- Lock in the new operating point by **pushing and HOLD the 'Op_OK' button until the first 2 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.
- Set Switches **S1, S4** to ON. Reinstall **J5** (AutoTune). Re-enable by cycling the inverter digital OFF and ON inputs (8 & 10).

- ➢ Now observe the inverter and 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, which winks off about every 3-5 seconds – this 'heartbeat' is normal. 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.

Method 2 **For other manufacturer's generator cells or other applications**

Make sure the inverter has the correct profile 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.

NOTE: 'Writing' a setup file extracted from an identical system via PlasmaVIEW pre-configures not only the operating parameters but also the master template.

Monitor the line current with a true RMS amp meter.

It will be necessary to configure the inverter for a manual mode of operation, using Non-Resonant Mode.

S1 OFF Forces PDM to 100% maximum for tuning purposes

S4 OFF Disables alarms and power limits. **It is possible to apply too much power**

1. **Non-Resonant Mode** Enables Manual operation of Freq. and Voltage (PlasmaVIEW Factory1)
2. **Jumper J5 OUT** Disables full Auto-Tune
3. **Turn the FREQUENCY** pot full CW clockwise until clicking sound is heard
4. **Turn the Voltage** pot full CCW counterclockwise (minimum) until clicking sound is heard then CW to 10% T1
5. **Turn the Frequency CCW** and as the system resonance zone is encountered the power will increase to a maximum and then drop off as the frequency is lowered further. Set freq. so as to achieve maximum power. If power didn't increase than turn freq. full CW and increase T1 somewhat and sweep freq. down again.
6. **Iterate** between T1 and Freq pots achieve desired power level.
7. **Reference** Method 1 bullet points identified as ➢ to complete the adjustments and 'Flash' the processor.

8.4 NEW External Power Input & Gain Scaler Calibration via START button

Auto Calibration Feature & Remote Power Input (pin #2)

Please note: The legacy Start button discovery sweep via push and hold works as normal.

The DAT510, and 410, have a new feature to simplify load matching. This feature will automatically determine the proper internal software scalers which allow the inverter to be applied outside of its indicated power levels. **This feature is ONLY active if:** AutoTune jumper is OUT **and** Constant Power NON-Resonant mode is selected via PlasmaVIEW. Because this function is likely to be used during initial system setup, best to turn OFF SW4 (fault current sensing). After calibration is complete and the processor is 'Flashed' any other operating mode is supported by this feature. The process consists of 3 steps: Auto Zero while in standby, Auto Scale when at full power, Flash to complete.

Remote Power Input (pin #2)

If a remote power polishing input (4/20 only, 5v or 10v full scale) is used and connected to #2 input, it will also be calibrated. Using this feature means that actual power is held constant rather than volt-amps (VA). Generally speaking, VA is fine for large municipal water type application where oxygen pressure is constant. You'll notice that actual power changes very slowly in response to PDM changes or a run command. This is deliberate and necessary because the external power measurement devices themselves are slow to respond.

1. **To activate**, press '**External Power Input #2**' located in Factory1 tab. When enabled new display and control information will present itself to the left of said button.
2. All DAT510 control input maximums are 10v, which includes #2, but the remote power monitors often only have a maximum of 5v available. To accommodate this situation, #2 has been configured in firmware to be selectable… either 10v or 5v. The selection is made via button labeled '**Pin2 Max Input Voltage**' located in Config tab (visible only when enabled per 1 above). Default = 5v.
3. Unlike the PDM input, which has a jumper to optionally terminate its input with a 500Ω resistor for a 10v signal (20ma), pin #2 doesn't have a termination resistor. A resistor must be added between #2 and #3, preferably on the 16 pin connector. **5v= 250Ω (4-1kΩ)** or 10v= 500Ω (2-1k).
4. Power Polishing is only active if AutoTune jumper is installed.
5. Before activating the auto calibration function, verify #3 by PlasmaVIEW or voltmeter.

Auto Gain Scaler Calibration Summary

1. Before beginning any calibration, the systems should be power up for at least **15 minutes**.
2. **Remove** the **AutoTune** jumper and select 'Constant Power **Non-Resonant Mode**' in Factory1.
3. After **30 seconds** in OFF/STOP mode, press the '**Start**' button for ½ to 1 second.
4. Switch Dip Switch 4 OFF and enable the output, ON/RUN mode, 100% PDM, adjust 'Voltage' pot if necessary to full desired power level using an external power meter or amp clip to estimate.
5. When the load power has stabilized **wait 30 seconds**, press the '**Start**' button for ½ to 1 second.
6. After about **10 seconds** the calibration process will be complete which is enunciated by a quick winking of the red '**HS Temp**' LED. This is a reminder to complete the process by '**Flashing**' the processor using the normal procedure shared by all DAT controllers.

7. You can now expect to see a value of **9x – Bx** (x= 0-9) in the '**DC Bus Amps – HEX**' (wrong label – should be AC Output Amps – HEX) found in the lower left corner of Numeric.
8. **Re-install AutoTune** jumper and turn **SW4 ON** …. DONE !

New User or Tuning Proceedure Review

If PlasmaVIEW is being used, skip to step 6. (PlasmaVIEW *must* be at least version 3.3.10)

If PlasmaVIEW isn't available, the full manual jumper J3 (via PlasmaVIEW) can be installed after which the mains must be cycled OFF and ON. Once the load calibration is complete and the unit 'flashed', the manual jumper can be removed followed by mains cycling to complete the process as above.

1. Use a manual tuning procedure for the first run. Set Frequency high, Voltage low and engage (ON). Increase voltage a small amount and adjust frequency down in search of a frequency that yields the highest power. Repeat these steps several times. If the voltage pot stops having an effect, turn counter clock wise until it reduces power.

2. The re-balance of circuits is now required. Push the **START** button momentarily for .5 to 1 second. The yellow LED's will blink back and forth a few times (~ 5 seconds). Now the tuning process can resume. When frequency and voltage are adjusted to desired power, proceed to the next step, repeat the START button procedure until desired power level is reached.

3. You will notice one of the temperature LED's winks every few seconds. This is a reminder to complete the programming process via the normal '**Flash**' process using the 'OP OK' button. PDM must be at 100% via input or SW1 off. The Flash procedure is the same as all other DAT products. Press OP OK momentarily for .5 – 1 sec to select fault tolerance percentage (40, 20 10%, 40 or 20 are typical) then press and hold until the first pair of RED LED's turn on steady (about 10 seconds)… then release. An instructional video can be found on PTI's web site in the Support tab.

4. Step 2 can be repeated as often as you like followed by step 3 when satisfied. When satisfied with above, put the system in standby (**STOP**), power down mains. **Remove jumper J3** and re-connect mains power.

5. Re-enable and if everything looks fine **Flash** the processor one last time to capture the latest changes. Install AutoTune jumper and be certain SW1 is back ON if external PDM control is desired. Re-enable dip switch SW4.

Procedure if still in Non-Resonant Mode:

6. 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.
7. Increase the voltage at the current (power) peak until ½ of the maximum desired current per leg (power) is reached. Readjust the frequency slightly to find the current peak.
8. Increase the voltage until the current reaches 90% of the expected maximum power.
9. Verify the frequency is still at peak with the frequency pot.
10. Increase the voltage pot CW to reach 100% expected power.
11. Set the High/Low power limits.
12. 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.
13. Push Op_Ok once again. The Yellow LEDS will flash faster. This is the +/- 20% limit.
14. Push Op_Ok once again. The Yellow LED will flash even faster. This is the +/- 10% limit.
15. Keep pushing Op_Ok and the cycle repeats.
16. The normal factory recommended limit is +/- 20% (40% total).
17. 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.
18. Set Switches S1, S4 and S5 to ON. Reinstall J5
19. (AutoTune). Re-enable by cycling the inverter OFF and ON.
20. 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.
21. If during the manual portion of the tuning effort it is not possible to reach the current peak, 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.

8.5 NEW PDM Mixed Mode (M-M)

Mixed Mode combines two control mechanisms into the normal PDM #6 input, which functions best in Non-Resonant mode. For example; if you've selected a 60% breakpoint… The turn down from 100% to 60% will be accomplished using T1 and 60% to 1% using the reduced T1 plus the normal chopping method. As you probably know, reducing the ozone generator power by reduces voltage (T1) normally would be non-linear but the DAT510 with the AutoTune jumper installed is a constant power device. This approach is ascetically pleasing for two reasons: no chopping occurs for the first 40% of turn down and chopping from 60% to 1% is at a reduced power and hence reduced noise. The processor maintains seamless linearity. Large commercial systems usually have stable gas pressures and flows and therefore are fine in Non-Resonant mode.

