

# SERVICING RICH COMBI PLUS AND SUPER COMBI INVERTERS

Note: The manufacturer [www.rich-electric.com](http://www.rich-electric.com) will not supply circuit diagrams or other service documentation. They will give limited online support for specific enquiries, but what is written here is mostly based on experience gained by third parties while repairing them.



Rich Inverters may at first glance seem quite formidable devices to work on, but if you follow the instructions given here, you'll find there're not *quite* as bad as they look. The biggest issue is probably the sheer number of screws that have to be removed and re-fitted, and the weight of the transformer, particularly the 3000 Watt models. There are also a number of re-assembly traps for the unwary, which, while they are trivial to correct in themselves, often require the re-removal of large numbers of screws! *Follow the re-assembly checklist without fail...*

## WHAT DOES A RICH INVERTER ACTUALLY DO?

(Note: This document only describes the Rich Combi and Super Combi "off grid" type inverters. A large number of Rich "grid-tie" inverters were also sold in Australia but we have little experience with these, as they rarely break down. However, the general construction is broadly similar and the instructions given here will at least help you get started).

Rich "Combi" inverters have the basic function of an Uninterruptable Power Supply (UPS). A UPS as used with computers usually contains a rechargeable battery, a 240V mains charger, and an inverter to produce 240V AC. The general idea is that if the 240V power is cut off, the battery powered inverter switches on instantly to allow the computer to continue running, at least long enough to save your work and shut the computer down correctly. Whenever 240V power is available, the computer then runs direct from that, while the battery is simultaneously recharged.

The Rich Combi inverter works much the same way, except that it normally uses much larger, externally mounted rechargeable batteries, and provides considerably more power (1,500 and 3,000 Watt models are available). Much like a computer UPS, they can be directly connected to an intermittent 240V mains supply, which will supply AC power and charge the battery bank whenever

power is available, and, when the power fails, the inverter automatically takes over. In an Off-Grid application, they can be connected to an auto-starting petrol or diesel generator. That allows smaller 240V appliances to be randomly operated for short periods, without needing to start and stop the generator every time. In that configuration the generator is normally set to automatically switch on whenever the battery charge falls below a preset level.

The Rich inverters can also operate in a “helper” mode, where they “assist” a generating plant to start appliances that require a heavy startup current. In that mode the inverter output is connected in parallel with the 240V input. This allows a lower-rated generator to be used in situations that would normally require a much larger one just to handle startup current.

### **REQUIRED TEST EQUIPMENT**

While a comprehensive repair and test facility requires an installation of heavy storage batteries and high-powered test equipment, most repairs can be done using fairly basic equipment.

### **MINIMUM FOR BASIC TESTING**

The minimum items you need are:

1. 0-30V 3A variable power supply (preferably higher current, and with adjustable current limiting)
2. Digital Multimeter
3. DC Connecting cables
4. 240V Plug and 240V socket with flying leads (made by cutting an extension cord in half).
5. 10 – 15W 240V incandescent lamp (in desk lamp or similar).
6. Battery drill with variable torque setting and good quality Phillips driver bits. (A power screwdriver could be used in a pinch, but it will run out of steam pretty quickly with all the screws. A drill will also usually deliver more torque for some of the tighter screws). You *don't* want to dismantle one of these with just hand tools....

### **COMMON FAULTS**

**“Inv Overload” message.** By far the most common fault you will encounter is “Inv(erter) Overload” on the LCD screen, and no 240V output. When DC power is applied the unit will flash its LEDs, beep, go through the normal 10 second startup routine and then produce the error message. You actually get this whenever the control board can't detect a 240V output. The usual cause of this is a faulty inverter module, (see Page 12) but it can also be caused by you simply forgetting to re-connect the blue and black 240V output wires to the inverter module, the main DC power cables or the 20 pin control connector to the inverter module. Basically, anything that stops the inverter module from working will give the “Inv Overload” message.

**“Heatsink over Temp” message.** This commonly happens after someone connects the DC power the wrong way round. The problem is rarely temperature related; it is nearly always caused by either the failure of a small power supply module on the inverter board, or failure one of the SMD interface chips. See Page 20.

**“Battery under Volt” message.** (When it clearly isn't). This is nearly always caused by the same chip that causes the inverter to fail. See Page 12

**Inverter works OK, but won't charge batteries when Mains applied.** In many cases, simply resetting the unit to factory standard (“Initialize”) will fix this. Other possible causes are blown off PCB tracks on the charge controller board, or bad solder joints on the relays.

**Inverter seems to function normally and the "Power Available" LED comes on, but there is no 240V output.** Usually caused by bad solder joints on the relays, as above.

**Blown PCB Tracks.** As mentioned above, a lot of faults are caused by parts of the PCB tracks being blown open-circuit. In most cases a simple visual examination will find these.

**Needs a Reset.** Before you do anything, try the "Initialize" function. A surprising number of inverters are fixed by simply doing that!

### FULL POWER LOAD TESTING

Note: It's rare for an inverter that produces 230/240V at 30 Watts or so to not work at higher power levels, so in most cases, if you can get it to work on the bench power supply, it will also work when connected to the customer's main battery installation. So the following equipment, while desirable, is not essential.

1. Ideally you would have two 100 Amp/hour "deep cycle" 12 Volt batteries which could be connected in parallel or series for full load testing. While you can use a couple of car batteries for brief testing, remember that at full load the inverter could be drawing as much as 250 Amps, which is equivalent a normal engine's cold cranking current!
2. 600A AC/DC Clamp meter for checking the accuracy of the inverter's own measurement system.
3. Two compact 1800 Watt fan heaters with switchable "half power", "full power" and "fan only". Two 1800W units connected to a double adaptor will allow testing at 900W, 1800W, 2700W and 3600W, which gives +20% overloads (1800W and 3600W) for 1500W and 3000W respectively.

### INITIAL TESTING

For the initial testing the only thing you will need to connect is the variable power supply.

**NOTE: Under no circumstances should you do the initial testing with lead-acid batteries. If you do that you run a very real risk of turning a relatively simple repair into a major one!**

Set the supply to about 14 Volts for 12V inverters (model number ending in 122) and about 28 Volts for 24 V inverters (model number ending in 242). If you have the polarity correct, when you attach the power leads there should be a bit of sparking as the main capacitors charge up, then the current should drop to almost zero.



If you set the power switch to "1" (ie on) there should be a beep, all the front panel LEDs should flash briefly, then the LCD Status screen should show "initializing" with a progress bar. After about 10 seconds there should be a "clunk" as a relay closes, and shortly after the yellow "AC Out" LED should light up.

If you measure the voltage between "L" and "N" on the AC out terminals it should be about 145 Volts AC, which is what you get under no-load conditions. This will jump up to the correct voltage when a load is applied. Of course, if the

device is in for service, it is more likely you will be get an error message. By far the most common messages are “Inverter Overload” and “Battery Under Volt.”



Both of these messages are normally caused by the H-Bridge driver chip on the inverter module. With 1500W models, often just the chip and its power supply resistor are faulty. With 3,000W models, at least one of the four banks of 10 MOSFETS will probably be blown too, but you can be lucky.

The other common message is “Heatsink over temp”. This has nothing to do with temperature, it often means the 5 Volt thermistor supply is missing, almost always because

somebody has connected the battery back-to-front and blown up the regulators! This can be an easy fix, or sometimes not. Another cause is a faulty damaged control interface IC.

**Note:** You also get the same message if the temperature sensor attached to the transformer core is unplugged!

Regardless, first, you have to get the modules out...

### REMOVING THE CASE

**NOTE:** The pictures below show a smaller (1500 Watt) model. The disassembly procedure for the larger (3000 Watt) models is very similar; there are just a couple more plugs to remove.

Whilst you *can* take out all the cover screws, disassembly and reassembly is somewhat simpler if you only remove the ones that are necessary, as shown in the photos below

The inverter is held together by a mixture of mostly M3 and M4 screws, with a few M2.5 screws in special locations. The main cover is made up of several pieces, but if you follow the directions below, it’s not too hard to remove it as one assembly. You only need to remove the screws marked with yellow arrows. It won’t hurt if you do remove the ones marked in red, but it doesn’t achieve anything, and makes re-assembly more time consuming.

