# Induction Power Supply Technical/Service manual for 80kW, 120kW, 480V input 2012

INDEX

I) SET-UP AND USE

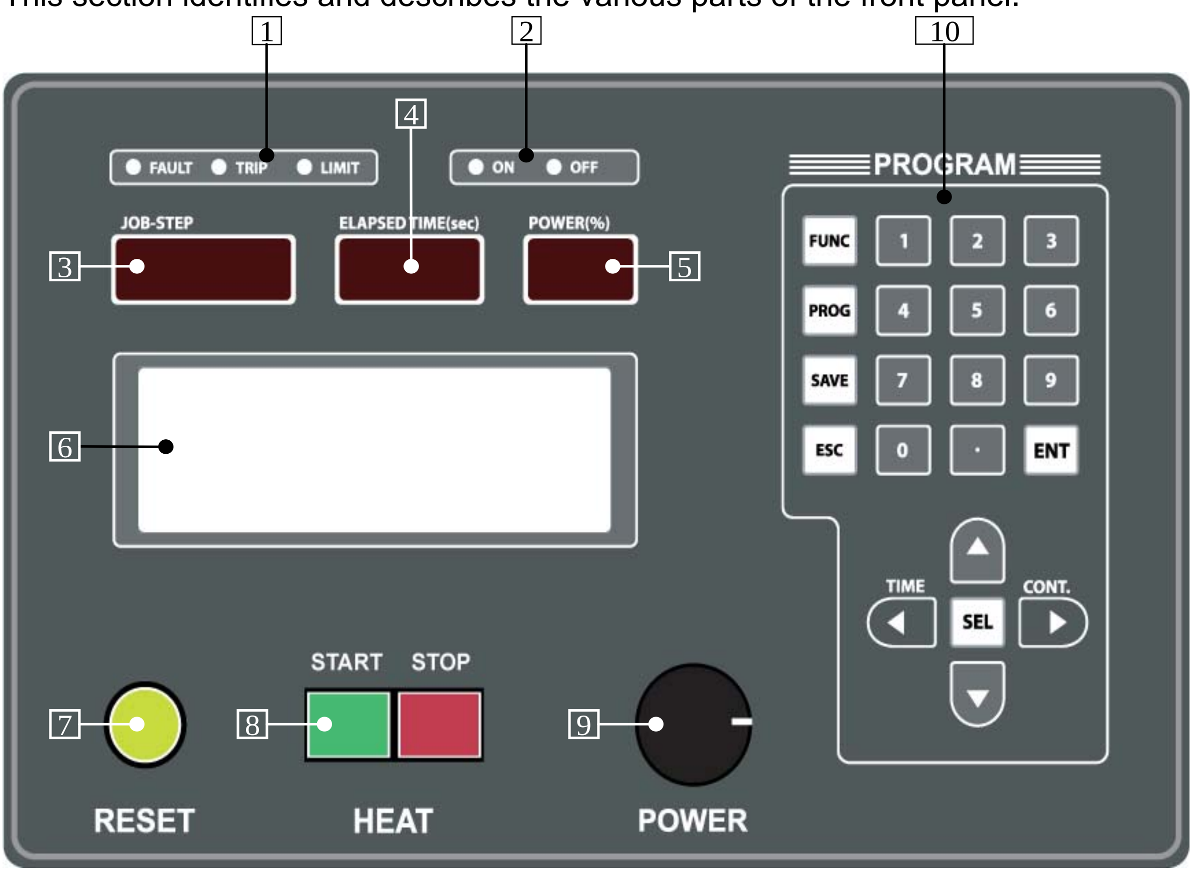
A) FEATURES

PPSTinc line of  power supplies with 480V,3ø, 50/60 Hz .input come in power levels of (40,80,120,160,240&320kW) and two frequency ranges (35-100 kHz & 135-400 kHz). The operations of the power supplies are very similar regardless of power level or frequency range.  They can be tuned to a large variety of coils by adding or removing the resonant capacitors and by the adjusting of the series inductor.

# Front panel description

Front panel description

This section identifies and describes the various parts of the front panel.



| | | | |
|---|---|---|---|
| 1) | Fault, Trip and Limit LEDs | 6) | LCD display |
| 2) | Heat On/Off LEDs | 7) | Reset button |
| 3) | Program Indicator | 8) | Heat switch |
| 4) | Time Indicator | 9) | Power Knob |
| 5) | Power Indicator | 10) | Program Buttons |

Figure 3: Front panel layout.

All units come standard with LCD display, and displays Power, Inverter Current, Output Voltage, and Frequency. The LCD also displays Frequency Limit, Voltage limit, Over Current Trip, Resonance Trip, Swing Thru trip and Faults for the interlocks on the Door, Water Flow, Inlet Water Temperature, and an Auxiliary Trip can be used as needed. The are five LED's indicating Faults, Trips Limits, Heat On & Heat Off. There are On/Off buttons, Power Pot, a nine pin D-sub connector for use with a remote loader and remote functions can be wired into terminal blocks inside the cabinet.

****** For display functions see users manual

B) SET-UP

The principles in setting up the power supply are the same. Inspect the unit, paying careful attention for signs of shipping damages. Included with each unit is an operation manual a pair of O-Rings needed for the work coil and keys to the cabinet door.

Open the cabinet and carefully check for loose bolts, look for loose plugs, loose connections or anything else that might have come lose during shipment.

a) Check connections on the power transformers.

b) Check tightness of ground connections

c) Check that all hose clamps are in place and closed tightly.

d) Check that all plugs are secure.

Connect the water hoses to the Power Supply.  A differential pressure of 30 PSI should be maintained.  Be sure to connect water supply to the "Water In" and return to the "Water Out".

Connect the three-phase power to the unit. Be sure the power is locked out prior to doing this. The Power Supply is designed for 408 to 480VAC, 3ø. The input is not phase dependent. Be certain that the unit is grounded to earth ground. Connect control breaker to two phases of the main circuit breaker. Connect the coil to the output blocks. Make sure that the O-Rings are installed. Set the number of capacitors and the series inductors to match to the coil so that the units will run with-in the frequency range. Turn on the water and check for leaks. Energize the 480VAC. to the unit, the main breaker can be engaged after the control breaker is on. The unit is now ready to run.

C) Tips for dependable Operation

a) Make sure all connections are tight

b) Do not run the unit above 400 kHz

c) Do not demand more power than the unit is tuned for once the unit reaches a limit (raising the power knob more will not deliver more power)

d) Provide adequate water flow

e) Avoid condensation inside the unit.

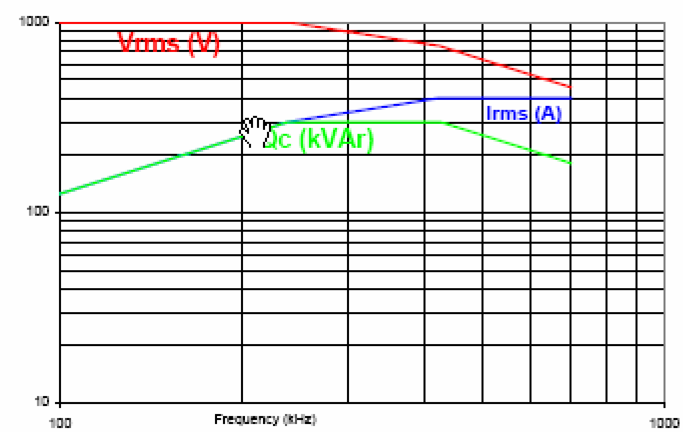
f) Run the unit near frequency limit. This results in lower inverter currents, less heating of components, and more efficient operation.

g) Make sure that the resonant load capacitors are securely tightened to the capacitor rails. Loose capacitors can overheat and fail.

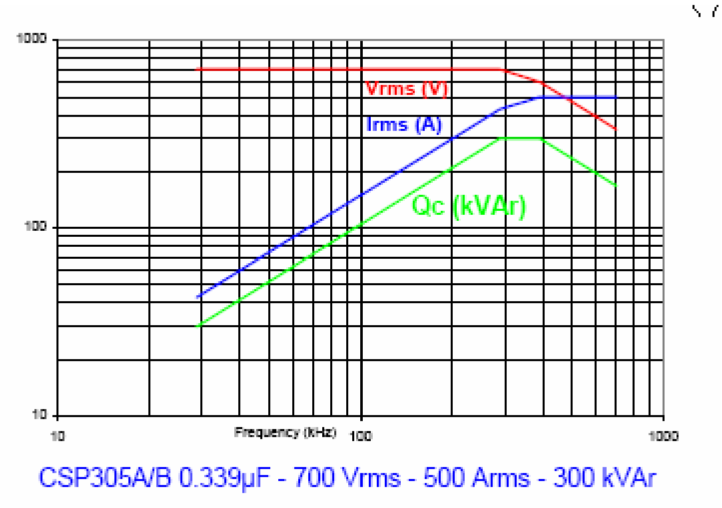
h) Place the resonant capacitors in opposition on the capacitor rails. This is absolutely necessary when using a series parallel cap rail configuration.

i) Do not exceeding the KVAR of the resonant capacitors.