1. Located in Numeric1 Tab. Default is off… **standard PDM chopping**, which is displayed as a Break Point of 100%. If the AutoTune jumper is out, M-M is forced off and the standard PDM turn down chopping mode is used.

2. Select a value between 50 and 60% in the 'enter value' window and 'Submit' Default 57%. This value will now appear in the upper window. Values less than 50% can cause the system power to hunt because the cell high voltage is below ionization potential.

3. If no other adjustments are anticipated, 'Save Flash' when finished.

8.6 NEW Inductor Location Selection (Pri/Sec)

Specifies on which side of the high voltage transformer the resonating inductor is located; Primary or Secondary. Secondary side systems must be treated very gently. Large municipal system are frequently secondary side systems..

1. Located in Numeric1 Tab. Default is **Primary** (Green). Pressing the button will toggle to '**Secondary**' and turn the button yellow.

2. If no other adjustments are anticipated, 'Save Flash' when finished.

8.7 NEW PWM Cycle Mode (Output Waveform Construction)

Specifies how the output waveform will be constructed. This not only applies to Run/Stop but the start and finish of each PDM chopping burst (30/Sec). Default is **4** which is suitable for Primary side inductor systems. In this case, no T1 PDM ramp occurs or is needed because the inductor nicely handles the integration. The sharper switching improved turn down linearity when PMD is low… say below 20%. This is standard, and unchangeable in all DAT210/310 products. Secondary side systems should be between 0 and 2, which provides multiple T1 steps and dwell thereby reducing transformer heating. 2 is generally fine but large systems above 20kw should be 1 or 0.

1. Located in Numeric1 Tab. Default is **4**. Select a value from the pull down located below meter display, which will update a couple of seconds. This can be done while the load is being driven.

2. If no other adjustments are anticipated, 'Save Flash' when finished.

8.8 NEW Frequency Tune Offset

Specifies a frequency offset (increase) after touch up tune, blink of the Locked LED. Determining a value requires a well instrumented test including oscilloscope and is generally a factory adjustment.

1. Located in Numeric1 Tab. Default is **0**. Insert a value in the lower window. This can be done while the load is being driven.

2. If no other adjustments are anticipated, 'Save Flash' when finished.

8.9 NEW PDM Integration Time (Auto Temperature Based or Fixed Time)

Controls the startup PDM ramp time, which is based on cell temperature, so as to minimize ozone cell thermal shock. This is usually is about 10-15 seconds but can be a minute if the cell is cold… say 50-55f. Default is '**Auto**' (Green). If the cell thermistor isn't connected the processor it will use a ramp in the 5-10sec range which is indicative of a warm and operational system at say 85f. Cells are often located far enough from the inverter that cell temperature measurement isn't available which would result in potentially dangerously short ramp time. This button can select a fixed ramp time of **30sec**, with or without temperature input.

1. Located in Factory1 Tab. Default is **Auto** (Green). Pressing the button will toggle ramp time to a fixed **30sec** and display as yellow.

2. If no other adjustments are anticipated, 'Save Flash' when finished.

8.10 NEW Auto Full Scale Calibration of PDM (Input #6 to Match PCL Output)

Located in the lower left corner of the Numeric tab is a button labeled '**Press to Calibrate PDM'**, this button will auto-scale a slightly deficient PDM input. This is a common problem with 4/20 inputs that might only be 17 or 18 or 19ma even though the PLC is at maximum output, which should be 20ma. Simply command 100% from the PLC, which may only be 18ma, and press Calibrate PDM and the DAT firmware will create the necessary scaler which will ensure the power platform is providing 100% output. The cal. Process may take 30 seconds as annunciated by adjacent 'Done' light. Next, pull AutoTune jumper and 'Flash' the processor using Op-Ok to permanently retain this new correction factor… replace AutoTune jumper. You'll notice the PDM Level window will turn Green, signifying no chopping.

8.11 NEW Multi-Unit Master / Slave Wiring and programming

GENERAL: All DAT products observe and lock onto the power line frequency for the purpose on providing a constant PDM phase reference. When multiply DAT inverters are connect to the same power feed (Mains) abusive power pulsations can occur if the units are allowed to free run. For example, PDM (Pulse Density Modulation) is the turn down method developed by PTI to linearly reduce the power delivered to a load. If 50% were selected and outputs observed, one would see the load is driven at full power for ½ the period and off the other half. The period for the bursts is ½ of line frequency… normal 60hz mains would produces a 30hz PDM rate. If multiple units are utilized this would result in 100% power and 0% power bursts, which will hammer the mains. The DAT product family has the ability to be interconnected in a multi-unit situation so as to spread out or time shift the PDM bursts resulting in a more uniform power demand as the system in turned down.
This feature has been present on the DAT210 series for all time. The newer DAT410 (480v) firmware v1.9 and up also includes this function; consult factory for DAT510 functionality. Wiring and programming is the same as the DAT210, in fact the two product families can be co-mingled if necessary. Best to use a current PlasmaVIEW version for programming.

Master Unit

1. The master unit provides a phase lock pulse at ½ the line frequency on **pin #4**. This is normally the 'Load Fault' enunciation output which can no longer be used for that purpose once it has been selected as a Master. Remove a Load Fault wire if present. However, the Load Fault LED retains the normal Load Fault enunciation.
2. Be certain a common connection exists between the **#3 terminals** of all units.
3. Connect a control wire of light gauge 22-24 is fine **from #4 Master to #10 of each Slave**.
4. When a Run (ON) command is provided, #4 will pulse low and also provide a Run to all Slave units, which can be inhibited by local Stop commands.
5. The Master Run/Stop (8/9/10) can be SPDT or momentary as desired.

6. With the unit powered up and in a standby mode, connect interface adapter and start PlasmaVIEW. In PV, press the **Connect** button and when data connection is verified start the **DAQ**. Select **Limits** tab.
7. In the left **Limits** stack the default **Unit Number is 0**, if not, change it to 0 (**MUST be 0**).
8. Click the grayed out football button labeled '**Slave/Standalone'** – turns Yellow and displays 'Master'.
9. Click **Set New** button, flashes yellow and askes for Level 1 password which is '**plasma**'.
10. A comm error box may appear, just OK and **<u>restart DAQ</u>**.
11. Notice the Unit Number (0) window in the topper display turns YELLOW. Phase locked Sync pulses are now present on #4 output (needs to connected to Slave to observe).
12. Click **Save Flash** button which programs the unit per above. You'll notice a DAT reboot.

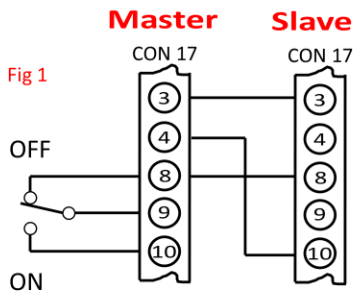
Slave Unit/s

1. Pin #10 should have a signal wire attached, per item 3 above.
2. The Slave STOP control can be momentary or more conveniently the normally closed contact from a SPDT relay, which is most common with singe standalone units. IMPORTANT – the normally open contact(Run) can NOT be connected to #10 as a continuous Run, or it defeats the phase lock signal. A STOP command always prevails over RUN**.** **Example**: if the Master has been given a Run but the Slave unit/s have a Stop present (pin #8 – low), the Slave is Stopped but when the Stop is released, the Slave unit will immediately Run. If the Master is Stopped, a Slave can be made to Run if a momentary Run is provided to the Slave/s. In the absence of a Master sync signal, Slave unit/s will phase lock to their own internal AC reference.
3. If momentary Stop is used, remember to validate Stop after mains power is applied. **The control logic won't permit a Run to be executed if it doesn't know if the Stop works.**
4. The same 'Limits' tab in PlasmaVIEW is used to program the Slave unit/s.
5. In the left **Limits** stack the default **Total Units is 8**, which can be changed to match the total number of units.
6. If a system consists of 1 Master and 1 Slave, then the Slave would be Unit 1, Total Units 2. In actuality a solution that produces better midpoint precision would label the Slave as Unit 4, Total of 8… even better would be Unit 8, Total 16. All the above produce the same basic result but the midpoint sync pulse is noticeably more accurately placed.
7. **DO NOT** click the grayed out football button labeled '**Slave/Standalone'**
8. To complete the programming, click **Set New** button, flashes yellow and askes for Level 1 password which is '**plasma**'if not already satisfied.
9. A comm error box may appear, just OK and **restart DAQ**.
10. Notice the Total Units window in the topper display is updated. Note: The pane labeled 'Limits – Operational' is only updated when the PlasmaVIEW program is run.
11. Click **Save Flash** button which programs the unit per above. You'll notice a DAT reboot.