Left side



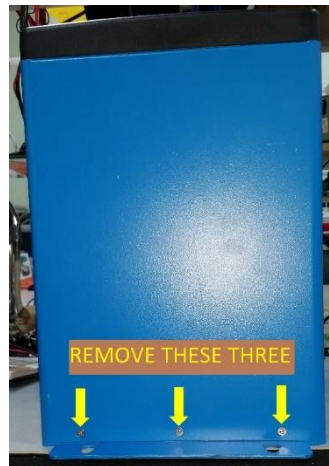
Right Side



Bottom



Top

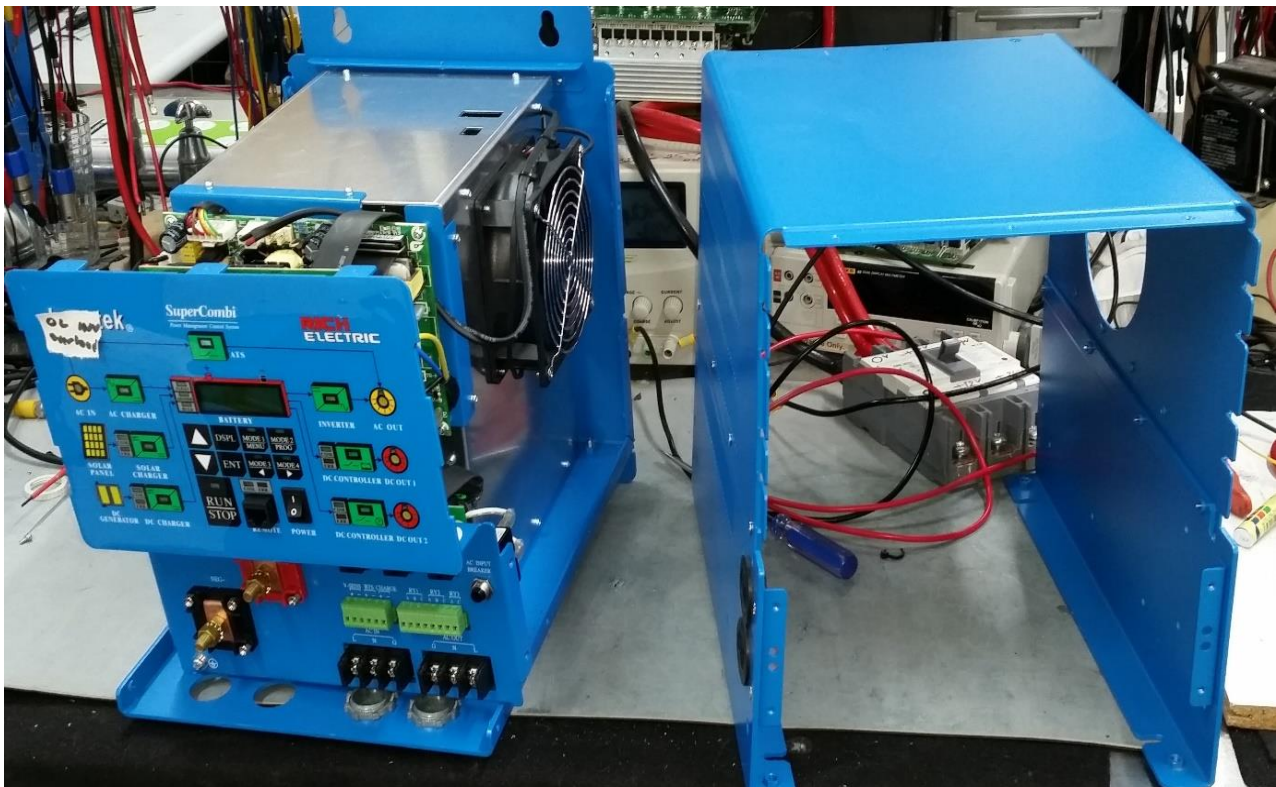


Once you've removed all the "yellow) screws, the cover can be partially lifted off, to simplify removing the plastic escutcheon, which hides another three M2.5 screws.

The escutcheon simply snaps into place, and it can be difficult to remove without scratching the paintwork if you haven't removed the case screws as described above. Once you've partially removed the cover, it's then easy to prise the escutcheon off with a flat-bladed screwdriver as shown, to reveal three M2.5 Screws hidden underneath it. (They have already been removed in this photo).



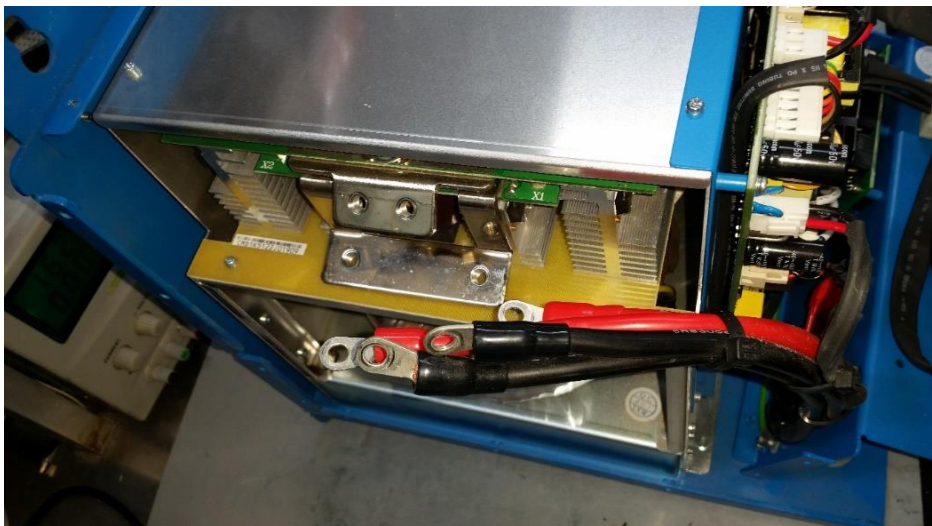
Once the three M2.5 Screws are removed, the cover can be lifted clear in one piece.



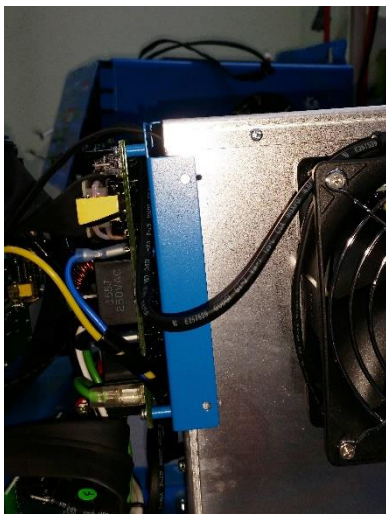
### DETACHING THE FRONT PANEL

Although it looks complicated, actually there aren't all that many connections between the front panel and the silver box that contains the inverter module.

You can start by removing the heavy red and black main power cables from the inverter module. Most models have two black and two red cables, the exception is the 24V 1500W model which only has one of each.



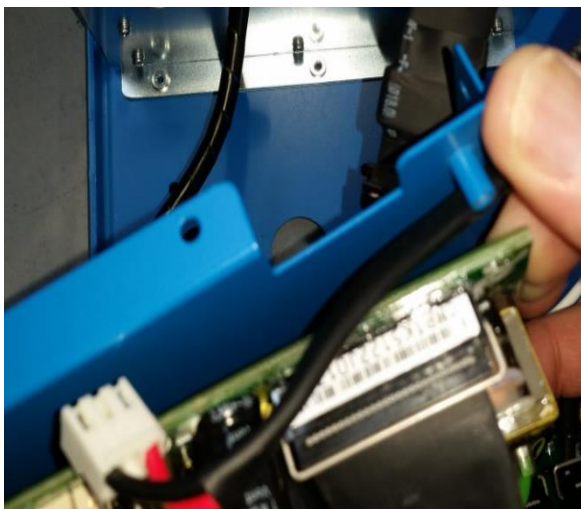
You next need to remove the screws from the blue sub-panel that holds the charger/switching board. There's no point removing the PCB from the blue sub-panel itself unless you specifically need to, and it prevents short circuits during testing.



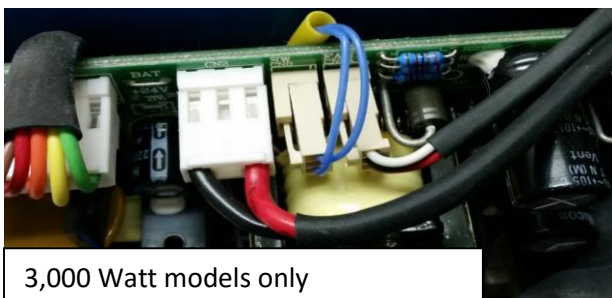
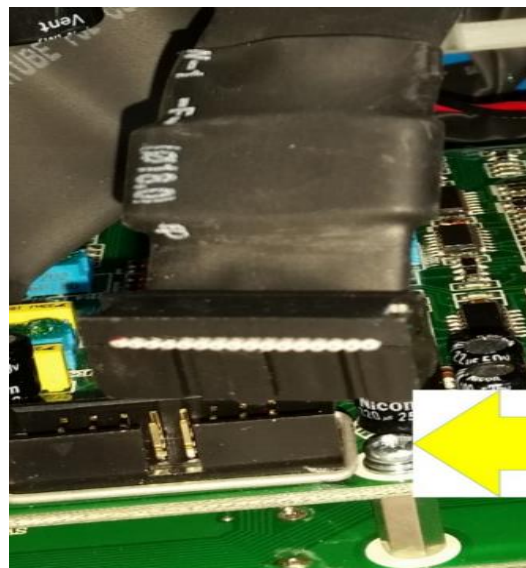
You will see that there are four cables that run under the charge/switcher board. Three of them come through a hole at the front of the shiny inverter case. These are the 240V output leads, (heavy blue and black, with spade connectors) and a sleeved cable with a white plug, which is the transformer core temperature sensor connection. These pull off easily and can be fed back under the PCB without needing to remove it.



NOTE: 3000 Watt models have a second fan at the bottom of the case, which plugs into a socket at the top of the charger/switcher board. There is also a socket next to it for an additional transformer temperature sensor. These sockets are not used on the 1500 Watt versions.