$KVAR = 2\pi fCV^2$ Kilo-volts-amperes-reactive




CSP305A/B 0.2µF - 1000 Vrms - 400 Arms - 300 kVAr

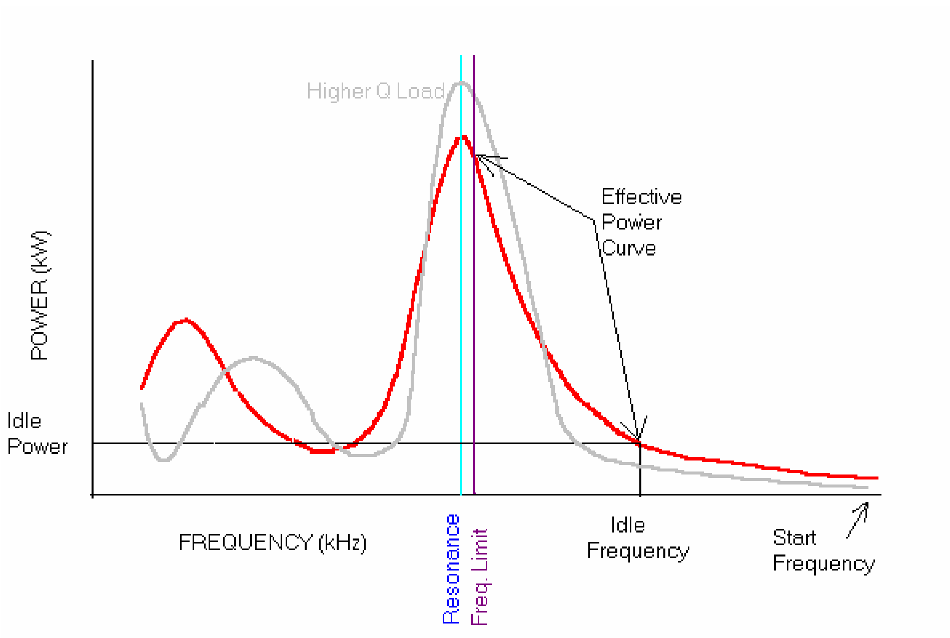



j) The water fittings in the power supplies are all brass or copper. Avoid using iron or steel components in the water path to avoid iron oxide build up in the water path.

k) Use only brass or stainless fasteners.

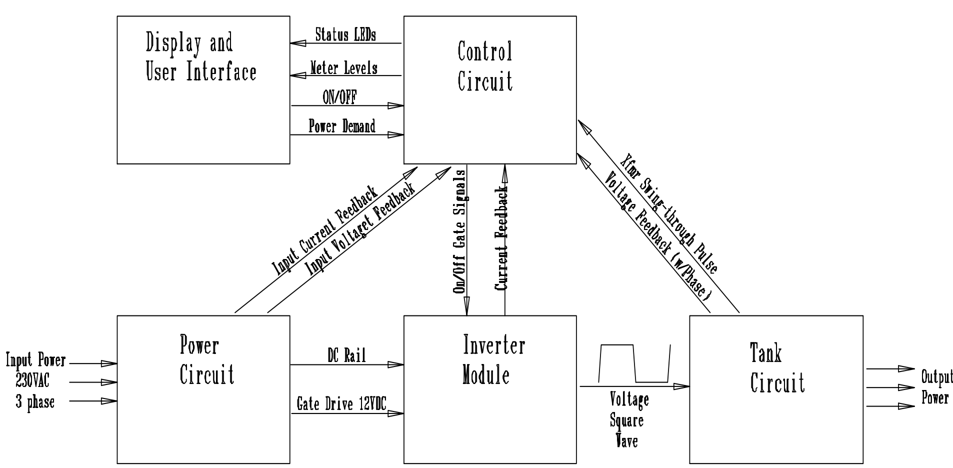
## D) BASIC OPERATIONAL THEORY

PPST power supplies operate taking the input three-phase AC and rectifying it for a DC rail that is used by the inverter modules. The inverter modules are a half-bridge configuration which feeds the tank circuit. For a given number of resonant capacitors work coil and series inductor setting there is a particular resonant frequency. Power is regulated by lowering the frequency of operation until power is reached on the resonant curve.




Each unit consists of these basic systems:

a) Power Circuits
b) Inverter Module
c) Tank Circuit
d) Control Circuit
e) Display and User Interface



a) Power Circuit:

The input power to these power supplies is 3 phase 480VAC. This runs through a circuit breaker to a 3-phase diode bridge to provide the DC voltage for the Inverter Modules. A single phase of the 480VAC goes to a step down transformer to provide 240VAC single phase. This is used to power a switching power supply that provides +5, +15, - 15VDC for the control board it is also used to powers fans, transformers and the independent 12VDC switching power supplies that run the gate drivers.

The units have a 24V CT, 1A transformer that connects to the control board and provides power to the 24VAC interlock loop. This transformer also provides a voltage reference for the power regulation circuit.

b) Inverter Module:

The heart of the Power Supply is the Inverter Module. The switching of the Power MOSFETS is the driving force for the Tank Circuit and the Power Supply. This is also the part of the inverter where service may be needed most often.

This assembly consists of the heat sink, Power MOS-FETS, Divider Capacitors, Snubbers and Gate Drivers.

The Inverter module sends a 340V square wave into the Power Transformer primary to set the frequency of the Tank Circuit. The output points of the Inverter Module are the center of the divider capacitors, which stay at the center of the main DC rail, and the center of the Power FETS, which varies from 0 to 680V (or wherever the 480VAC rectified sits).

The main DC rail sits across the Inverter Module, and in particular across two sets of 2.2uF capacitors, the divider capacitors, in parallel with each other and in parallel with the Power FETS on the other side of the Inverter Module. The out puts of the Inverter Module to the Power Transformer come from the center of the Divider Caps, and from the center of the FETS. Across each set of FETS, positive and negative, there is also a snubber board. Each FET S switching pair has one snubber board, and 6-2.2uF divider caps. There are three in parallel by two in series. There are seven such sets per inverter.

The gate drivers turn the FETS on and off, and are powered by independent 12V switching power supplies. They must be independent because one set of FETS flies from 0 to 680V as they switch. The delay between off and on is called the Dwell, and is approximately 310ns on the high frequency units and 720ns on the low frequency units. This is set at the factory. The Gate Drivers receive 70ns pulses from the control board that turn on and off the small FETS on the Gate Driver Board. These pulses are fed through ferrite cores, acting as transformers. The

FETS are feed by a resonant ring circuit, with the output of that resonant ring feeding the input of the gate driver IC. The output of the gate drive IC is low when the input is high, and vice-versa. There is a 1MΩ resistor on the Gate Driver Board to act as a pull-up in the absence of any signal, so that the gate of the power FET would be held low. This allows the multiple outputs secondary loops on each core in the units. In addition, these cores give isolation to the control board from the large voltages and di/dt's of the inverter module.

When the gate drivers get a +ON pulse, then the set of FETS with their drains connected to the positive DC rail (positive FETS) turn on. This brings the FET center to +660V (or whatever the positive rail is). The next pulse is a +OFF pulse. This turns the positive FETS off, and the FET center goes down through the 680V middle and because of the inductance of the circuit, swings all the way down to the negative rail voltage. At this point, after a suitable dwell time, the –ON pulse comes, and the negative FETS turn on. A while later, the –OFF pulse comes, the negative FETS turn off, and the FET center voltage swings through to the positive rail voltage.

During this process, the voltage spikes on the FETS are kept low by the snubber boards, utilizing a peaking filter. The filter caps are pre-charged to the rail voltage through the 220Ω resistors, and the diode prevents them from discharging during voltage swings in the opposite direction, so that only the spikes above the rail are absorbed by the filter caps.

The most common reason for servicing on the Inverter Module is a shorted FET. Usually only a FET or FETS on one side, positive or negative, fails.