A few wiring suggestion schematics follow the operational description.

Master / Slave Schematics

Fig 1



Simplest tandum interface but requires Master being powered and funtional. If Master is not powered, slave could be started if Master switch is On & a momentary connection is made between 9 & 10 of Slave connector, as per Fig 2.

Fig 2

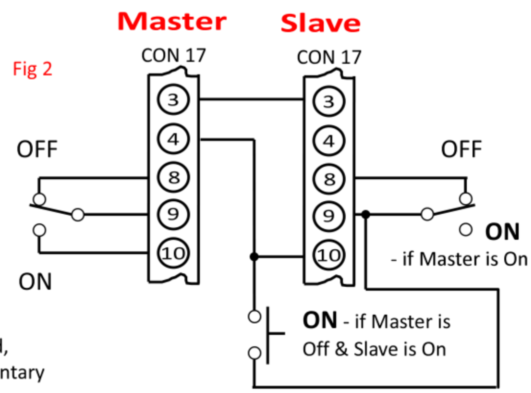
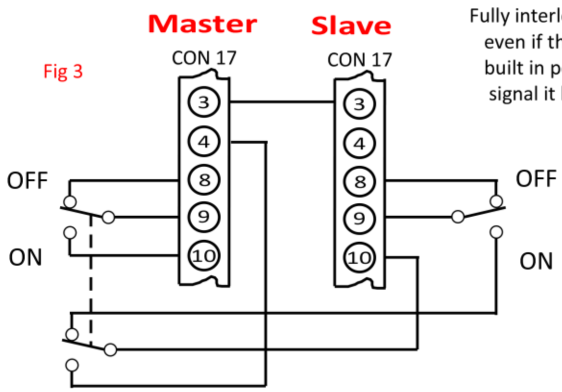
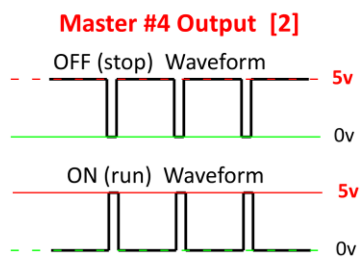


Fig 3



Fully interlocked but totaly seperate. Each can be operated even if the power is off for the other. Each DAT has it's own built in power line phase lock but if Slave #10 detects a phase signal it locks onto it and ignors its own.



Notes:

1. Switch and button contacts must be low current signaling rating.
2. The pulses presented in Stop waveform won't cause the Slave unit to Run.
3. If the Master mains are off, #4 will drop from 5v to ~ 2.7v but typically won't enable Slave... best to interrupt as shown in Fig 3.

9 Troubleshooting

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 CON17 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 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. Using PlasmaVIEW, Factory1 Tab, Push button labeled 'Toggle OVC Protection' so as to turn RED and RUN again. 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.

10 NOTES & GENERAL INFORMATION

Enhanced product features include

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.

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.

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.

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.

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.**

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

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.

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

Plasma Block® will **engage when AC power is applied** if continuous ON command is present one of the options described in Section 5.4 (Page 16), thereby simplifying restart in simple, controlled environments.

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.

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

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

11 Warranty

PTI Electronic Transformer / Inverter
Limited Warranty

The PTI Electronic Transformer / Inverter is warranted by Plasma Technics, Inc®., to the original purchaser to be free from defects in material and workmanship under normal use and service for a period of **ONE (1) year** from the date of purchase under the following terms and conditions:

The obligation of Plasma Technics, Inc®. is expressly limited to repairing or replacing, at the option of Plasma Technics, Inc.®, any PTI Electronic Transformer / Inverter returned to it during the warranty period, which is determined by PTI to be defective in material or workmanship.

Any improper use /operation or installation other than in accordance with the published application materials, instructions and specifications established by Plasma Technics, Inc.® shall void this warranty.

The obligation of Plasma Technics, Inc.® Shall not include any transportation charges, costs of removal or installation, labor charges or any direct, indirect, consequential or delay damages.

Attachment or use of components or accessories not compatible with the PTI Electronic Transformer / Inverter shall void this warranty.

Any alteration not authorized by Plasma Technics, Inc.® in writing, accident, misuse, abuse or damage to the PTI Electronic Transformer / Inverter shall void this warranty.

The electronic transformer / inverter subject to this warranty is not warranted as suitable for any particular purpose or use of the purchaser. The suitability of any PTI Electronic Transformer / Inverter for any purpose particular to the purchaser is for the purchaser in the purchaser’s sole judgment, to determine. Plasma Technics, Inc.® assumes no responsibility for the selection or furnishing of a transformer suitable to the purchaser’s needs or the purposes of any particular purchaser.

This warranty is in lieu of any other warranty express or implied, including specifically but without limitation warranties of merchantability or efficacy and of all other obligations or liabilities in connection with the sale or use of the PTI Electronic Transformer / Inverter.

12 Unico Appendix

Excerpts from Unico's installation manual regarding Series 1100 & 1105. Some dimensions are hard to read, even though these are the source graphic as received. Feel free to email or call with any questions.

Mechanical Installation

Overview

Proper mechanical installation of the drive is essential for safe, reliable operation and to simplify electrical wiring and maintenance. This chapter provides information and instructions for determining the best mounting location, selecting an enclosure, planning a layout, and installing the unit.

Forms

Drives are classified into twelve different *forms* according to their physical size and construction. These forms correspond, for the most part, to different heat sink sizes and sometimes to different box sizes or mounting methods. Refer to Table 0-3 through **Error! Reference source not found.** near the end of this chapter to determine the form of a unit based upon its voltage, torque, and power ratings.

Installation Site Considerations

It is important to chose a mounting location that protects the drive from harmful environmental conditions while, at the same time, safeguarding personnel from the dangerous voltages of the drive system.

Enclosure

A drive can be supplied either as an unmounted open chassis, an unmounted enclosed unit, or mounted within a larger enclosure as part of a packaged drive system incorporating additional components. Open-chassis (IP00) units must be mounted inside an enclosure for safety. The integral enclosures provided with Form 9N, 12N, 13N, 17N, and 17X drives provide NEMA 3R (IP23) protection and can be converted to NEMA 4 (IP66) using the solid gland plate provided with the enclosure. Form 13, 17, 22X, 30, 34, 34X, 48, and 48X enclosures provide NEMA 1 (IP20) protection. Both open-chassis and enclosed versions of all models may be either foot- or flange-mounted.

Figure **0-1** through

Figure **0-5** provide the physical dimensions and mechanical layouts of the drives. Refer to these figures when planning your layout. For simplicity, only the dimensions of enclosed drives are shown. Chassis units occupy approximately the same space.

Attention

To provide protection against electrical shock, chassis units must be mounted in an enclosure meeting at least the requirements of Protective Type IP20 (or NEMA equivalent) according to EN60529 and with top surfaces meeting at least the requirements of IP40 (or NEMA equivalent). It is recommended that a key or tool be required to open the enclosure and that enclosure doors be interlocked with the electrical supply disconnect.

Operating Environment

The drive should be mounted in an environment that is free from corrosive and volatile vapors, dust and particles, mechanical shock, excessive vibration, water or excessive moisture, and temperature extremes. The required ambient operating conditions are specified in **Error! Reference source not found.**.

Cooling

Thermal management techniques may be necessary to keep the drive operating within required temperature specifications, particularly when units are installed within confined spaces. Drives cool themselves using fans that circulate air across a heat sink. Air can be drawn from either inside the enclosure or outside, depending upon the mounting configuration. Some applications may require additional ventilating or cooling equipment.

Thermal Load

If the drive is to be installed in a separate enclosure, its thermal load must be considered. The total power dissipated by each drive is given in

Table 0-6 (1100, 1105, and 1130 drives), **Error! Reference source not found.** (1110 drives), **Error! Reference source not found.** (1120 drives), **Error! Reference source not found.** (1200 drives), and **Error! Reference source not found.** (1230 drives) at the end of this chapter. Dissipation figures are provided for the control section and heat sink independently since the heat sink can be mounted externally to the enclosure. Use this information, in conjunction with the enclosure manufacturer's recommendations, to size the enclosure and to determine cooling airflow requirements. Power dissipation of units operating on 380 V power lines is the same as that listed for 460 V.