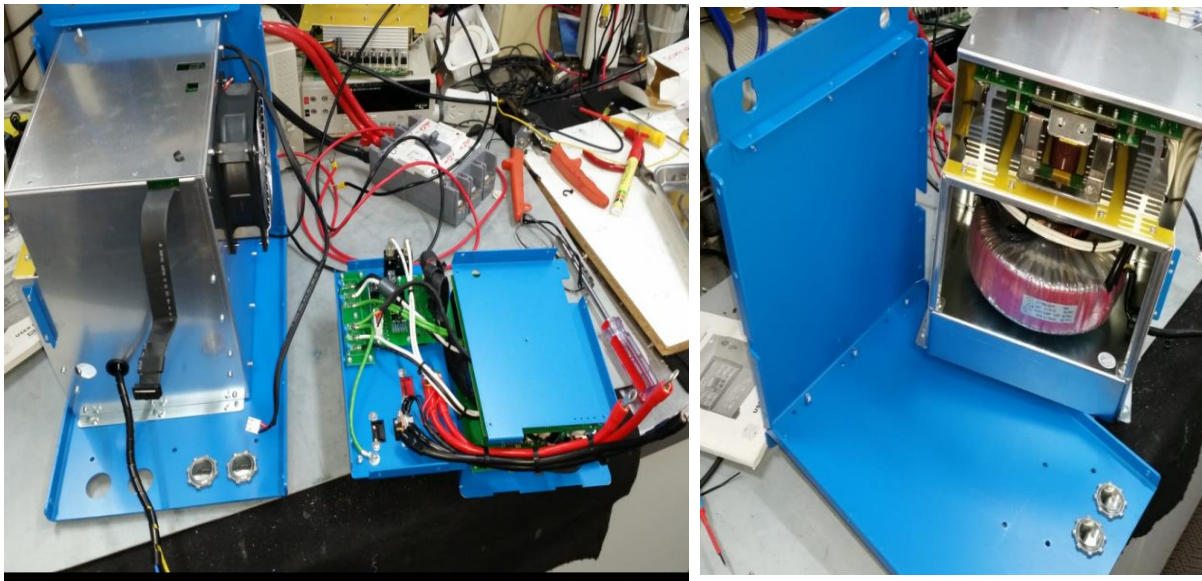
The other cable consists of heavy-duty red and black wires with a white plug. This is the top fan power connection. That plug can't be pulled out from under the Charger/Switcher PCB but you can release it by just removing one of the corner screws and bending the PCB upwards as shown. Finally, remove the 20-way connector from the front PCB.



3,000 Watt models only

Once you have removed the above cables, the front control panel section can be completely removed from the inverter section. The inverter/transformer section can then be removed from the blue outer casing. The shiny aluminium case has holes that line up with the screws that hold the blue

casing together, which may give the impression that something is still attached, but wiggling it and bending the rear panel slightly will make it come free.



#### **DISMANTLING THE ALUMINIUM INVERTER CASING.**

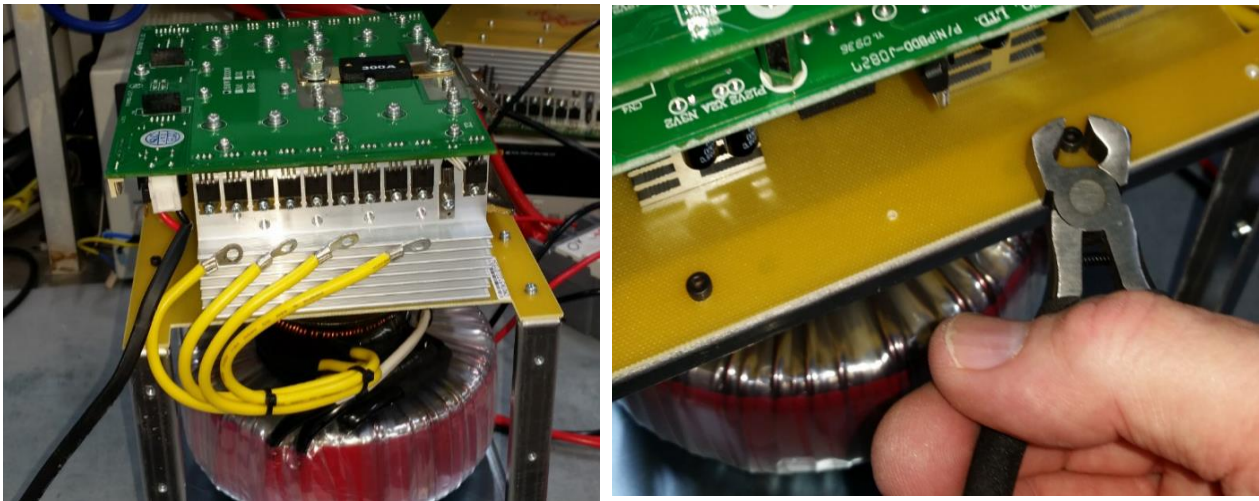
You can start by removing the top cover and checking the 300A (or 150A) fuse. If it is blown, and there are no signs of other obvious damage, then most likely the user has connected the 12V (or 24V) power back to front. If you are extremely lucky, that will be the only damage and after replacing the fuse you can proceed to the “Testing” and re-assembly section. If you then get a “Heatsink over Temp” message, that usually either means that a track has been blown off somewhere, or a regulator has been damaged, causing the temperature sensor system to malfunction (see later). In that case you will have completely disassemble the module:

First you need to cut off the cable ties holding the fan cables, and then “unwind” the cables from the fan. (3,000 Watt models have two fans, but the process is the same). With care you *can* get the cable unwound without cutting the cable ties, but you need to be careful not to over-stretch the fan cable.



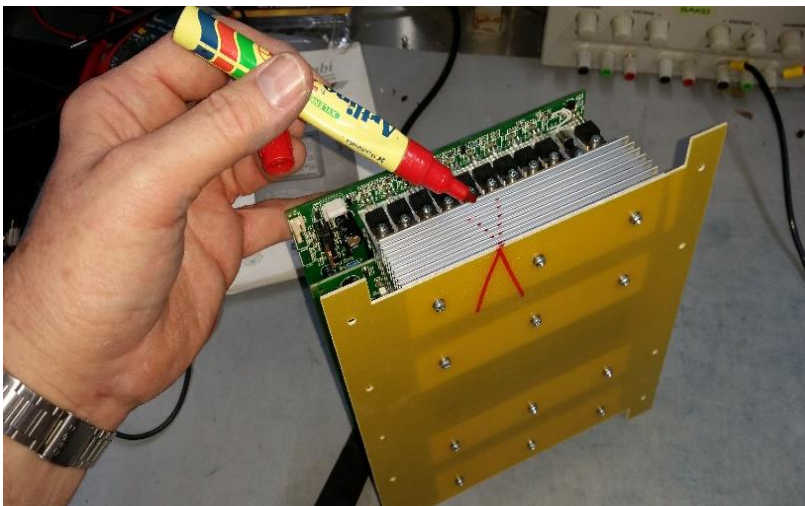
After that, it's mainly a matter of removing a large number of M3 screws. This is where a variable-speed drill with a variable torque chuck is invaluable. One with a high-capacity lithium battery is also desirable as there are a lot of screws to remove. Once the screws are removed, you will then be able to disconnect the fan leads. (This is almost impossible to do if you don't unwind the leads first)

The module itself sits on a yellow insulating sheet which is screwed to the transformer mounting frame. First disconnect the four yellow and four white heavy wires from the heatsinks.

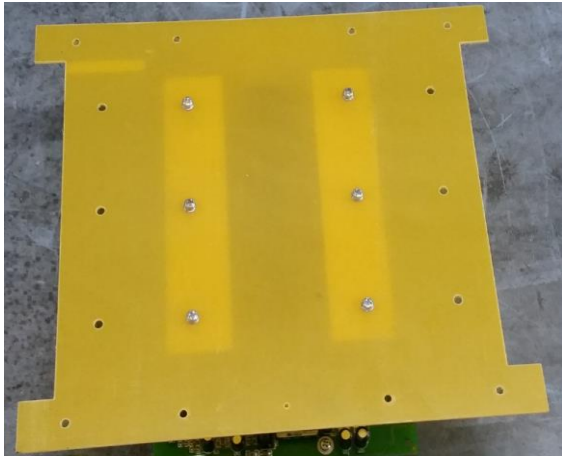


Then remove the screws holding the yellow insulating sheet. Note that two of them need a right-angle Allen (hex) key to remove because you can't get a screwdriver down to them. However, they are not very good quality screws and the heads tend to strip, so you'll probably find it easier to loosen them with a pair of pliers or wire cutters, and then remove them by hand.

**This next step is EXTREMELY IMPORTANT!**



If you need to completely remove the yellow sheet, mark the *original* position of the plastic sheet with respect to the heatsink. There are four different ways this piece could go on and they all will seem to fit OK; but the result of three of them will be that you can't QUITE get the aluminium case to go back together, and you won't be able to figure out why! The hole positions look like they're symmetrical; they're NOT!! Not quite anyway....