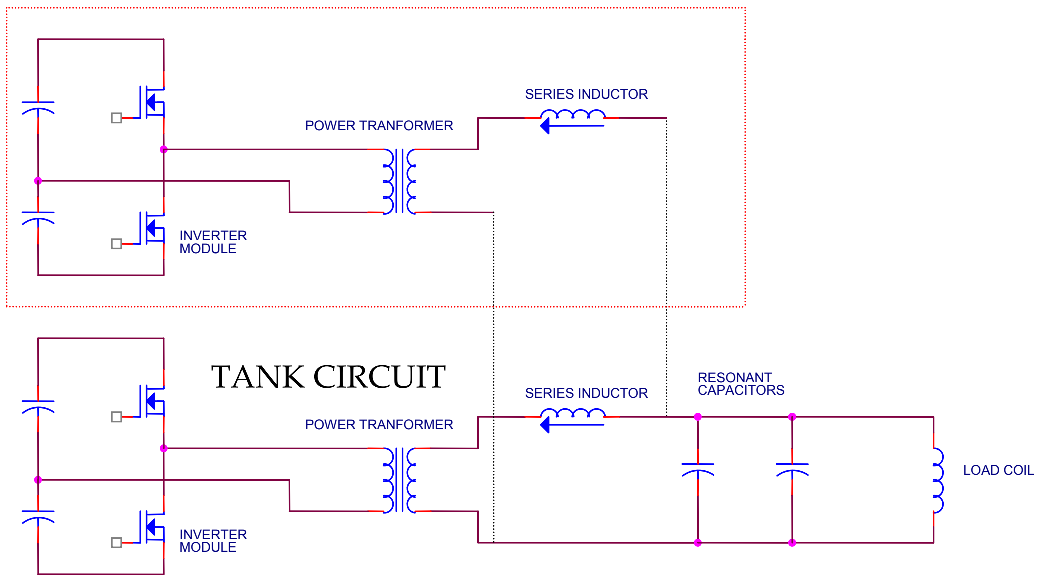
c) Tank Circuit:

This circuit consists of the Power Transformer, the Series Inductor, the Capacitor rail and resonant capacitors, and the load coil which is the user supplied coil to affect the desired inductive heating.

This circuit oscillates at the frequency dictated by the control board, and sent by the Inverter module into the Power Transformer primary.

The magnitude (Voltage) of the oscillation is a function of the value of the resonant capacitors loaded, the setting of the series inductor, and the particular load coil attached. By proper selection of capacitors and adjustment of the series inductor, this circuit can be tuned to run efficiently with a large variety of load coils at a wide range of frequencies.

The current and voltage in the tank circuit can be much different from inverter current and voltage.




d) Control Circuit:

The Control Board sets the frequency of the Tank Circuit. It generates the pulses to the Gate Drivers. It contains the feedback monitoring circuitry that provides for limits and trips. This feedback circuitry is also used for the Power stability. The Control Board is connected with a 30 in flat cable (CN1) to the Display Board.

The Display Board consists of an LCD display, Power Pot, ON/OFF buttons indicator LEDs,

There is a 25 in cable (CN6) taking the gate pulses to a Buffer Board. This board, mounted between the Inverter Modules which then sends the pulses to the Gate Drivers.

The control board receives feedbacks for AC voltage, AC current, Inverter current, Capacitor Rail voltage, and a transformer “swing-thru” pulse.

1) AC voltage comes from the control transformer.

2) AC current comes from the Supply CT board. The AC current in this path is measured by 3 CT’s, and this is used as one input to a multiplier to measure the input power.

3) The Inverter current is generated by the CT’s on the inverter module output, which is rectified by the CT OR’ing board.

4) The Capacitor rail voltage is provided by the PT transformer. This feedback is phase sensitive. There is a jumper to select the transformer ratio, to allow for a lower voltage limit on the lower frequency units. 100:2, 100:4, 100:6 ratios are available.

5) The Transformer Swing Thru. In the power transformer there is a loop of yellow wire. This generates a pulse every time the voltage swings through, as the

FETs switch. This pulse is used in the swing thru trip circuit.

e) Display and User Interface:

There are two LED's that indicate that the unit is on and running (orange) or that the unit is not running (green). There are three other LED's to indicate Limits Faults and Trips. The faults and trips are part of the protection circuits that turns the unit off. The LCD also indicates limit, faults and trip conditions. The limit conditions are Voltage (measured on the capacitor rail), Current (measured on the output of the inverter module), Power (measured on the input AC) and Frequency (measured by comparing the output voltage square wave from the Inverter Module with the phase of the voltage on the Capacitor Rails). The faults indicate interlock conditions that when not satisfied, prevent the unit from running. The interlocks enunciated are Flow, indicating insufficient water pressure to the unit, Temperature, indicating inlet water temperature of above 110°F,Inverter temperature above 110°F , Door, indicating that the door switch is not closed, and Auxiliary, which is available for a user designed interlock. The Auxiliary interlock is also used to enunciate insufficient power fail condition.

E) TUNING:

When ever possible know the inductance of your coil. This will make tuning much easier. $f_r = \frac{1}{2\pi\sqrt{LC}}$

The coil matching range of the high frequency power supplies is approximately from .03uH to 2.5uH depending on the coupling of the part and coil. The goal in tuning the unit to the desired load coil is to get maximum power at the desired frequency at the lowest inverter current possible.

This will have the power supply operating near resonance, and therefore at a power factor that is close to 1. This gives the most efficient operation. It is best to go through the tuning process with the coil loaded as it will be during use.

In general, a small coil will need more capacitors than a larger one, and less taps on the series inductor.

With the "Start Frequency" set to maximum 440 kHz and the power knob set to minimum, turn on the breakers, and push the "Heat" on button. The frequency should stay around 400 kHz. If it goes up, the resonant point is higher than 400 kHz, and more capacitance should be added on the capacitor rail. Slowly bring up the power. The frequency should drop to an "idle" frequency. This should be the edge of the power curve. For a high-Q load, full power may be within a few kilohertz of this point, for lower-Q loads, full power could be 10-25 kHz lower. If the frequency drops down to around 135 kHz with no significant power being generated, then power supply as reached its lowest frequency level. This occurs when the resonant point of the load is out of range or, with a low-Q load; the power supply may have run past resonance without generating much power. If the resonant point is too low then removing capacitors will bring the resonant point back in range. If the resonant point is too high, then adding capacitance is necessary. If the Q of the load is low but the resonant point is in range, quite often the power or voltage will show a quick increase and decrease as the power supply scans down through its frequency range. In this case, changing the taps on the series inductor for lower inductance will help.

If an idle frequency has been found, then bring up the power until the desired power has been achieved or a limit has been reached.

F) Basic Tuning steps

a) For a current limit, increase the series inductance (move the top tap back) or remove one capacitor.

b) For a frequency limit, decrease the series inductance (move the top tap forward) or add a capacitor.

c) For a voltage limit. Add a capacitor (this will decrease the voltage but will raise the current and lower the frequency). Decrease the coil inductance or the buss inductance must be lowered (this will lower the voltage but also raise the frequency). In some instants the use of a series/parallel capacitor rail may be necessary.

It is a good idea to record the settings that are used for a particular coil or applications so that it will not be necessary to retune the same coil, and as a reference for similar coils.

## II) Field Service: Determining and fixing the problem

A) Power up Problem situation 1

1) Nothing happens when small breaker is turned on.

a) The two yellow wires (# T & B) that connect to the two phases on the input of the large circuit breaker are not connected.

b) The fuse on step down transformer 1-33 is blown or fuse holder as come loose.

c) Wires to the control breaker are not making contact.

d) Transformer 1-33 has failed

B) Power up problem situation 2

1) When the small breaker is turned on, you can hear the fans start up, but nothing lights on the front panel.

a) This could be that the 50-pin flat cable is unplugged.

b) The connector CN5 to the control board is unplugged.

c) The input or output connector of the control power supply maybe unplugged or improperly attached (40W power supply mounted on inside of front door).

d) The control power supply has failed. (Check to see that the voltages are present on CN5)

e) The pins on the connector are not making contact to the female side. Check on the front side of the connector and the back side of the control board. If either the +5V or Gnd. is missing the display will not come up.