Air Circulation

Air circulation can be controlled by selecting the mounting configuration. Foot-mounted drives stand away from the mounting surface and pull ambient air from behind the unit to cool the heat sink. Flange-mounted drives dissipate heat outside an enclosure by allowing the heat sink to protrude through a cutout in the enclosure wall. The smallest units, which do not have finned heat sinks, must be flush mounted. Refer to Section 0 for mounting instructions (Installation Procedure).

Layout Considerations

The following information should be considered when planning a mechanical layout.

Dimensions and Weights

The physical dimensions of each drive are provided in

Figure 0-1 through

Figure 0-5. The approximate weight of each unit is given in Table 0-3 through **Error! Reference source not found.**.

Attention
Make certain that the mounting surface is strong enough to support the weight of all components to be mounted on it.

Space Requirements

Sufficient space must be provided around each drive for cooling airflow, access to electrical connections, and maintenance. Minimum recommended clearances above and below, to the side of, and behind the heat sink and fans of the various units are indicated in Table 0-1. If multiple drives are to be installed adjacent to each other, allow twice the indicated clearances between units. Be sure to also leave enough clearance for removing and replacing the cover during installation and servicing.

Table 0-1—Minimum Mounting Clearances

Form	Vertical	Horizontal	Behind
	in (mm)	*in (mm)*	*in (mm)*
13, 13N, 17, 17N, 17X, and 30	6.00" (152)	3.00" (76)	1.13" (29)
48 and 48X	3.00" (76)	6.00" (152)	2.25" (57)
9N and 12N	6.00" (152)	3.00" (76)	—
22X, 34, and 34X	3.00" (76)	6.00" (152)	2.25" (57)

Orientation

Drives must be mounted upright (so that the cover label reads correctly) to permit proper cooling airflow. Under no circumstances should units be installed upside down or on their sides in an attempt to change the direction of airflow or to facilitate wiring.

Position the drive so that its keypad/display can be accessed comfortably by the operator. The average adult is 5' 6" (168 cm) tall, so mount accordingly if possible.

Cable Routing

Separate electrical conduits are required for incoming power, output to the motor, and control wiring.

Installation Procedure

Both chassis and enclosed drives can be either foot- or flange-mounted.

Figure 0-1 through

Figure 0-5 provide the physical dimensions and mechanical layouts of the units. Refer to these figures when planning your layout.

Attention
Make certain that the mounting surface is secure before mounting the drive. Equipment damage could result from an improperly mounted unit.

Attention
Exercise care during installation to prevent metal shavings, conduit knockouts, and other debris from falling into the unit(s). Personal injury and/or equipment damage could result.

Attention
The drive may weigh a considerable amount. To avoid the risk of personal injury and/or damage to the drive, two or more people should work in unison when lifting and maneuvering a unit. Follow industry prescribed safe lifting practices at all times.

Foot Mounting

A drive may be foot-mounted to a subpanel inside an enclosure or directly to an enclosure wall. Mounting feet are provided with Form 12N 1105 and 1120 drives and all Form 9N 1200 drives. Feet are available as a factory-installed option with Form 17N, 30, and 34 1105 drives, Form 17 1120 drives, Form 13N, 17X, and 48X 1230 drives, and all 1100, 1110, and 1130 drives. Optional foot-mounting brackets are available with Form 22X 1230 drives. Mounting feet and brackets keep the heat sink and fans, if so supplied, the proper distance from the mounting surface. Certain low-power Form 13 models do not have finned heat sinks and, therefore, cannot accept feet. These models must be mounted flush with the surface.

Mount Form 13, 13N, 17, 17N, 17X, and 30 drives using four 1/4" (6 mm) bolts or studs with nuts. Mount Form 34, 34X, 48 and 48X drives using four 3/8" (10 mm) bolts or studs with nuts. Attach the top feet first to suspend the drive, then secure the bottom feet. Mount Form 9N and 12N drives using four #10 (5 mm) bolts or studs with nuts. Attach the bottom feet first, then secure the the top feet. Refer to the flange-mounting diagrams for hole locations.

Form 22X drives may be foot-mounted to a subpanel inside an enclosure or directly
to an enclosure wall using the optional 709-628 foot-mounting bracket kit. Attach the brackets first to the mounting surface using 5/16" (8 mm) bolts or studs, then mount the drive unit to the protruding 5/16"–18 x 3/4" studs.

Flush Mounting (Form 22X)

Form 22X drives may be flush mounted to a subpanel inside an enclosure or directly to an enclosure wall. The units require a cutout in the panel or enclosure wall to allow air to vent out the back. Allow clearance behind the cutout for airflow as recommended in **Table 0-1**. Mount the drives using at least six 5/16" (8 mm) bolts or studs. Rest the bottom mounting slots on the bolts or studs while securing the top.

Flange Mounting

A drive may also be flange-mounted with its heat sink protruding through a cutout in the enclosure wall. This allows heat to be dissipated outside the enclosure. A mounting flange is provided with all 1100, 1110, 1130, 1200, and 1230 drives, with Form 13, 13N, 17N, 30, and 34 1105 drives, and with Form 17 1120 drives. It is available as a factory-installed option with Form 12N 1105 and 1120 drives and Form 9N 1200 drives. Factory-installed mounting adapters are also available for mounting some smaller drives in larger cutouts (see Table 0-2). Allow the recommended clearance behind the heat sink and fans for airflow (see Table 0-1).

Mount Form 9N, 12N, 13, 17, 17N, 17X, and 30 drives using #10 (5 mm) bolts or studs with nuts. The number of bolts or studs required varies with the size of the drive. Form 22X drives use sixteen #10 (5 mm) studs through the holes in the heat sink flange. The corner studs of each unit must pass through the console; others may be welded. Form 34, 34X, 48, and 48X drives have 1/4"-20 mounting studs protruding through both sides of the heat sink that require (12) 5/16" (8 mm) mounting holes. Secure the unit across the top and bottom using six additional 1/4" (6 mm) bolts with nuts. Refer to the flange-mounting diagrams for hole locations and cutout dimensions. An adapter uses the same hole pattern as a drive that uses the same cutout. Chassis units are designed to provide NEMA 4 (IP66) integrity when flange-mounted inside a suitable NEMA 4 enclosure using the gasket provided.

Table 0-2—Flange-Mounting Adapters

Form	Part Number	Description
9N	711-556	Adapter for mounting the drive within cutout for a Form 13 and 13N drives
9N	711-557	Adapter for mounting the drive within cutout for a Form 17, 17N, and 17X drives
12N	709-624	Adapter for mounting the drive within cutout for a Form 13 and 13N drives
12N	708-520	Adapter for mounting the drive within cutout for a Form 17, 17N, and 17X drives
17, 17N, and 17X	709-623	Adapter for mounting the drive within cutout for a Form 30 drive

Mounting the I/O Fanning Strip

The optional I/O fanning strip is generally mounted beneath the drive. Attach the strip from behind the mounting surface using nuts to secure the four #6-32 standoff screws.

Figure 0-1—Form 9N Mounting Dimensions (1200 Drive)