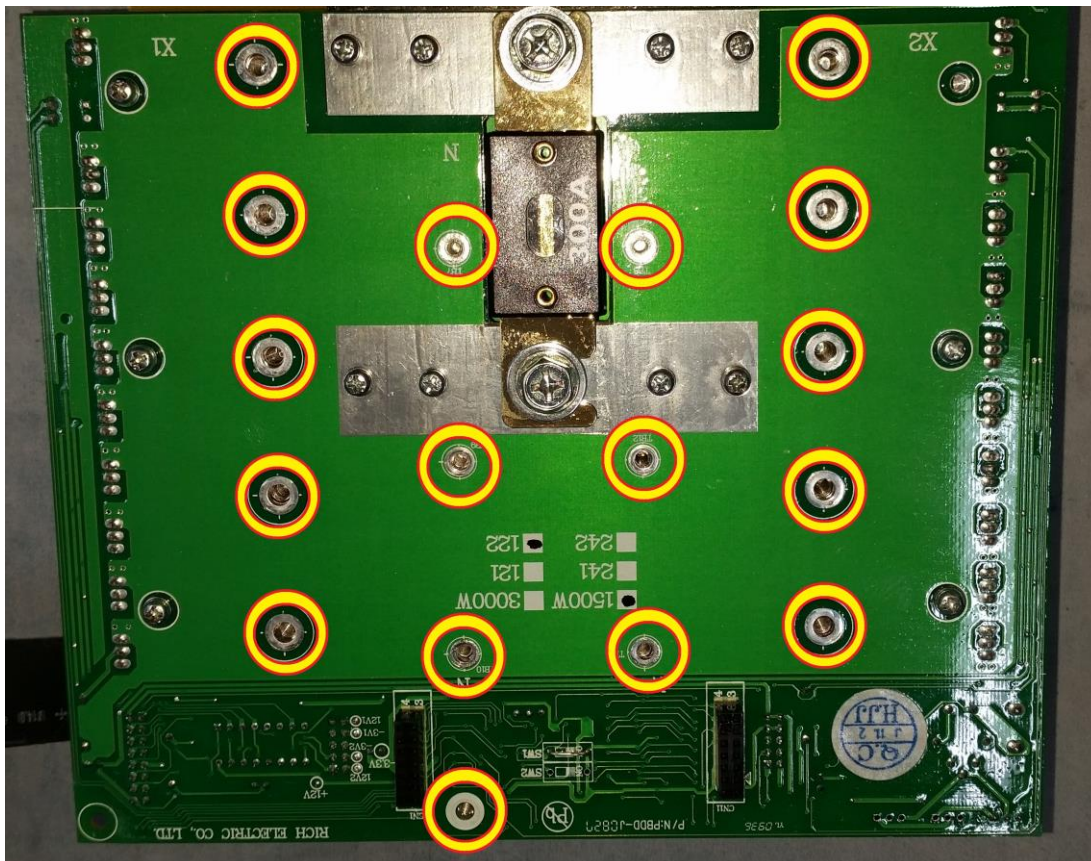
### DISASSEMBLING THE INVERTER BOARD.

This is another case where you have to remove a lot of screws. It won't hurt if you remove them all, but it will save you a lot of time if you only remove the ones you need.

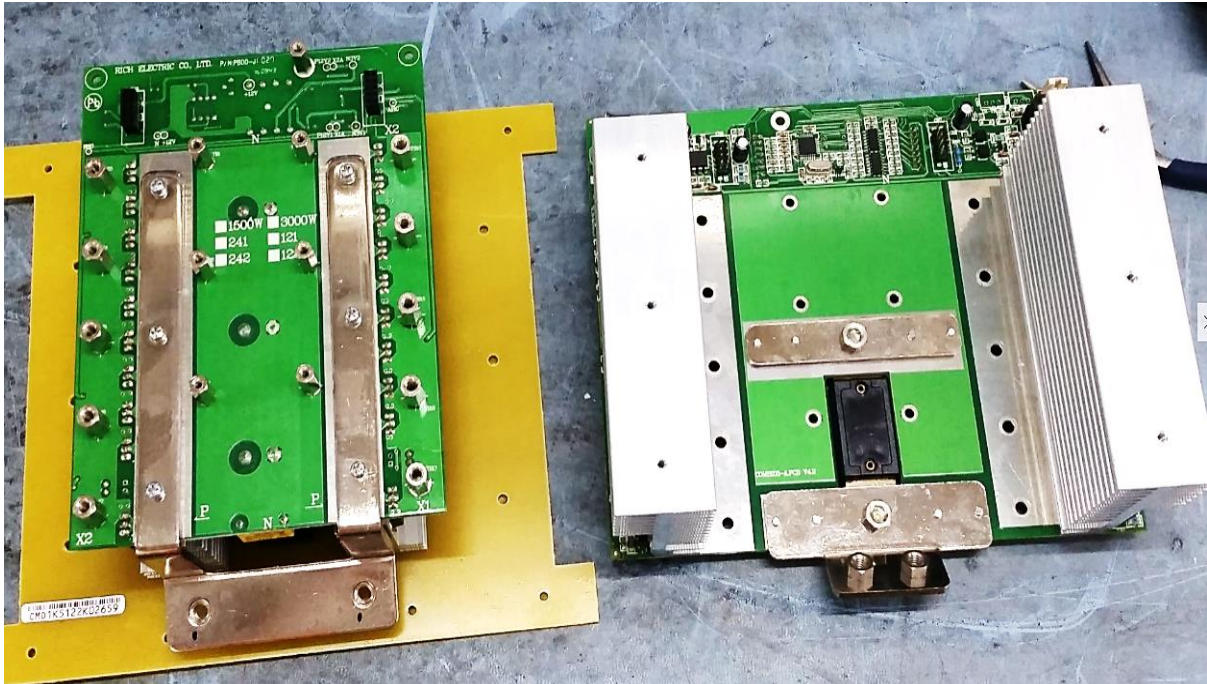
In most cases, you don't have to remove all the screws from the yellow insulating sheet, but (as above) if you do, **MAKE SURE YOU MARK IT FIRST!**

If you leave these 6 screws in you will be able to access the boards well enough with no risk of forgetting to mark the board.

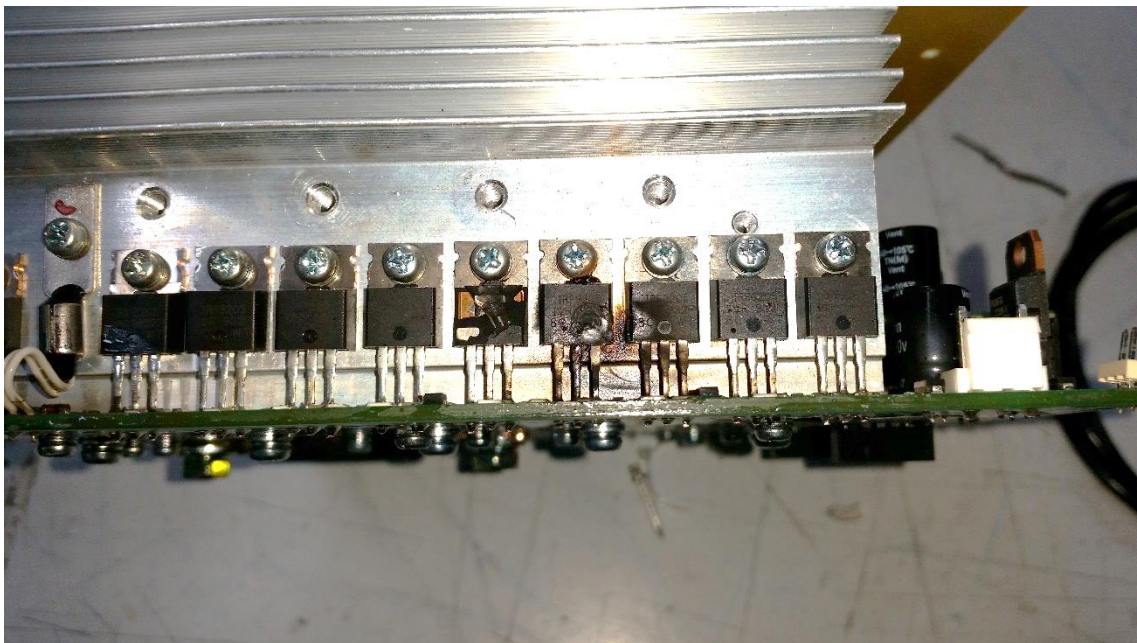
Then remove these 17 (!) screws.



Once you've done that, the two sections of the module will easily pull apart.

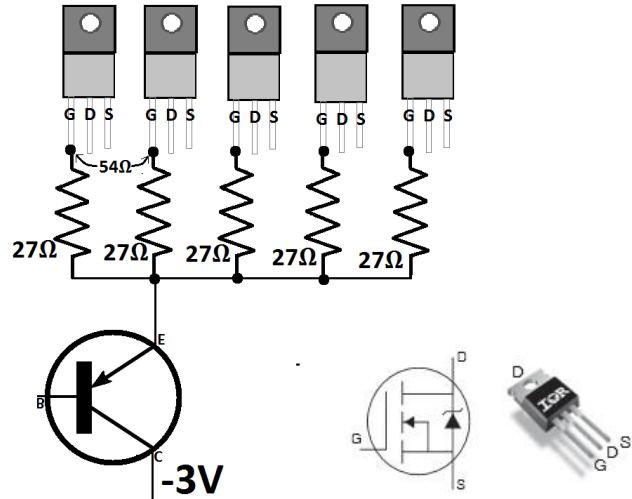
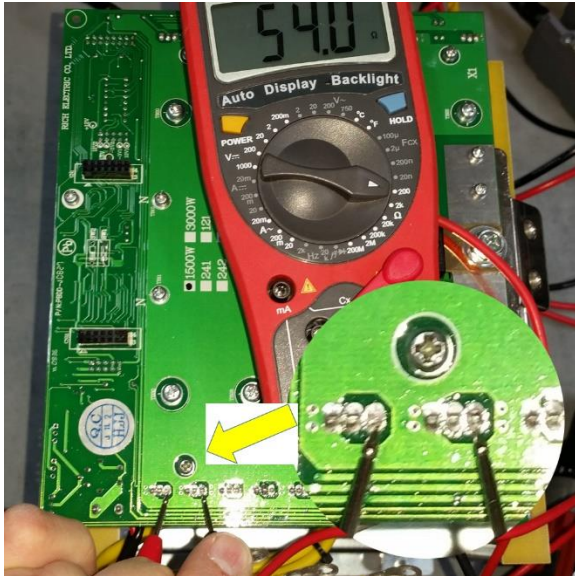


There are four heatsinks, each of which holds a bank of 10 IRF3205 MOSFETS (except for the 1,500W 24V model which has only 6 per bank). If you are unlucky you will encounter a sight like this. The bad news is, you can generally take it for granted that all the FETs in that bank will be blown, along with their 27 $\Omega$  gate drive resistors plus a pair of driver transistors. The good news is, in most cases only a single row of MOSFETS in an inverter will be blown.