C) Turn on small breaker and display goes to full register.

a) Minus 15V is missing

D) Turn on small breaker and frequency is zero

a) Plus 15V is missing

If the +15V is missing and you turn Heat ON there will be a Swing Thru trip

E) A flow trip is indicated:

a) Check that water connections are not reversed. Check that there is sufficient water pressure; 30PSI differential pressure is needed.

b) Flow switch set to high

c) Flow switch failed. Measures open

F) The Large Circuit breaker will not stay up.

a) The E-Stop button is depressed. Turn the E-Stop counter- clockwise to release.

b) The 24VAC interlock loop has an open connection. This circuit runs from the control transformer (DT-1077) to the under voltage relay on the left side of the main circuit breaker, from the UVR to pin 1 of the E-Stop switch from pin 2 of the E-Stop to the common of the Door Switch, and from the NO contact of the door switch back to the transformer. Make sure all those lines have continuity. See control wiring diagram.

c) UVR is bad. a good UVR should measure 4M Ohms.

d) Circuit breaker is bad

G) Unit was running large breaker tripped

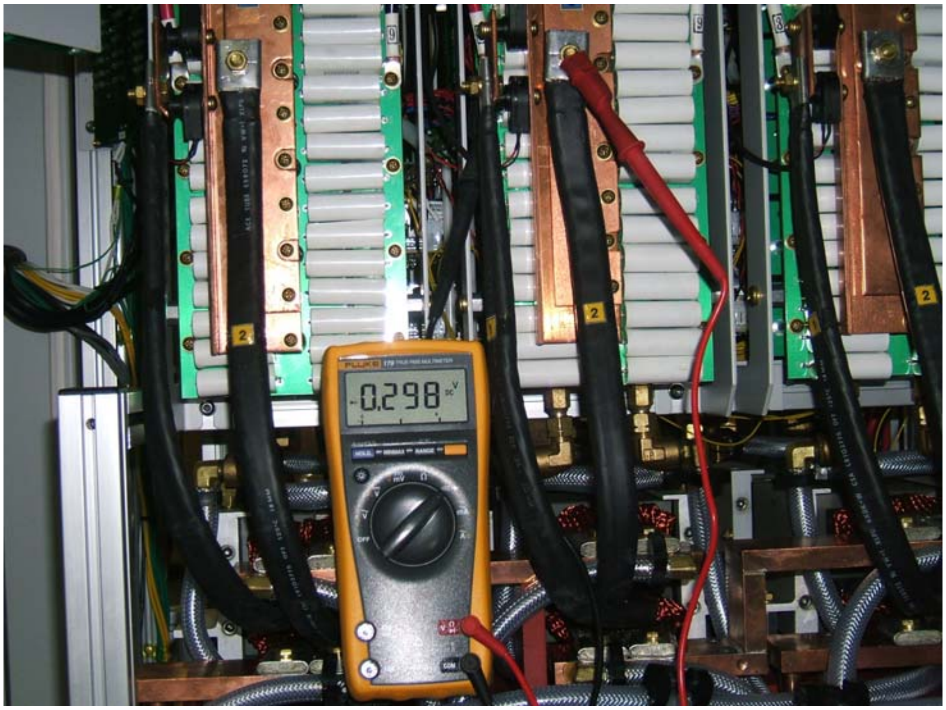
a) Check E-stop

b) Check door Switches

c) Check Transformer DT-1077

d) Check line voltage, Power failure

e) Inverter assy. crowd barred. (If Inverter has crowd barred you do not want to reengage breaker) Check inverters with millimeter in diode mode.



H) Unit runs at low power, trips as power is increased

1) The capacitor voltage feedback may be missing or have the phase reversed. If the power supply trips at about 10% power or 10% voltage.

a) Check the connections to the PT board.

b) Check connections at pins 11 & 12 of connector CN3 at the control board.

c) The leads to the PT at the capacitor rail may have been reversed.

d) The PT may have failed.

I) Runs to lowest frequency and delivers no power

a) Tank circuit frequency is too low or below resonates. Is this a large coil and/or there are too many capacitors loaded?  Remove capacitors.

b) The tap is to far back on the series inductor.

J) Unit goes to current limit at low power

a) Unit is missed tuned

b) No load in coil

c) Matching transformer leads reversed

d) Bad breaker; one leg is passing low or no voltage.

K) Current trips

a) Possible loose connection on three phase input power

b) Loose connection on Diode Bridge

c) Transformer lead is loose.

d) Shorted CT transformer

L) Resonant trip

a) A capacitor on the capacitor rail may be not securely fastened to the capacitor rail or shorted. As the voltage increases in the tank circuit, it may arc.

b) A connection on the power transformer is loose

c) A short to the coil occurred.

d) Input voltage has an in balance.

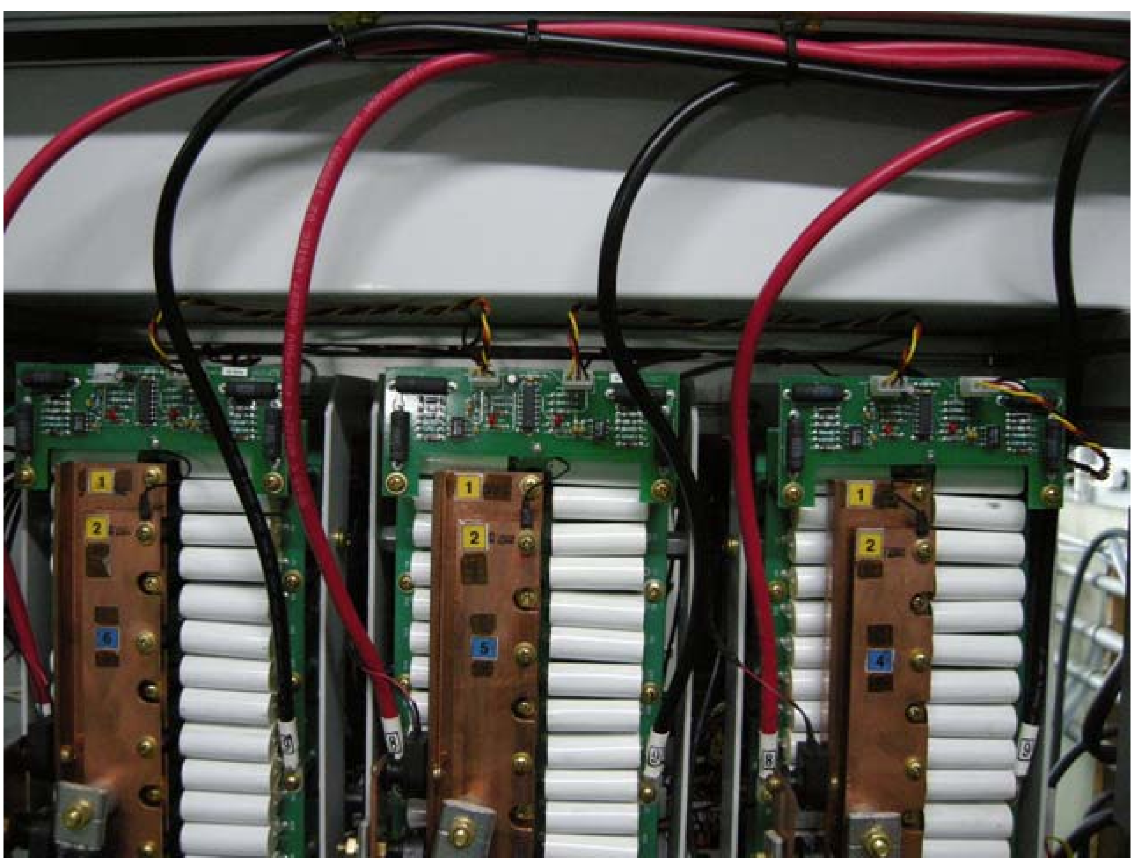
1) Check that all three phases of the AC input are present and equal.

2) Check the connections at the circuit breaker, and at the diode bridge.

e) Bad breaker; one leg is passing low voltage.

d) Gate pulse wire is reversed.

1) This is most likely to happen at the end of a heat cycle.



M) Swing thru Trip

A) During initial tuning.

1) The most common reason for Swing thru trip during initial tuning: Unit is missed tuned

a) The load frequency is above the operating point of the unit (above 440 kHz)

b) The load frequency is low, and there is not enough current for the voltage to swing thru.

c) The start frequency is adjusted below the operating frequency.

d) The tap selection is to far back.

e) The selection for the configuration of the cap rail is wrong. Ex. (the cap volt feed back is set up for a parallel cap rail but the cap rail is series/parallel.