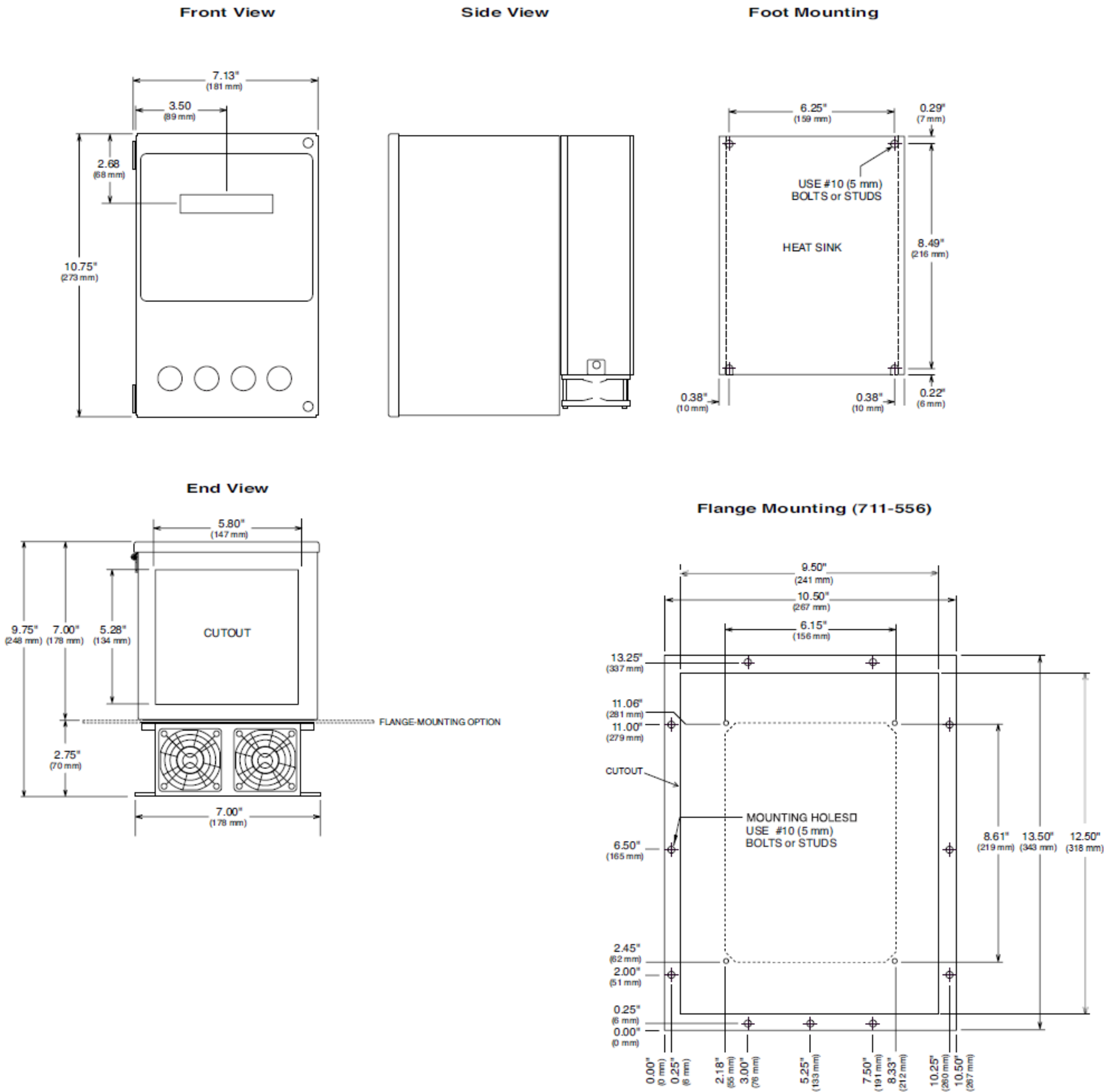
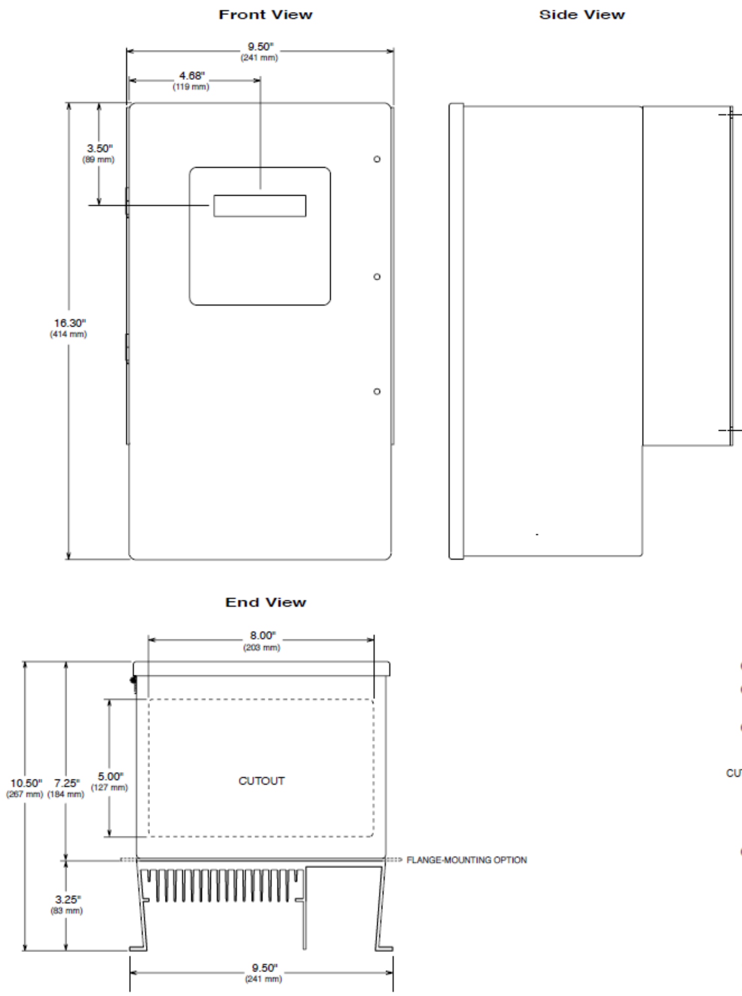
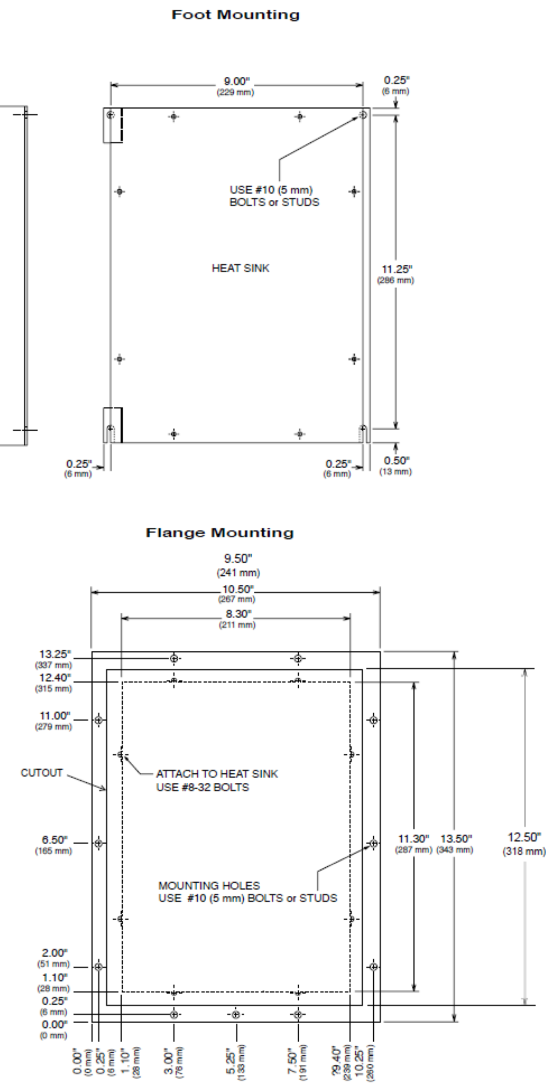


Figure 0-2—Form 12N Mounting Dimensions (1105 and 1120 Drives)