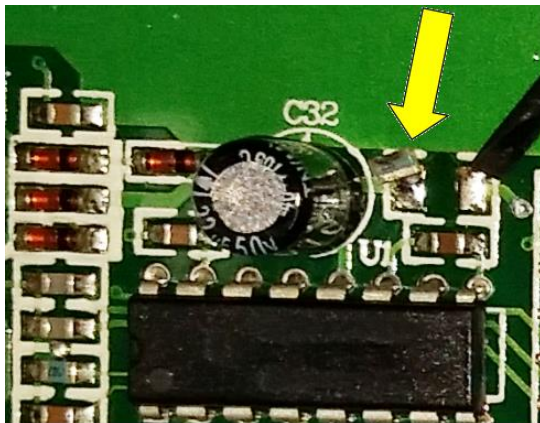


A simple way to check if a row of MOSFETS is OK is to do a resistance measurement between the gate pins of adjacent MOSFETS. They're actually broken up into two groups of five, each MOSFET in each group connecting to a common drive line via a 27 $\Omega$  resistor.

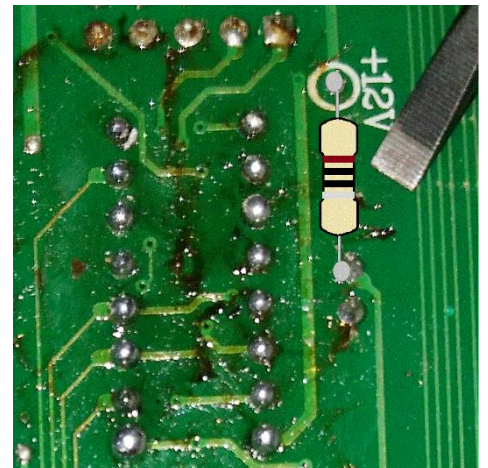
Because each gate has a 27Ω resistor in series with it, you should be able to measure 54Ω (2 x 27) between any two gates in each group of 5. If you measure between gates of MOSFETS in the two different groups, you should measure about 80Ω. As a general rule, if all 40 (or 24) MOSFETS measure correctly, it is fairly safe to assume that they are OK, and that only the driver IC is faulty.



The MOSFET driver IC U1 is an Intersil HIP4082IPZ. (The manufacturer helpfully files the numbers off their ICs). However, these were pretty easy to identify as they are widely used in high-powered car audio systems and are readily available for under \$A10.



A sure sign that the chip is blown is that this 10Ω chip resistor has unsoldered itself from the PCB. (In the example shown here, it hasn't quite fallen off). If you can find the resistor and it still measures OK, you can solder it back in



after you change the chip. However, in a lot of cases it will be open-circuit, and the PCB may also be charred. If so, you can fit an ordinary 10Ω on the other side of the board as shown on the right.

Remember that a 10Ω chip resistor will often be marked "100" which means "10" followed by no (0) zeros.



## REMOVING THE HIP4082IPZ CHIP

A major problem is that the inverter modules use very thick copper foil on the PC boards, and unless you have heavy duty desoldering equipment, you may have trouble removing and replacing the chips.

Although many of the tracks are quite narrow and easily damaged, the through-hole connections are heavily copper plated and so it can be difficult to get enough heat into them without damaging the other tracks.



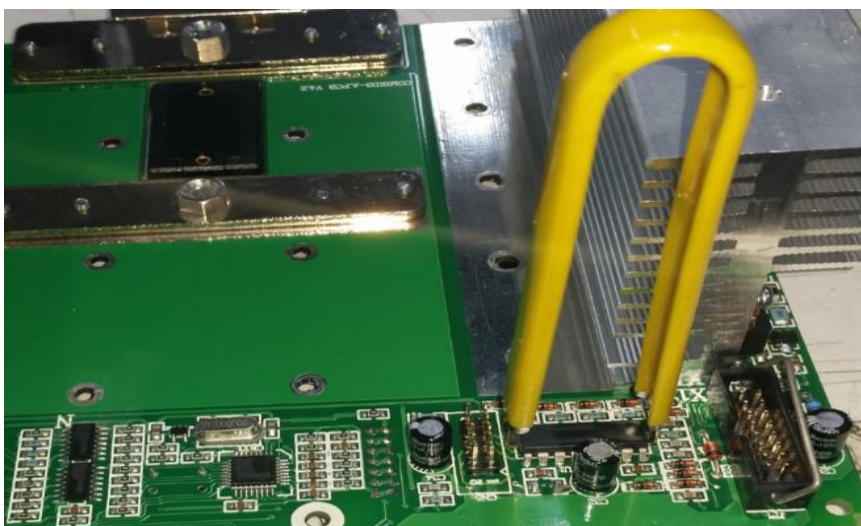
The standard way of doing this is to cut the IC away from its pins with a pair of fine-pointed side cutters, and then desolder and remove them one by one. While this will work, it still can be tricky because of the heavy gauge of copper foil used, and also because the board uses lead-free solder, which is notoriously difficult to work with.

One handy trick is to make an “unsweating” tool from a piece of thick copper as shown here. This one was made by flattening a piece of copper pipe, then using a piece of veroboard or similar as a template to drill 16 x 1.0mm holes in the same dimensions as a standard 16 pin 0.1-inch IC. The holes are then drilled out to 2mm and any burrs removed. (The one shown isn't too accurately drilled but it still works perfectly well.)

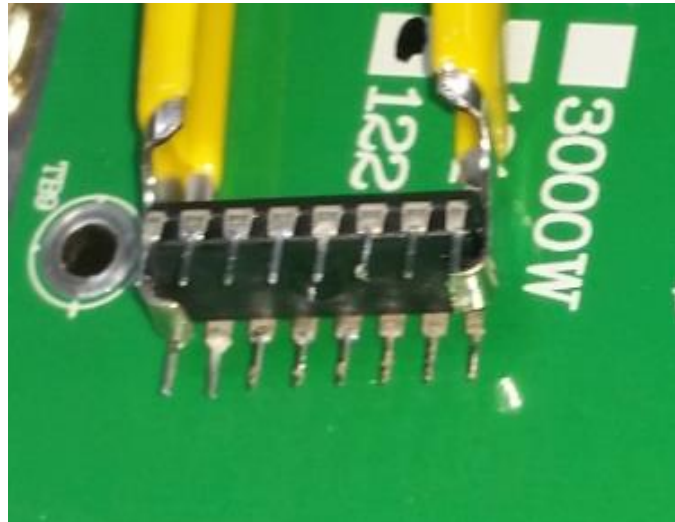
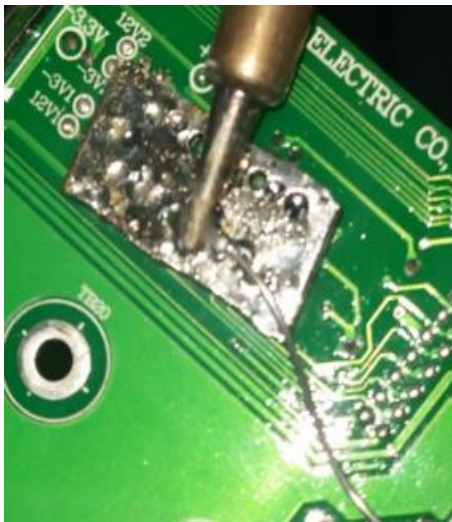


The copper is then heavily tinned with ordinary solder (preferably the old-fashioned tin-lead type).

The IC is gripped by an IC pulling tool (such as the Jaycar TH1818) The one shown here one has been squeezed so that its jaws tend to remain closed and so grip the IC without needing to hold it.