B) Unit was running and got swing thru trip

1) A short to the coil

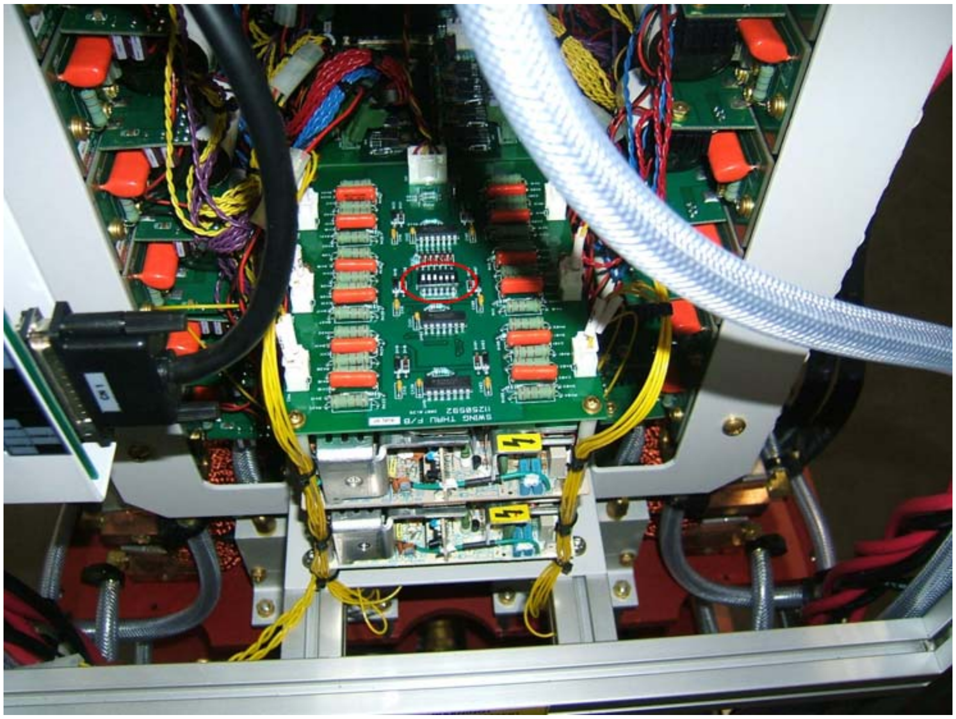
2) Shorted cap

3) 12V is absent from one or more of the switching power supplies

a) Check LED indicator

4) An Inverter is not running

a) Try running the unit and deselecting the swing thru pulse one inverter at a time.



C) Unit was recently worked on.

1) Large circuit breaker is not up.

2) Connector CN5 is not plugged into the Control Board.

3) 25-pin cable (CN6) on Control board is not plugged in.

4) 25-pin cable to buffer board is not plugged in (CN401).

5) An inverter module is not plugged all the way into buffer board.

6) An input to the swing thru board is unplugged.

7) If an inverter module has been worked on and the leads of the twisted pairs to the gate drivers have been reversed

8) If a module has been replaced, and the transformer leads are backwards

9) If a module has been replaced, and the gate signal leads are switched (top / bottom plugs on the buffer board reversed)

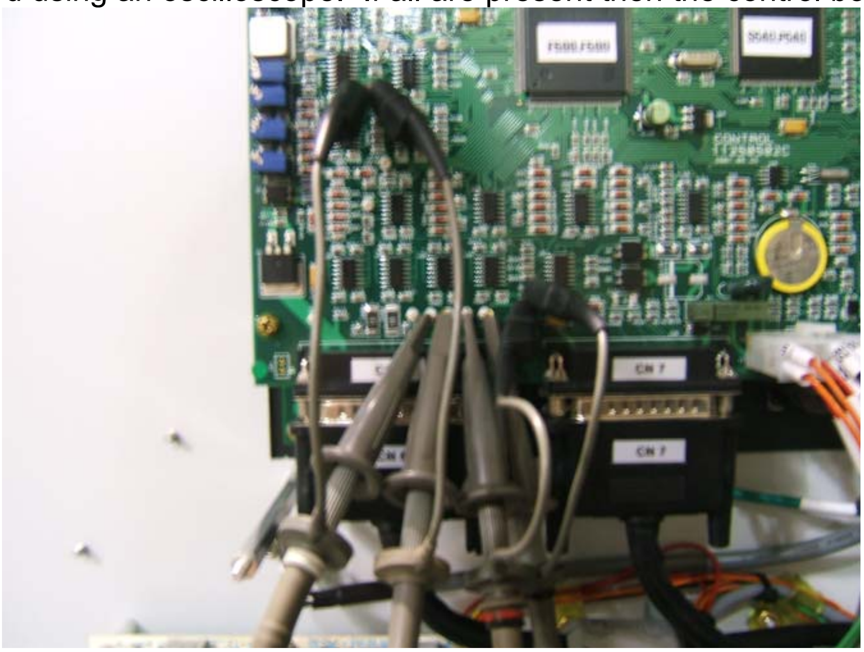
10) Input voltage has an imbalance.

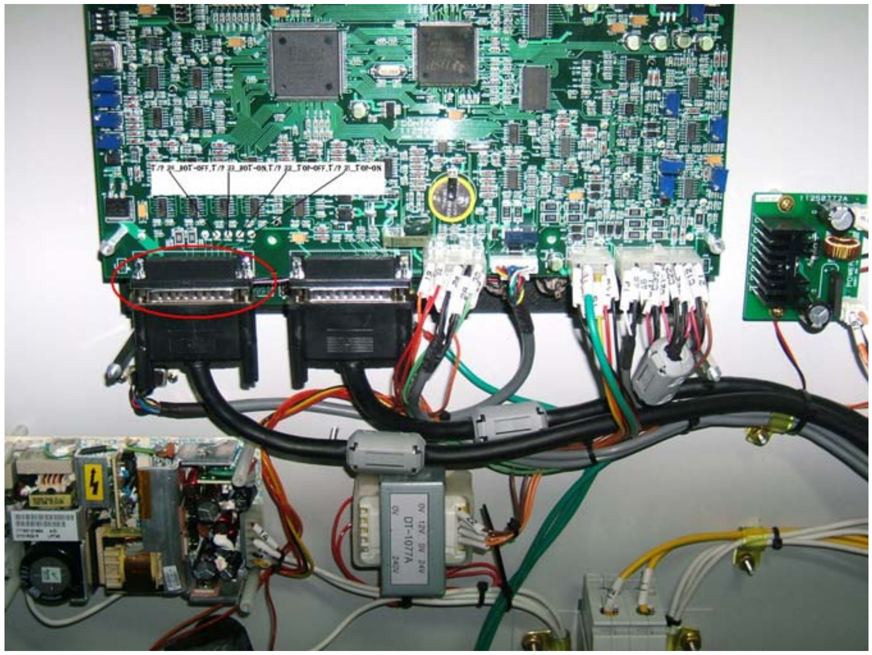
a) Check that all three phases of the AC input are present and equal at the input and the output of the breaker.

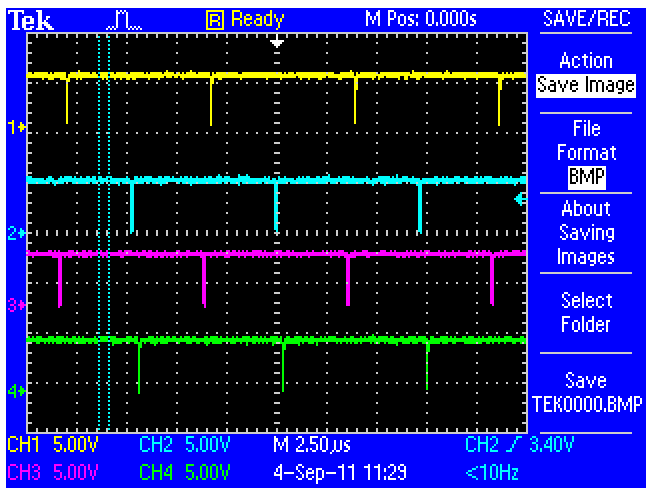
D) Inverter had crowd bared (if an inverter has shorted to ground it can damage the control board)

1) Control board ON/OFF pluses missing. Running control logic with no power to inverter module enables you to check that all the signals that are needed to run the inverters are present. This can be done by placing a jumper on pins 3&4 on JP3 and removing the cable from CN6.

a) Control ON/Off pulses can be checked on TP21, 22, 23 & 24 on the control board using an oscilloscope. If all are present then the control board is O.K.