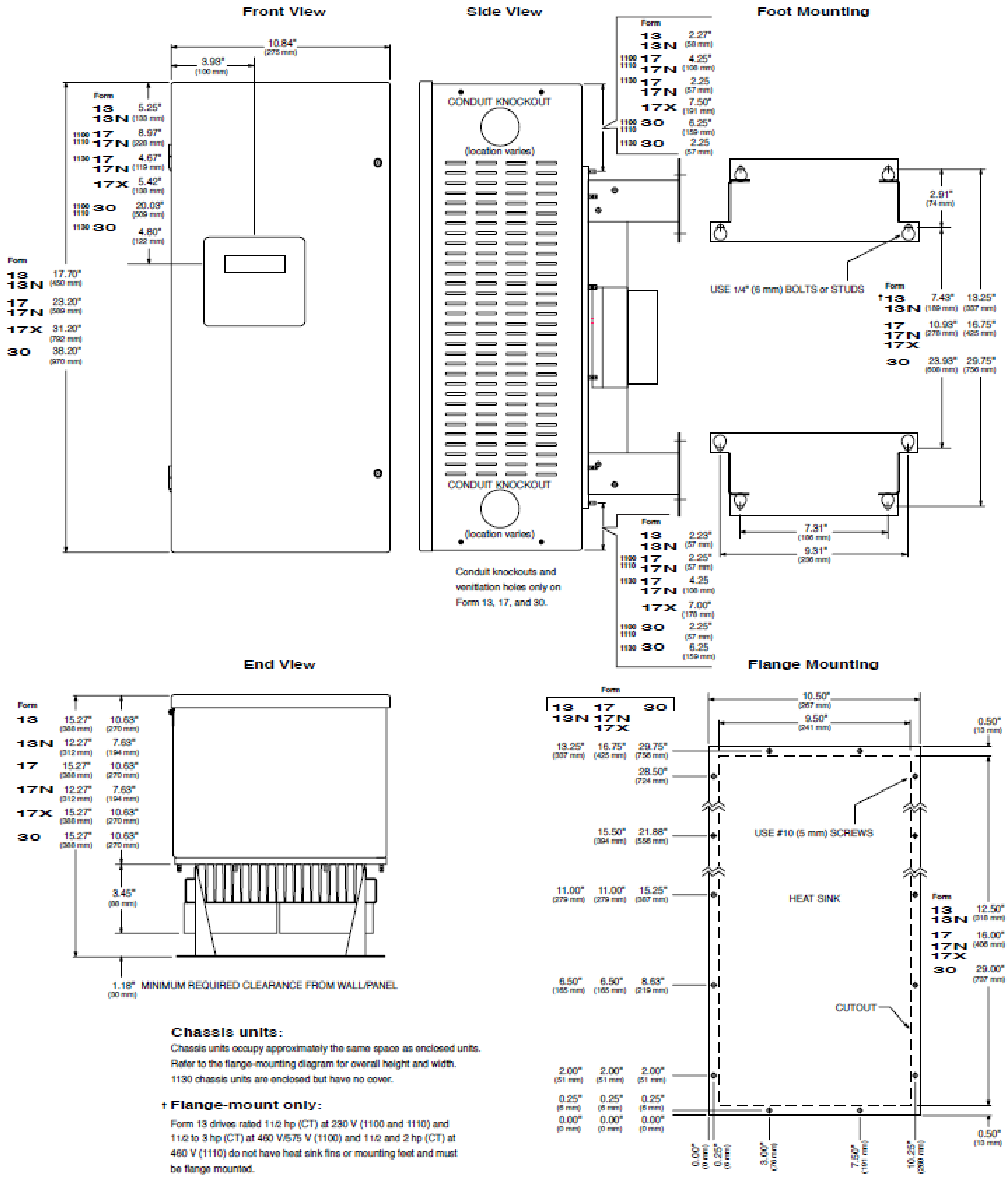


Chassis units:

Chassis units occupy approximately the same space as enclosed units. Refer to the front view dimensions for overall height and width of foot-mounted units and to the flange-mounting diagram for overall height and width of flange-mounted units.

Figure 0-3—Form 13, 13N, 17, 17N, 17X, and 30 Mounting Dimensions

(1100, 1105, 1110, 1120, 1130, 1200, and 1230 Drives)



Chassis units:
Chassis units occupy approximately the same space as enclosed units. Refer to the flange-mounting diagram for overall height and width. 1130 chassis units are enclosed but have no cover.

† Flange-mount only:
Form 13 drives rated 11/2 hp (CT) at 230 V (1100 and 1110) and 11/2 to 3 hp (CT) at 460 V/575 V (1100) and 11/2 and 2 hp (CT) at 460 V (1110) do not have heat sink fins or mounting feet and must be flange mounted.

Figure 0-4—Form 22X Mounting Dimensions (1230 Drive)

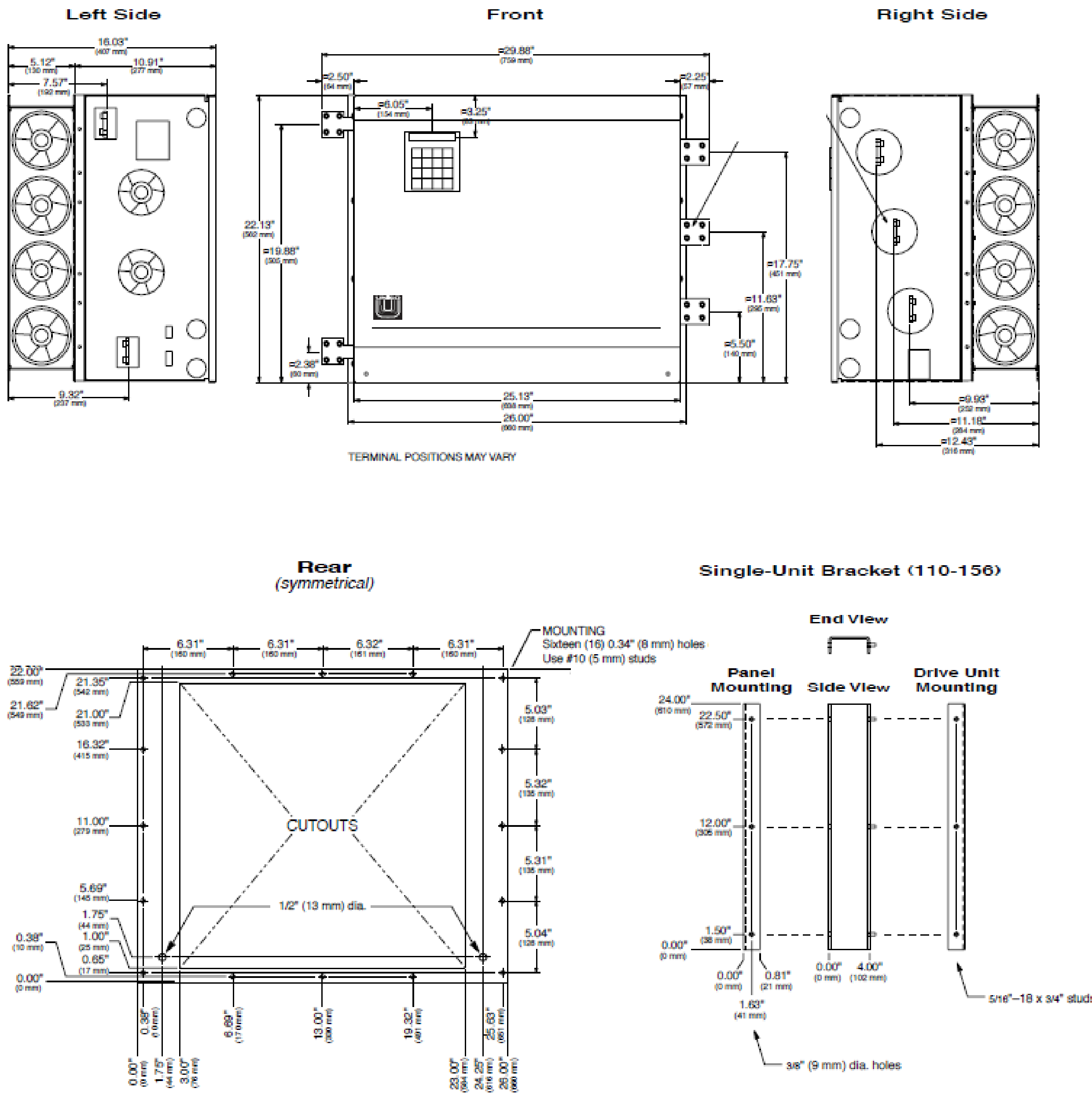


Figure 0-5—Form 34, 34X, 48, and 48X Mounting Dimensions (1100, 1105, 1200, and 1230 Drives)