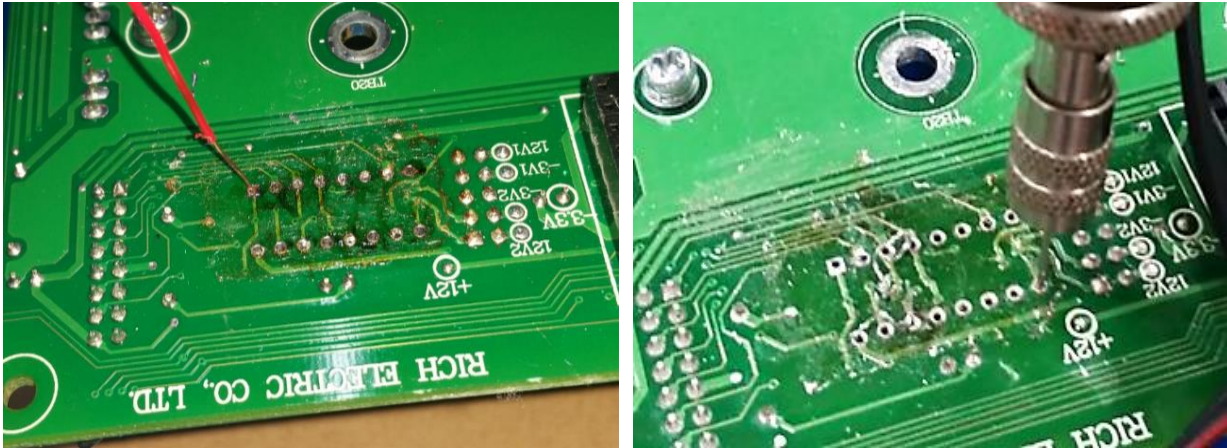


The best way to unsolder the chip is to use an iron with a large heavy tip but only just hot enough to melt the solder easily. The Jaycar TS1485 80 Watt iron is actually ideal for this, except that it does tend to get somewhat hotter than required. If you have a Variac and run it from 160 Volts or so, that will give you plenty of reserve heat, without risk of overheating the PC board.



Turn the board over and position the copper piece over the IC pins and carefully heat it with either the TS1485 or a temperature controlled soldering iron (at about 380°C). When the solder begins to melt, add more solder until all the holes are filled, and keep moving the iron tip to keep all the solder molten. After a couple of minutes, if you wiggle the IC puller slightly, you will start to hear a creaking sound as the solder begins to let go. Don't try to rush it; just keep gently wiggling the puller, and at some point the chip will suddenly pull free. This will allow you to remove the chip without damaging it or the PC board. (In fact, this is an excellent way of recovering useable DIP ICs from double-sided PC boards). Although this may seem like a cumbersome method, it makes it extremely unlikely the board will be damaged by heat.

Next you need to remove the solder from the holes. Once again, the heavy copper foil makes this difficult, mainly because of the lead-free solder, which is particularly hard to remove with solder wick. One solution is to simply drill out the holes using an 1.0mm drill bit and a small hand-held PCB drilling tool run at low speed. With care, this will be satisfactory. Another approach is to clean out the holes with bare copper wire, although this takes some practice. Using a TEMPERATURE CONTROLLED iron set to about 380°C, carefully melt the solder in each hole, allowing sufficient time for it to melt all the way through. Then, withdraw the iron, and then immediately "jab" a piece of bare copper wire into the hole, pushing about 30-40mm of wire out the other side. After a couple of seconds, you should be able to pull the wire back out, leaving a clean hole.



Another approach, which takes a bit of care but is extremely effective, is, after the IC has been pulled out (or falls out), apply more heat and more solder to the copper removal tool until it is completely covered, and the flux is starting to smoke. Then, in one smooth motion, flip the board over and bang its aluminium heatsinks down hard on the benchtop. If everything goes to plan, all the IC holes will be left clean and completely free of solder! (However you must make sure the solder is melted right through the holes, hence the smoking flux bit).

You just have to make sure no stray splashes of solder are left across any PCB tracks (use a wire brush). It may look a bit “feral” but once you get the hang of it, this is by far the quickest and easiest way of getting a DIP chip off a plated-through-hole PCB board!



Whichever way you do it; we strongly recommend you use an IC socket rather than just soldering the new chip in. In particular, you should use a “machine screw” type socket (such as the Jaycar PI6456), because their stiff pins can be easily pushed through PCB holes not totally cleared of solder.

Don’t forget to replace the 10Ω resistor!

If a bank of FETS is blown, then you will have to refer to “**If the MOSFETs are blown**” below. (You will still have to replace the HIP4082IPZ, regardless). On the other hand, if the FETS seem OK, replace the 17 heatsink screws and continue as follows:

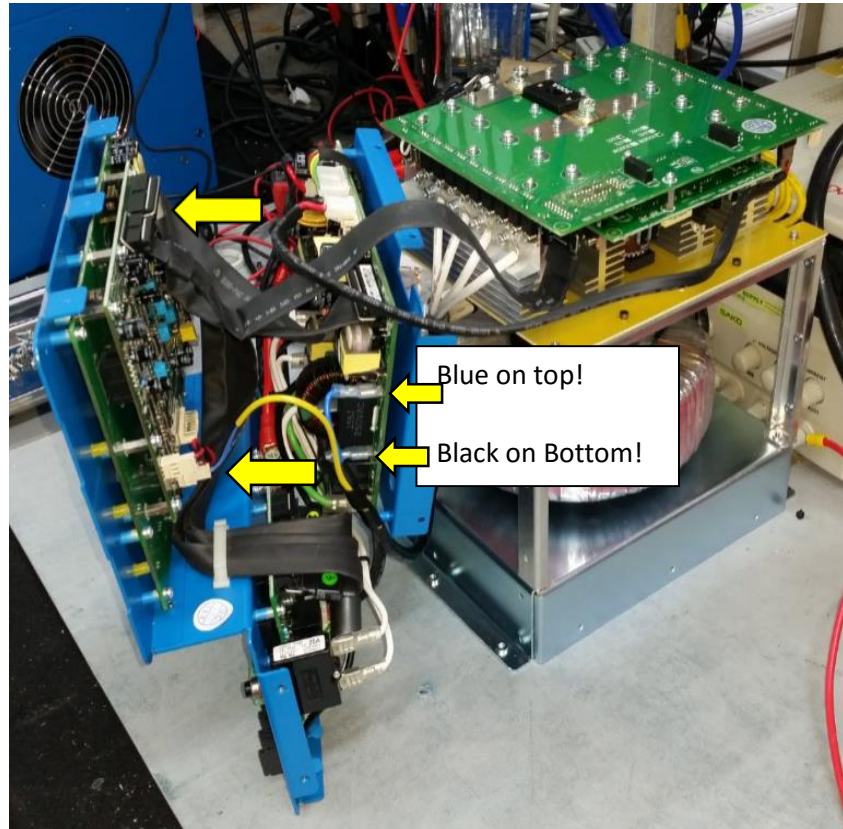
**HINT:** If you think you might be seeing this inverter “again” because of the questionable operational practices of its owner, one handy trick is to mount the IC socket (and the IC) on the other (top) side of the board. You will then have to *very carefully* bend all the IC pins up the other way to make the correct connections in the socket. If you leave out the two aluminium inner case top cover screws at the front of the inverter when you re-assemble it, you will be able to easily remove the top cover (and replace the IC) without needing to dismantle the entire unit. Or you could just cut a hole in the top cover. (You will need to mount the replacement 10Ω resistor on top as well).



## REASSEMBLY AND TESTING

For initial testing you only need to plug in the 20 pin ribbon connector and the transformer temperature sensor, and ensure that the heatsinks can’t touch the metal frame. When you apply 12V (or 24V, as appropriate) and set the front power switch to “1” (on), if everything is OK, it should go through the normal 10 second startup sequence and then it will tell you there is an “Inverter Overload”. That’s OK, you always get that message if the transformer wires (white and Yellow) or main DC power aren’t connected. All it’s really saying is that it’s not detecting any 240V output.

If that checks out, you need to go to the full test. This requires you to re-fit the 4 yellow and 4 white heavy wires, the heavy red and black cables, the 20 pin ribbon connector, the blue and black AC output wires and the heatsink temperature sensor. You don't really need the fan connectors at this point, although the picture here does show the fan power cable fitted. It also shows the yellow plastic sheet re-fitted and attached to the transformer frame, but you really only need to fit a couple of the screws

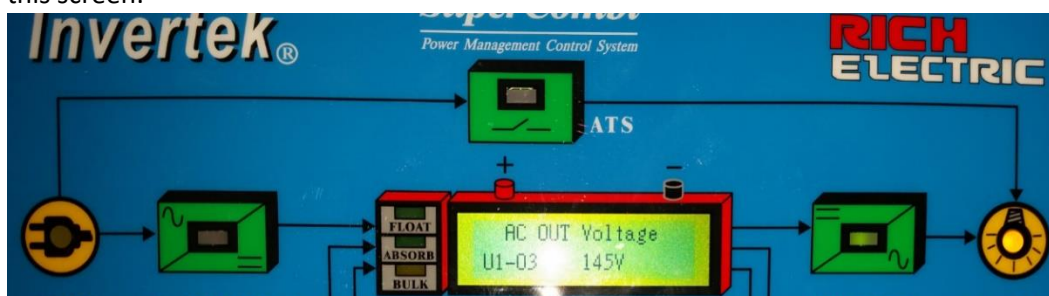


to provide insulation, as before. If you take a bit of care to avoid short circuits, you can run the inverter for short periods at full power in this condition. The only reason you would need to connect the fan(s) at this point is to check that they activate with heavier loads, and you can only do that if you have batteries to run the unit from.

**NOTE:** Take particular care to make sure you fit the blue and black AC output wires the right way round, as shown in the above picture (Blue at the top). If you get that wrong, it will work OK as an inverter, but will blow the circuit breaker when you apply 240V input for charging. (NB: The terminal marked "N" connects to black, not blue!!)