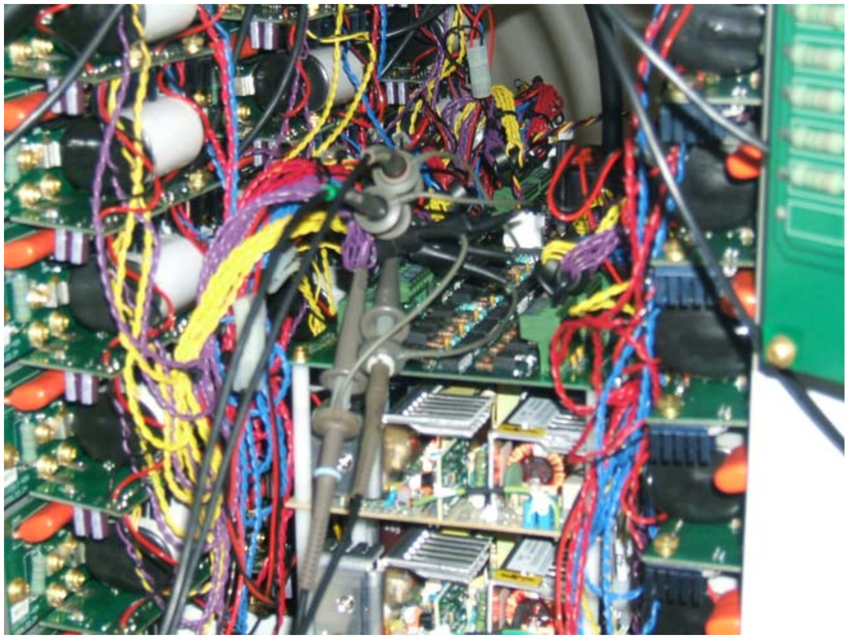

2) Buffer board pluses missing.

a) The pulses on the buffer board can also be checked by running only control logic. you will need to connect CN6 and Jumper 1&2 on JP3

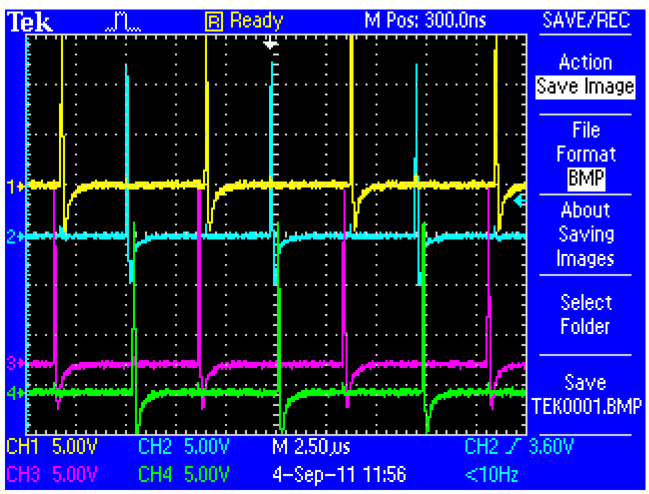
1) Use scope probe and insert into one of the four cores that go from the buffer board to the gate drivers for each inverter. Connect ground of scope to positive end of probe. You will be measuring current pulses induced into scope probe.

2) If pulse is present move to the next.

3) If any of the pluses are missing the buffer board is bad.



Yellow twisted pairs Bottom OFF, Purple twisted pairs Bottom ON, Red twisted pairs Top OFF, Blue twisted pairs Top ON




N) Inverter Failure & DC supervisor

1) The DC Supervisor will enunciate if an inverter has failed.

a) Unit was running and an INV FAIL is enunciated on the display.

1) If main breaker is still up

a) Remove side panels.

b) The failed inverter will be designated by an LED that is OFF.

O) Inverter Removal and Replacement

Before attempting to disassemble this unit, make sure that the power is off and the water supply is shut off. The steps for reinstallation are the reverse of those for disassembly.

Useful tools include 7/16", 5/8" & 13/16" wrenches, a #2 Phillips screwdriver. Use only brass hardware to replace any screws and/or washers that you may misplace.

| | Disassembly | Reassembly | |
|---|---|---|---|
| 1 ↓ | Unplug the two connectors from the Buffer board. | Plug the connector with the Red & Blue wires into the top 6-pin header of the buffer board, and the connector with Yellow and Violet wires into the lower 6-pin header. | 10 ↑ |
| 2 ↓ | Remove the #8 screw that secures the DC power wire from the front/center of the heat sink. This wire is black on the left inverter assy and red on the right. | Reinstall #8-32 screw, with washer and lock washer to secure DC power input wire. Red on the right and black on the left. | 9 ↑ |
| 3 ↓ | Remove the ¼-20 nut and washers from the AC bus that holds the cable from the transformer primary. Remove the aluminum spacer. | Re-install the spacer, re-connect the lead from the transformer primary to the ¼-20 stud and fasten with washer, lock washer and nut. | 8 ↑ |
| 4 ↓ | Remove the two 10-32 x ½ screws which hold the Xfmr bus that connects the other lead to the transformer primary. Do not remove the cable from the bus. Remove the CT's from the standoffs once the bus is free. | Place the CT's over the standoffs on the DC bus. Be sure both CT's are facing the same way, (i.e. with both labels and arrows facing outwards). Replace the bus and secure with the two 10-32x1/2 screws. Tighten securely, but don't over tighten as these are going into aluminum standoffs. | 7 ↑ |
| 5 | Disconnect the two water lines from the inverter assy. Use a 13/16" wrench to | Re-connect the water lines to the lower part of the inverter assy. Use a wrench | 6 ↑ |
| 6 ↓ | Remove the 10-32 x ½ screws that holds the inverter "handle" (vertical aluminum front- piece) to the upper mounting bracket. | Insert the 10-32 x ½ screw and washer that secures the inverter "handle" to the upper mounting bracket. | 5 ↑ |

| | | | |
|---|---|---|---|
| 7 ↓ | Now the inverter assy can be lifted out and pulled forward a few inches in order to reach the ground wire and rear DC connection. | Lift the inverter assy into the holes of the rear mounting bracket, and then slide down into place. | 4 ↑ |
| 8 ↓ | Remove the green/yellow ground wire from the top of the heat sink. | Reconnect the ground wire to the top of the heat sink using #8-32 x 3/8 screw and lock washer. | 3 ↑ |
| 9 ↓ | Remove the rear DC connection from the rear center of the inverter assy. This wire is red on the left-hand inverter assy and black on the right-hand side. | Attach the rear DC connection to the inverter assy using 8-32 x ½ screw, washer and lock washer. Red on left side and black on the right. | 2 ↑ |
| 10 | Carefully lift out heat sink assembly | Place the inverter assy back into the inverter, but do not attach to the rear bracket yet. | 1 ↑ |

P) Repairing the inverter

a) Check across each of the gate drivers (3-12) on the inverter.

b) Remove the 4mm screws (3-9) form all the gate drivers that measure bad.

c) Measure the removed gate drivers again. The gate drivers may still be good but the FET was pulling them down.

e) Check the MOSFETS below the removed gate drivers.

d) Remove snubber board (3-15) that is connected to the bad FETs.

f) Remove and replace the bad FETs

g) Before reinstalling the snubber boards check both of the blocking diodes (3-10) that are on the snubber board.

h) Check R801 & R802. They should measure 220 ohms. If one of the resistors has opened this could account for the divided voltage being wrong.