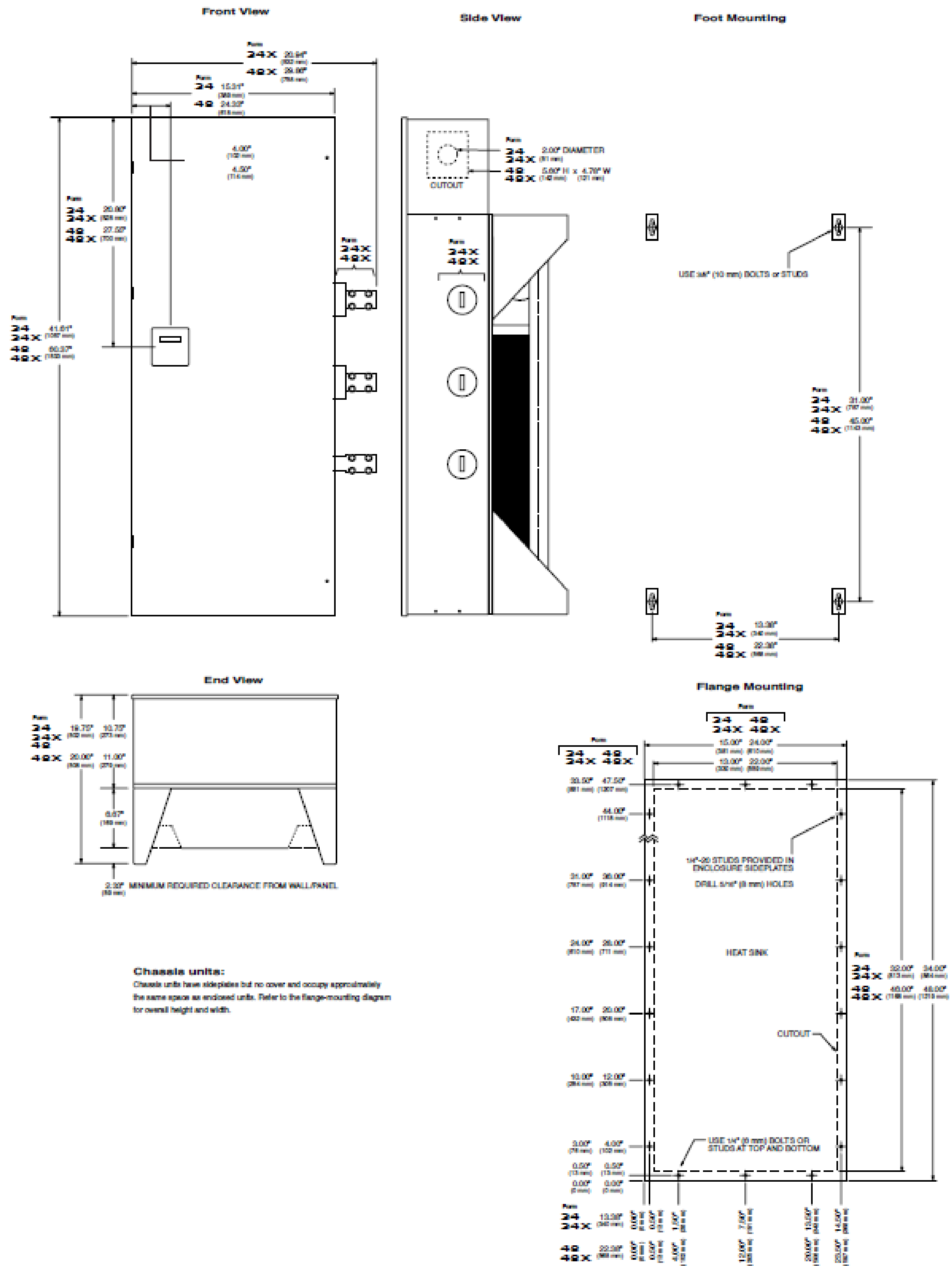


Table 0-3—1100 Drive Forms / Weights

Power			Form	Weights	
CT *hp (kW)*	VT *hp (kW)*	ET *hp (kW)*		Chassis *lb (kg)*	Enclosed *lb (kg)*
230 V					
1 1/2–7 1/2 (1.1-5.5)	2–10 (1.5-7.5)	—	13	30 (14)	45 (20)
10–30 (7.5-22)	25–40 (18-30)	—	17	55 (25)	70 (32)
40–60 (30-45)	50–75 (37-55)	—	30	105 (48)	130 (59)
460 V					
1 1/2–5 (1.1–3.7)	2–7 1/2 (1.5-5.5)	—	13	30 (14)	45 (20)
7 1/2–50 (5.5-37)	10–60 (7.5-45)	25–75 (18-55)	17	55 (25)	70 (32)
60–125 (45-90)	75–150 (55-110)	100–150 (75-110)	30	105 (48)	130 (59)
150–250 (110-185)	200-300 (150-225)	250–350 (185-262)	48	400 (181)	450 (204)
300–350 (225-262)	350-400 (262-300)	400–500 (300-375)	48	500 (227)	550 (249)
575 V					
1 1/2–5 (1.1–3.7)	2–7 1/2 (1.5-5.5)	—	13	30 (14)	45 (20)
7 1/2–60 (7.5-45)	10–75 (7.5-55)	25–100 (18-75)	17	55 (25)	70 (32)
75–125 (55-90)	100–150 (75-110)	125–150 (90-110)	30	105 (48)	130 (59)
150–300 (110-225)	200–350 (150-262)	250–400 (185-300)	48	400 (181)	450 (204)
350–400 (262-300)	400-500 (300-375)	500–600 (375-450)	48	500 (227)	550 (249)

Table 0-4—1105 Drive Forms / Weights

Power			Form	Weights	
CT hp (kW)	VT hp (kW)	ET hp (kW)		Chassis lb (kg)	Enclosed lb (kg)
230 V					
11/2–3 (1.1-2.2)	2–5 (1.5-3.7)	—	12N	15 (7)	25 (11)
5–20 (3.7-15)	71/2–25 (5.5-18)	—	12N	20 (9)	30 (14)
460 V					
11/2–5 (1.1-3.7)	2–71/2 (1.5-5.5)	10 (7.5)	12N	15 (7)	25 (11)
71/2–20 (5.5-15)	10–25 (7.5-18)	15–30 (11-22)	12N	20 (9)	30 (14)
25–40 (18-30)	30–50 (22-37)	40–60 (30-45)	17N	40 (18)	50 (23)
50–100 (37-75)	60–125 (45-90)	75–150 (55-110)	30	100 (45)	125 (57)
125–150 (90-110)	150–200 (110-150)	200–250 (150-185)	34	260 (118)	290 (132)
575 V					
11/2–10 (1.1-7.5)	2–15 (1.5-11)	10–20 (7.5-15)	12N	15 (7)	25 (11)
15–40 (11-30)	20–50 (15-37)	25–60 (18-45)	17N	40 (18)	50 (23)
50–100 (37-75)	60–125 (45-90)	75–150 (55-110)	30	100 (45)	125 (57)
125–200 (90-150)	150–250 (110-185)	200–300 (150-225)	34	260 (118)	290 (132)

Table 0-5—1110 Drive Forms / Weights

Power		Form	Weights	
CT hp (kW)	VT hp (kW)		Chassis lb (kg)	Enclosed lb (kg)
230 V				
11/2–3 (1.1-2.2)	2–5 (1.5-3.7)	13	30 (14)	45 (20)
5–20 (5.5-15)	71/2–25 (7.5-18)	17	40 (18)	60 (27)
25 (18)	30 (22)	17	50 (23)	70 (32)
30–40 (22-30)	40–50 (30-37)	30	100 (45)	125 (57)
460 V				
11/2–5 (1.1–3.7)	2–71/2 (1.5-5.5)	13	30 (14)	45 (20)
71/2–20 (5.5-15)	10–25 (7.5-18)	17	40 (18)	60 (27)
25–40 (18-30)	30–50 (22-37)	17	50 (23)	70 (32)
50–75 (37-55)	60–100 (45-75)	30	100 (45)	125 (57)

Table 0-6—1100, 1105, and 1130 Power Dissipation

Power			Dissipation		
CT *hp (kW)*	**VT** *hp (kW)*	**ET** *hp (kW)*	**Control** *kW*	**Heat Sink** *kW*	**Total** *kW*
230 V					
1 1/2 (1.1)	2 (1.5)	—	0.042	0.054	0.095
2 (1.5)	3 (2.2)	—	0.043	0.062	0.105
3 (2.2)	5 (3.7)	—	0.048	0.088	0.136
5 (3.7)	7 1/2 (5.5)	10 (7.5)	0.054	0.140	0.194
7 1/2 (5.5)	10 (7.5)	15 (11)	0.063	0.204	0.266
10 (7.5)	15 (11)	20 (15)	0.072	0.261	0.333
15 (11)	20 (15)	25 (18)	0.095	0.392	0.487
20 (15)	25 (18)	30 (22)	0.111	0.506	0.617
25 (18)	30 (22)	40 (30)	0.127	0.637	0.764
30 (22)	40 (30)	50 (37)	0.151	0.751	0.902
40 (30)	50 (37)	60 (45)	0.184	0.979	1.163
50 (37)	60 (45)	75 (55)	0.214	1.224	1.438
60 (45)	75 (55)	100 (75)	0.247	1.452	1.699
460 V					
1 1/2 (1.1)	2 (1.5)	—	0.042	0.040	0.082
2 (1.5)	3 (2.2)	—	0.043	0.046	0.089
3 (2.2)	5 (3.7)	—	0.046	0.065	0.111
5 (3.7)	7 1/2 (5.5)	10 (7.5)	0.054	0.104	0.158
7 1/2 (5.5)	10 (7.5)	15 (11)	0.062	0.151	0.212
10 (7.5)	15 (11)	20 (15)	0.071	0.193	0.264
15 (11)	20 (15)	25 (18)	0.087	0.289	0.376
20 (15)	25 (18)	30 (22)	0.102	0.373	0.475
25 (18)	30 (22)	40 (30)	0.117	0.469	0.586
30 (22)	40 (30)	50 (37)	0.142	0.553	0.695
40 (30)	50 (37)	60 (45)	0.173	0.720	0.893
50 (37)	60 (45)	75 (55)	0.203	0.901	1.104