While not essential, you can also connect up 240V in and 240V out leads at this point. The easiest approach is to just buy a cheap 3 metre extension cord and cut it in half to provide the two leads required.

When everything is connected, attach the 12V (or 24V) power supply and switch the unit to "1" (on). There should be a beep, followed by the standard 10 second bootup sequence, a clunk of a relay and this screen:



The green "Inverter" and orange "Power Available" lights should come on, and (if no load is connected) it should show an AC output reading of 145V.

If you then plug in a lamp with a 25 Watt 240V light bulb into the extension cord socket, the voltage output should jump up to 240V for a few seconds with the bulb will illuminate at full brightness, then it will suddenly dim and the output voltage will drop back to 145 Volts. That's because it takes a load of at least 30 Watts to trigger the full 240V. The bulb will draw more than that when the filament is cold, but as soon as it heats up, the resistance will increase and the power will drop back below 30W after 10 seconds or so.

With a 24 Volt inverter and a 3 Amp power supply, the biggest load you can apply will be about 60 Watts before the unit shows an "low battery voltage" warning. With a 12V unit you will only be able to use half that, so the 25 Watt bulb provides a quite good test.

In general, if an inverter can supply 30 Watts, it will also work at full power, the only thing you can't test is whether the fan(s) will work. If you don't have the batteries on hand for a full test, it's a good idea to check the fans on the power supply before re-assembly, just to ensure that they are at least theoretically functional.

### FULL POWER TESTING

For a full-power test, and more importantly, the charger test, you will need a suitable heavy duty battery pack, and some heavy-duty cables, (car jumper cables will do in a pinch). If you don't have access to those there will be nothing for it but to test the unit at the customer's installation.



As mentioned at the start, a good test load for full-power testing is a small fan heater. The cheap little unit shown here is rated at 1,800 Watts maximum, and allows you to select 900 or 1,800 Watts, "fan only" and "off". This is a good size because as mentioned earlier, if you use two of them connected via a double adaptor you can get a good range of test loads. Also, you can still use it as a heater when you're finished.

**WARNING!** Be very careful when connecting the heavy-duty battery power leads. If you get them the wrong way round, you will be basically connecting them across the diodes built into the MOSFETs, which for intents and purposes constitutes a short-circuit. There is a fuse but it usually doesn't blow fast enough to protect the circuitry. It's a good idea to gingerly touch the terminal first, the way you when connecting car jumper leads. Note that this applies whether the inverter is switched on or not!

With the battery(s) connected the startup sequence should be exactly the same as before, except that when the "Power Available" light comes on you should be able to switch on the heater(s) without shutting the inverter down. A few seconds later the fan should start up. (3000 Watt models

have 2 fans; the bottom one only ever comes on then the transformer core gets hot, which takes a while).



If you keep pressing the “up” arrow you should come to a reading called “Battery Current” and it will show the current drain as a minus figure. For example if you have a 24V inverter running a 900 Watt load it will show something like: “-40A”. (Naturally the currents will be larger with 12V inverters).

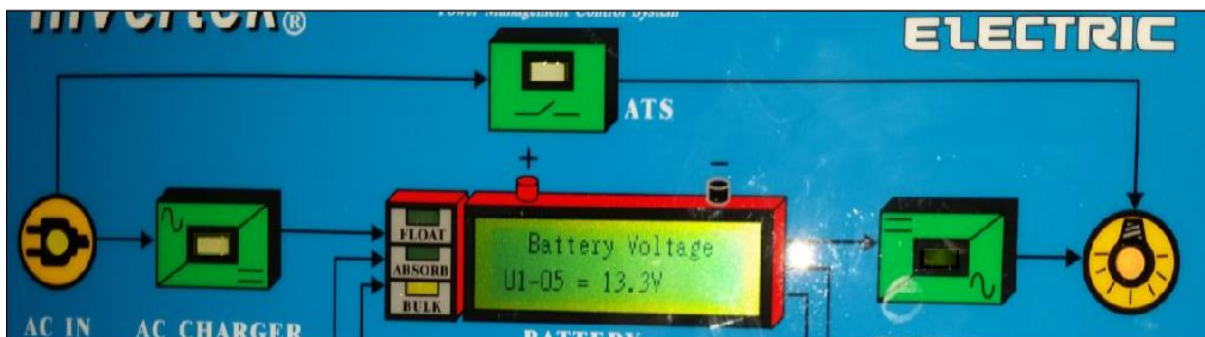
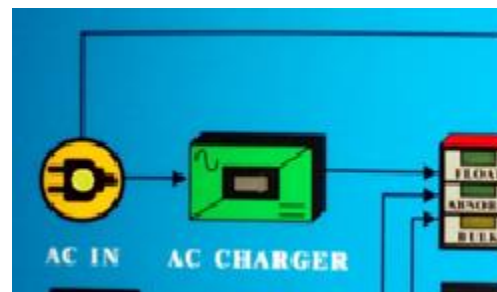
Running it up to 3600W (ie both heaters on full) you will get something like “-160A”. A few seconds later you should hear a beeping and get a warning message: “Intermittent overload”. If you then drop back to 2700W, the message should clear.

Generally, if you can get an inverter to run at full load for 15 seconds or so, you can pretty well guarantee it will continue to do so indefinitely.

### TESTING THE CHARGER

If you plug the other half of the extension cord into 240V while the inverter is running, the first thing that should happen is the “AC IN” LED illuminates.

After about 10 seconds, if all is well, you will hear a relay click and these lights will come on: “AC in”, “AC Charger”, “ATS”. The “Power Available” light on the right should stay on, and the “Inverter” light will go out.



The battery voltage will start to climb and the battery current will read something between (+)1 and (+)70 Amps, depending on the mains voltage and the state of the battery.

The 240V AC power input will also be routed through to the output socket by a relay, so the load will then be running on direct mains power.

Note that the charger is not particularly sophisticated, it is basically just a transformer and four diodes, with an electronic relay to switch the charge on and off. The peak charge current may thus vary considerably with the mains voltage.

If you get no charge output, the most common cause is an incorrect setting, and an “Initialize” (full software reset) will usually clear it. Another common cause is faulty solder joints on the switching relays as shown here.



If the inverter passes all the above tests, it's probably OK and you can re-assemble it.

## THINGS TO REMEMBER WHEN ASSEMBLING THE INVERTER MODULE CASE:

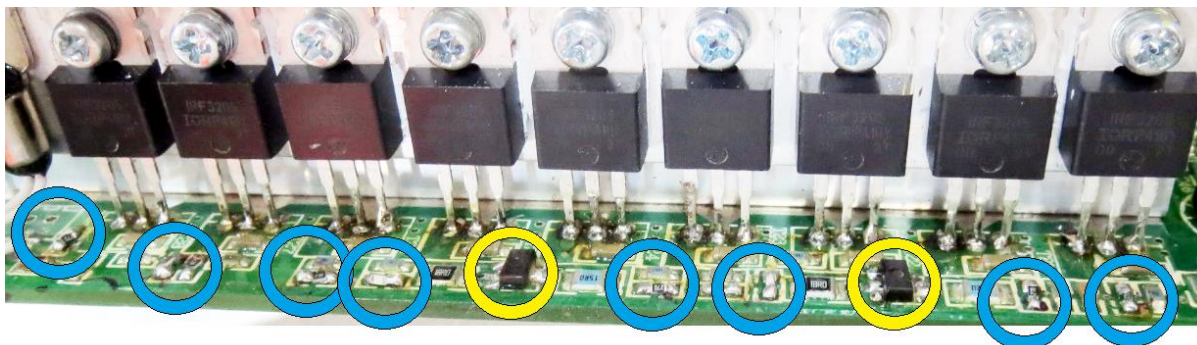
1. Make *absolutely sure* you have the yellow insulator sheet the right way round and you've replaced all the screws.
2. Make *absolutely sure* you've plugged in all the cables, including the fan plugs and the 20-pin connector, because you'll have to take everything apart again if you forget!
3. Be VERY careful not to get the fan lead and power cable caught between the edge of the inverter circuit board and the metal case. If you do, you'll never be able to get the case screws to fit.
4. Space out the way you insert the M3 screws into the aluminium case. That is, put some in the bottom, then some in the top, some on the right, some on the left and so on. That way you can spot any assembly errors before you put too many screws in.
5. Remember some of the case screws also hold the small blue sub- panel.
6. Make *absolutely sure* that you get the heavy DC power cables the right way round and
7. Make *absolutely sure* that the DC connector screws are done up tight (There are some pretty massive currents flowing!).
8. Putting the blue cover back on is a lot easier if you turn the inverter upside down so that the weight of the transformer pulls the screws into place.

## IF THE MOSFETs ARE BLOWN

Generally, it will be fairly obvious when the MOSFETs are damaged, but if not, the resistance check shown on page 11 is a pretty reliable indicator.

If any one MOSFETs in a bank is damaged, you can take it for granted that the others will be too, along with their  $27\Omega$  gate resistors, the two PNP driver transistors, the HIP4082IPZ driver IC, and its  $10\Omega$  resistor.