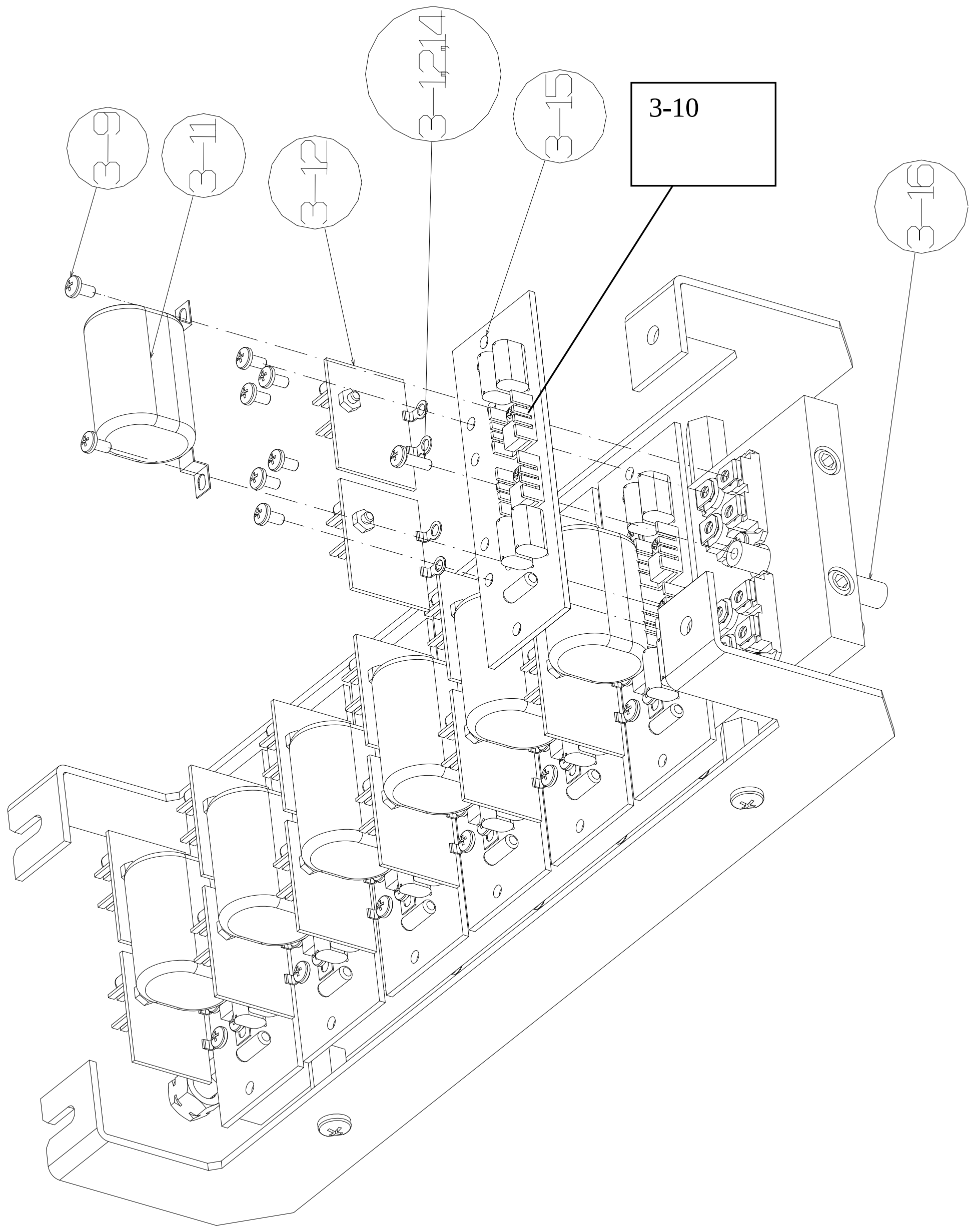
i) Replace the snubber board if a blocking diode is bad or a resistor has opened.

j) Replace the bad gate drivers.

It is important that all the wires to the gate drivers are reinstalled in the same orientation that they were originally. If any of the twisted pairs are reversed the inverter will trip.

k) Check the value of the snubber cap (3-11). If the value has changed replace it.

l) Reinstall the inverter.


3-9
3-11
3-12
3-12,14
3-15
3-10
3-16

Q) Converting an inverter module from a right to a left (or vice-versa):

a) Change the output bus work to face the opposite direction

b) The yellow twisted pairs on the connector marked bottom and the red twisted pairs on the connector marked top need to be moved to the other end of their respective connectors.

c) The purple and blue twisted pairs stay in their same locations.

d) The tricky part here is that all ferrite core (including the ones that you don't move) need to be reversed in polarity. This can be done by loosening one end of the wire loop from the connector, removing the core and flipping it 180° and then re-securing the wire.

R) Changing Capacitor rail configuration.

A) Three step to change from parallel to series parallel

1) Change the physical configuration of the cap rail (see exploded views below)

a) Remove 4 of 4-19, part # 11250836, CONNECTOR, CAP RAIL

b) Install 2 of 4-36, part # 11250875, SERISE CONNECTOR CAP RAIL

c) Install 2 of 4-37, part # 11250876, JUMPER CAP RAIL

2) Change Voltage feed back connections (see photos below)

3) Change the display configuration

a) Press the "PROG" key for 1 second

b) Enter password-0000

c) Select "SYSTEM"

d) Use (down arrows) to go to "C.RAIL"

e) Use (left arrows) change to "SREIES/PARL"