(continued)

Table 0-7—1100, 1105, 1130, 1200, and 1230 Fuse Specifications *(continued)*

Power			Dissipation		
CT hp (kW)	VT hp (kW)	ET hp (kW)	Control kW	Heat Sink kW	Total kW
460 V					
60 (45)	75 (55)	100 (75)	0.241	1.068	1.309
75 (55)	100 (75)	125 (90)	0.289	1.332	1.621
100 (75)	125 (90)	150 (110)	0.364	1.725	2.089
125 (90)	150 (110)	200 (150)	0.448	2.169	2.617
150 (110)	200 (150)	250 (185)	0.225	3.062	3.287
200 (150)	250 (185)	300 (225)	0.275	3.999	4.274
250 (185)	300 (225)	350 (262)	0.325	4.937	5.262
300 (225)	350 (262)	400 (300)	0.375	5.874	6.249
350 (262)	400 (300)	500 (375)	0.425	6.811	7.236
575 V					
1 1/2 (1.1)	2 (1.5)	—	0.042	0.039	0.081
2 (1.5)	3 (2.2)	—	0.043	0.045	0.088
3 (2.2)	5 (3.7)	—	0.046	0.065	0.111
5 (3.7)	7 1/2 (5.5)	10 (7.5)	0.054	0.102	0.156
7 1/2 (5.5)	10 (7.5)	15 (11)	0.062	0.150	0.212
10 (7.5)	15 (11)	20 (15)	0.071	0.185	0.256
15 (11)	20 (15)	25 (18)	0.087	0.285	0.372
20 (15)	25 (18)	30 (22)	0.102	0.369	0.471
25 (18)	30 (22)	40 (30)	0.117	0.454	0.571
30 (22)	40 (30)	50 (37)	0.142	0.538	0.680
40 (30)	50 (37)	60 (45)	0.173	0.692	0.865
50 (37)	60 (35)	75 (55)	0.203	0.876	1.079
60 (45)	75 (55)	100 (75)	0.241	1.046	1.287
75 (55)	100 (75)	125 (90)	0.289	1.299	1.588
100 (75)	125 (90)	150 (110)	0.364	1.675	2.039
125 (90)	150 (110)	200 (150)	0.448	2.113	2.561
150 (110)	200 (150)	250 (185)	0.225	2.992	3.217

Table 0-7—1100, 1105, 1130, 1200, and 1230 Fuse Specifications

Rated Power	Input Current	Fuse Current	Fuse Voltage	Recommended Semiconductor Fuse	
hp (kW)	*A_{rms}*	*A_{rms}*	*V_{rms}*	*Manufacturer*	*Part Number*
230 V					
1 1/2 (1.1)	4.2	10	250	Bussman	FWX 10A14F
2 (1.5)	5.1	10	250	Bussman	FWX 10A14F
3 (2.2)	7.5	10	250	Bussman	FWX 10A14F
5 (3.7)	12.1	20	250	Bussman	FWX 20A14F
7 1/2 (5.5)	17.8	25	250	Bussman	FWX 25A14F
10 (7.5)	23.2	30	250	Bussman	FWX 30A14F
15 (11)	34.9	50	250	Bussman	FWX 50A
20 (15)	45.7	60	250	Bussman	FWX 60A
25 (18)	57.3	80	250	Bussman	FWX 80A
30 (22)	68.1	90	250	Bussman	FWX 90A
40 (30)	89.6	125	250	Bussman	FWX 125A
50 (37)	112.0	150	250	Bussman	FWX 150A
60 (45)	133.6	175	250	Bussman	FWX 175A
75 (55)	166.7	225	250	Bussman	FWX 225A
380 V					
1 1/2 (1.1)	2.4	4	500	Bussman	FWH 4A14F
2 (1.5)	2.9	4	500	Bussman	FWH 4A14F
3 (2.2)	4.3	6	500	Bussman	FWH 6A14F
5 (3.7)	7.0	10	500	Bussman	FWH 10A14F
7 1/2 (5.5)	10.3	15	500	Bussman	FWH 15A14F
10 (7.5)	13.4	20	500	Bussman	FWH 20A14F
15 (11)	20.1	25	500	Bussman	FWH 25A14F
20 (15)	26.3	35	500	Bussman	FWH 35B
25 (18)	32.9	45	500	Bussman	FWH 45B
30 (22)	39.1	50	500	Bussman	FWH 50B
40 (30)	51.5	70	500	Bussman	FWH 70B

(continued)

Table 0-7—1100, 1105, 1130, 1200, and 1230 Fuse Specifications *(continued)*

Rated Power	Input Current	Fuse Current	Fuse Voltage	Recommended Semiconductor Fuse	
hp (kW)	*A_{rms}*	*A_{rms}*	*V_{rms}*	*Manufacturer*	*Part Number*
380 V					
50 (37)	64.4	90	500	Bussman	FWH 90B
60 (45)	76.8	100	500	Bussman	FWH 100B
75 (55)	95.9	125	500	Bussman	FWH 125B
100 (75)	125.8	175	500	Bussman	FWH 175B
125 (90)	157.8	225	500	Bussman	FWH 225B
150 (110)	185.6	250	500	Bussman	FWH 250A
200 (150)	247.5	325	500	Bussman	FWH 325A
250 (185)	309.4	400	500	Bussman	FWH 400A
300 (225)	371.3	500	500	Bussman	FWH 500A
350 (262)	433.2	600	500	Bussman	FWH 600A
400 (300)	495.1	700	500	Bussman	FWH 700A
500 (375)	618.8	800	500	Bussman	FWP 800A
460 V					
1 1/2 (1.1)	2.1	3	500	Bussman	FWH 3A14F
2 (1.5)	2.6	4	500	Bussman	FWH 4A14F
3 (2.2)	3.7	5	500	Bussman	FWH 5A14F
5 (3.7)	6.1	10	500	Bussman	FWH 10A14F
7 1/2 (5.5)	8.9	12	500	Bussman	FWH 12A14F
10 (7.5)	11.6	15	500	Bussman	FWH 15A14F
15 (11)	17.4	25	500	Bussman	FWH 25A14F
20 (15)	22.8	30	500	Bussman	FWH 30A14F
25 (18)	28.6	40	500	Bussman	FWH 40B
30 (22)	34.0	45	500	Bussman	FWH 45B
40 (30)	44.8	60	500	Bussman	FWH 60B
50 (37)	56.0	80	500	Bussman	FWH 80B
60 (45)	66.8	90	500	Bussman	FWH 90B

(continued)

Table 0-7—1100, 1105, 1130, 1200, and 1230 Fuse Specifications *(continued)*

Rated Power *hp (kW)*	Input Current *A_{rms}*	Fuse Current *A_{rms}*	Fuse Voltage *V_{rms}*	Recommended Semiconductor Fuse *Manufacturer*	 *Part Number*
460 V					
75 (55)	83.4	125	500	Bussman	FWH 125B
100 (75)	109.4	150	500	Bussman	FWH 150B
125 (90)	137.2	200	500	Bussman	FWH 200B
150 (110)	161.4	225	500	Bussman	FWH 225A
200 (150)	215.2	300	500	Bussman	FWH 300A
250 (185)	269.1	350	500	Bussman	FWH 350A
300 (225)	322.9	450	500	Bussman	FWH 450A
350 (262)	376.7	500	500	Bussman	FWH 500A
400 (300)	430.5	600	500	Bussman	FWH 600A
500 (375)	538.1	700	500	Bussman	FWH 700A
600 (450)	645.7	1,000	500	Bussman	FWH 1000A
800 (600)	861.0	1,200	500	Bussman	FWH 1200A
1000 (750)	1076.2	1,400	500	Bussman	FWH 1400A
575 V					
11/2 (1.1)	1.7	3	700	Bussman	FWP 3A14F
2 (1.5)	2.0	3	700	Bussman	FWP 3A14F
3 (2.2)	3.0	4	700	Bussman	FWP 4A14F
5 (3.7)	4.9	10	700	Bussman	FWP 10A14F
71/2 (5.5)	7.2	10	700	Bussman	FWP 10A14F
10 (7.5)	9.2	15	700	Bussman	FWP 15A14F
15 (11)	14.0	20	700	Bussman	FWP 20A14F
20 (15)	18.4	25	700	Bussman	FWP 25A14F
25 (18)	22.8	30	700	Bussman	FWP 30A14F
30 (22)	27.2	40	700	Bussman	FWP 40B
40 (30)	35.6	50	700	Bussman	FWP 50B
50 (37)	44.8	60	700	Bussman	FWP 60B

(continued)