f) Press "ENT" then "SAVE" key to save change

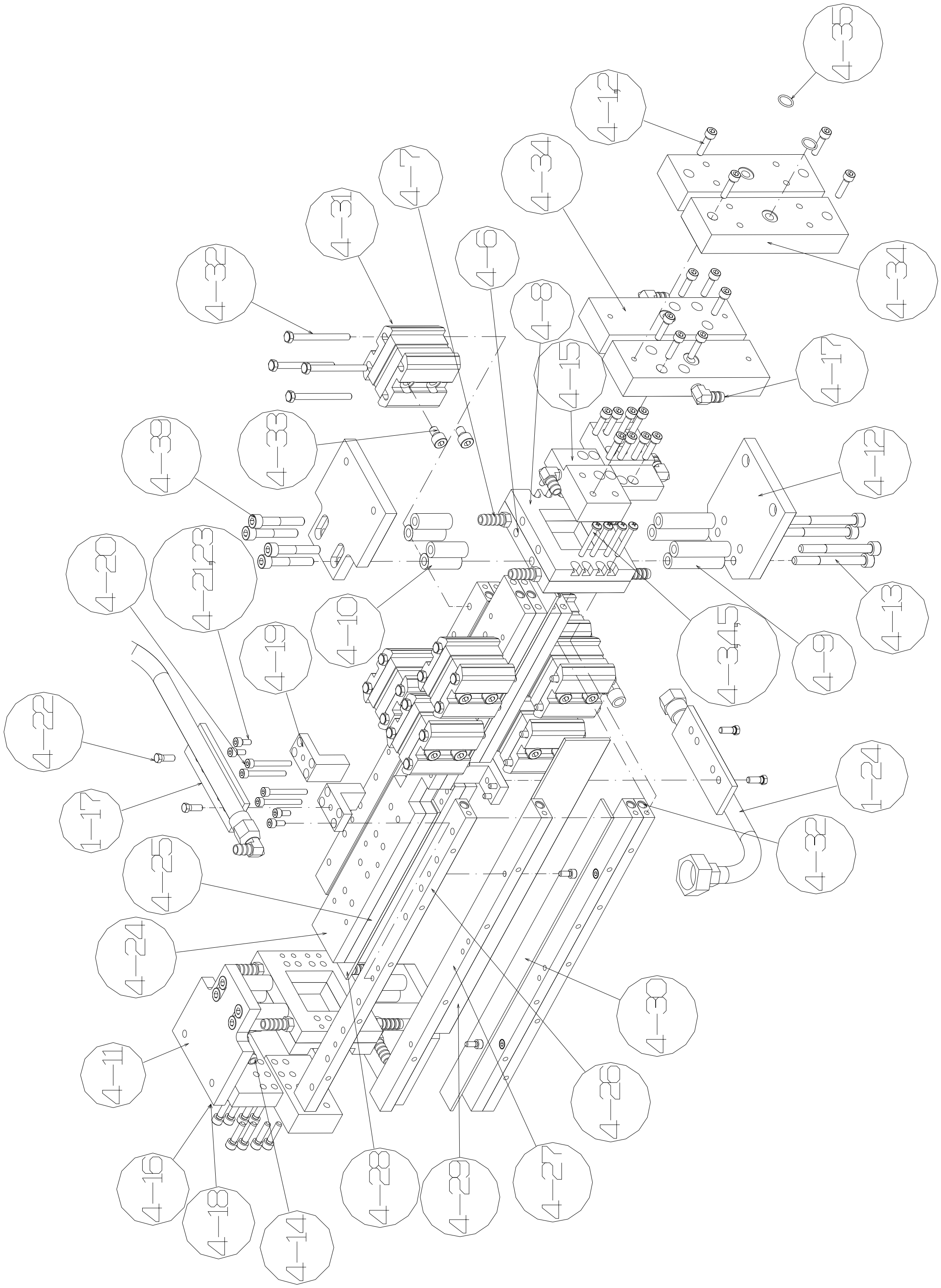



**Figure 4-1: Cap. Rail assembly (Parallel configuration)**

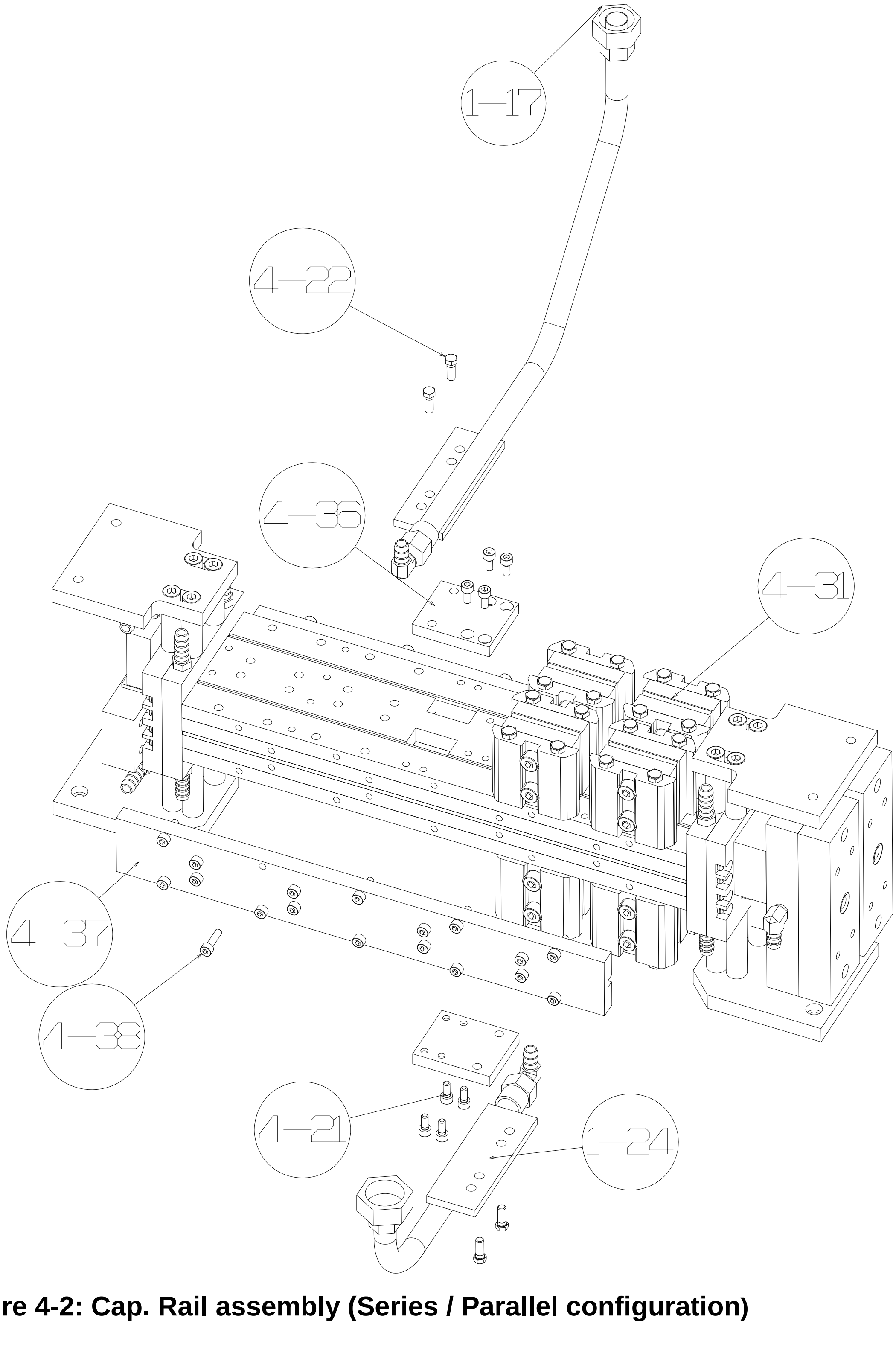
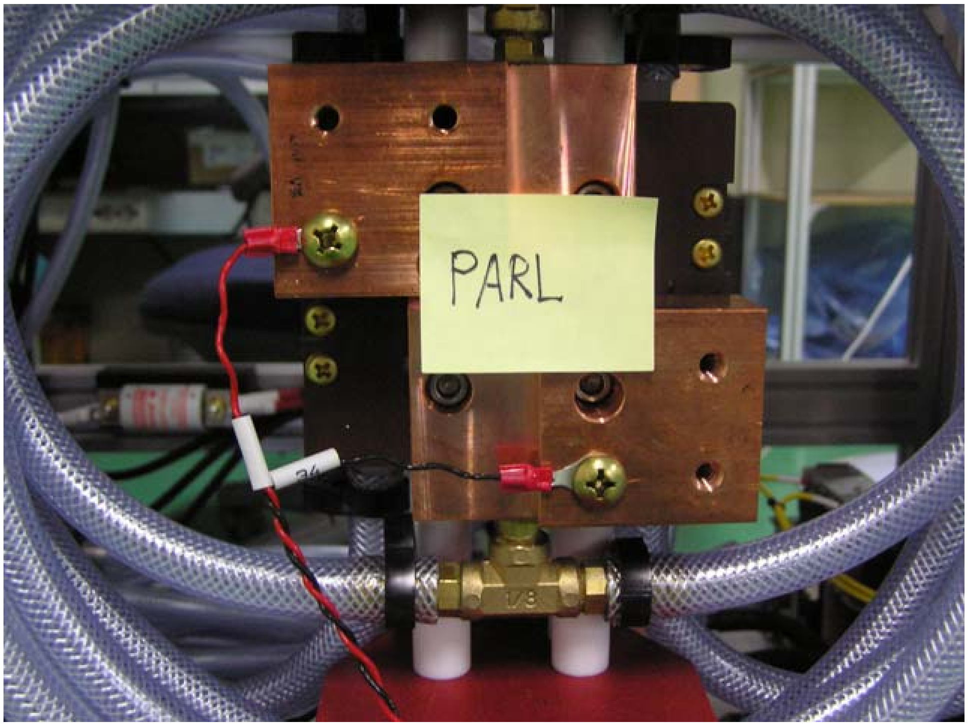
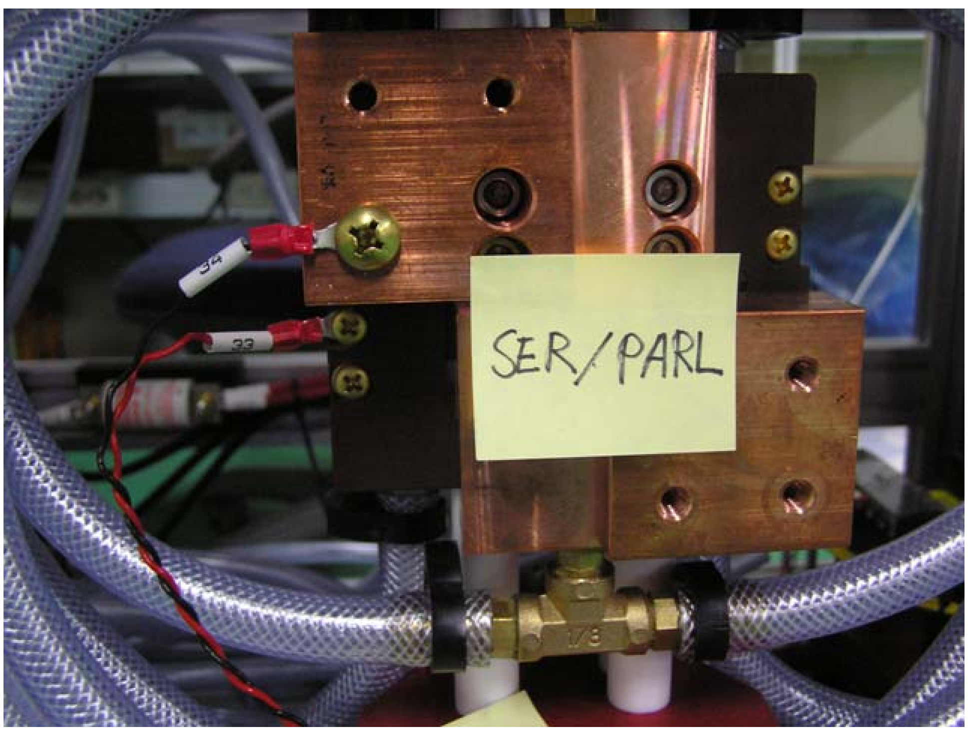



**Figure 4-2: Cap. Rail assembly (Series / Parallel configuration)**


PARL


SER/PARL