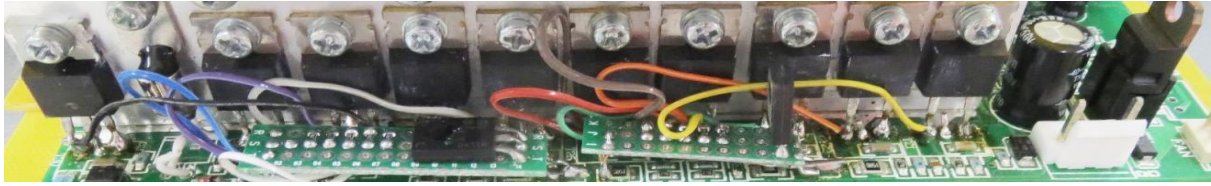
You can just replace all the parts in the usual manner, but unless you have very keen eyesight, steady hands and the right soldering and unsoldering equipment, you may find this a real challenge.



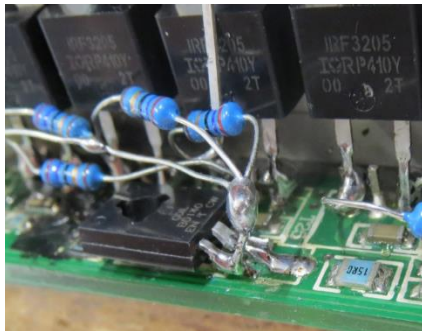
In this example the tiny  $27\Omega$  resistors are ringed in blue, the transistors in yellow. (Not all resistors are shown). A suitable replacement for the transistors is the 2SB1132, although just about any SOT89 package PNP transistor rated at more than 60V and 500mA should work.

However, there is no particular virtue in doing it this way, and a less neat, but perfectly functional repair can be made by simply cutting the leads of the faulty MOSFETs and soldering the leads of the new ones onto the stumps. You don't really need to connect the Drains (centre pin) as a perfectly good contact is made from the metal tab via the screw connection.

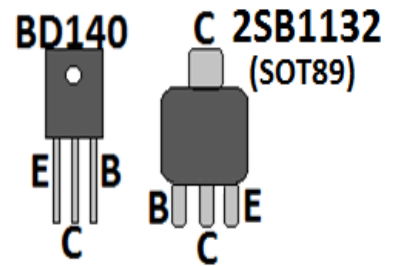
The burned-out  $27\Omega$  SMD resistors can be left in-situ and ordinary axial-leaded ones used instead. Also, the faulty SMD transistors can be replaced with readily available BD140s.



In the example above, the SMD resistors and BD140s were mounted on a strips of prototyping board and wires run to the MOSFET gates.



In the next example, axial leaded  $27\Omega$  resistors were soldered directly between the MOSFET gates and the BD140 Emitters. (Sleeving would be a good idea; but this was just a prototype). *Make sure you get the BD140 connections correct!*



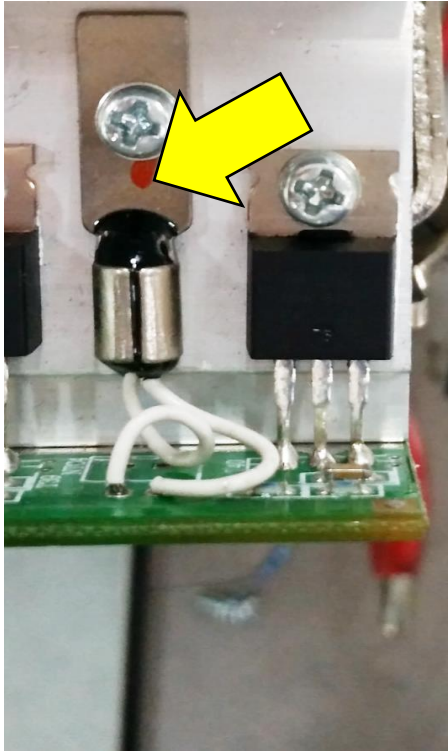
Note that if you want to do everything in the “textbook” manner, the best way to get the MOSFETS out is to use the same TS1485 80W Jaycar iron as was suggested you use to remove the driver chip:



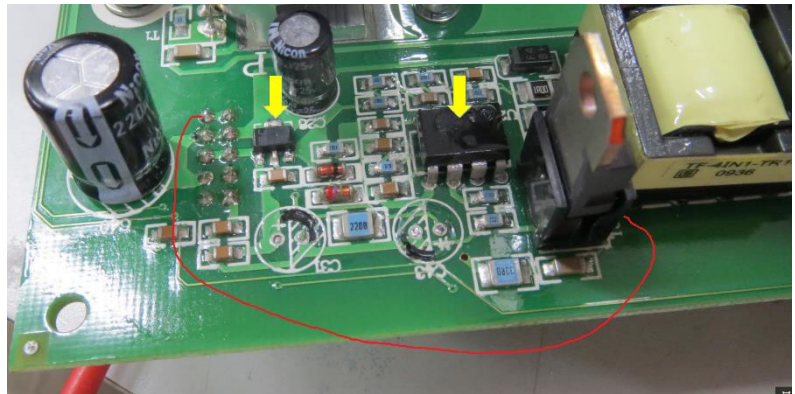
You simply remove all the mounting screws, grip the MOSFET tab with pliers, melt the solder with the TS1485 and carefully pull the MOSFET out. (Pulling it out using your fingers is possible only if the solder is fully molten, and by that time it may be too hot to hold). Smaller irons will not work, and as it is, you will need to give the TS1485 time to reheat between removals, such is the heat sinking capability of the copper foil!

After that it's a simple matter of drilling out the holes with a 1mm drill bit and generally cleaning up any stray bits of solder.

## OTHER FAULTS



The most common other fault seen is “Heatsink Over Temp”. Usually there’s nothing wrong with the temperature; it’s normally a failure of the 5V supply that feeds the temperature sensing thermistors shown here. There is one thermistor for each heatsink. You should measure about 5 Volts on one wire of the thermistor and about 2 Volts (depending on temperature) on the other wire. If you measure no voltage, this usually due to a failure of the small switching power supply mounted on the smaller module.

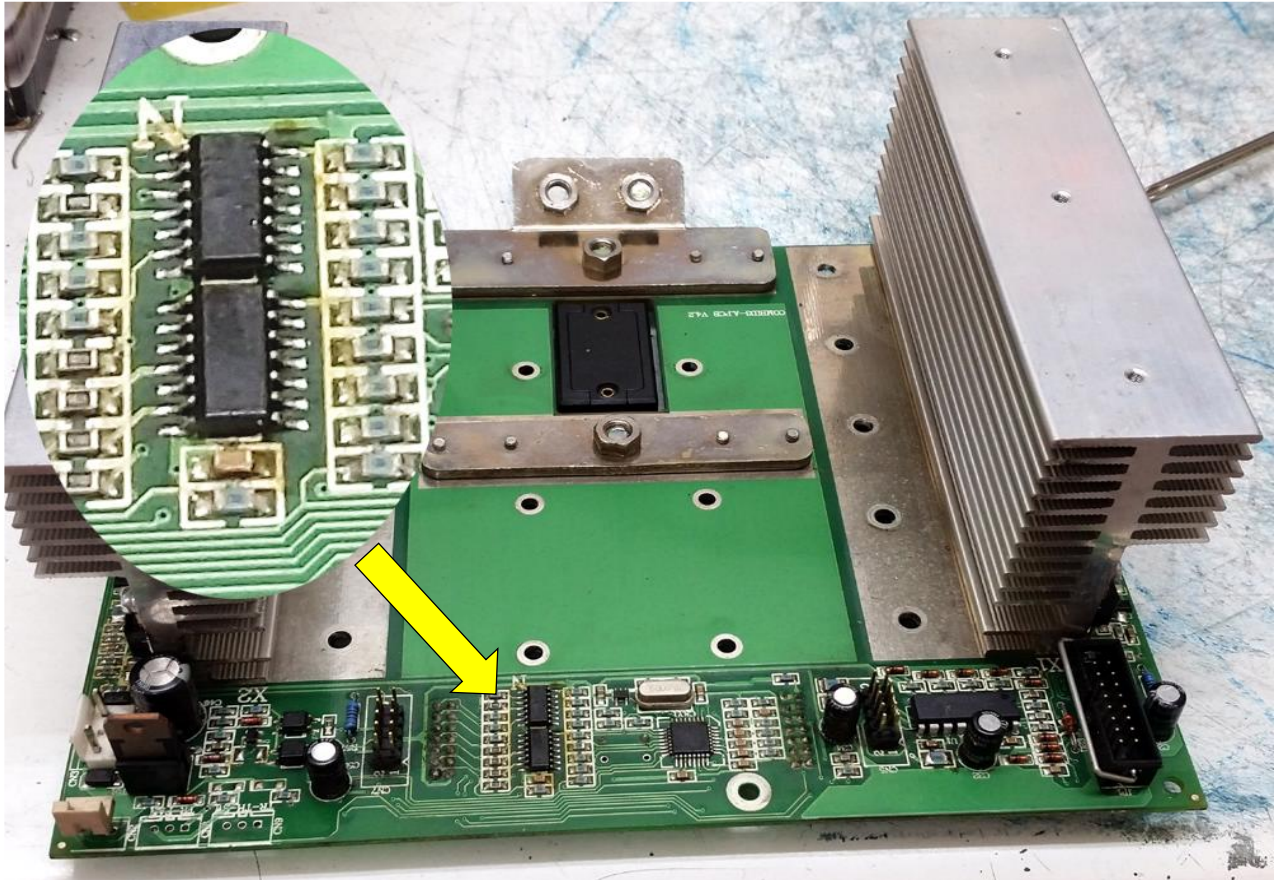


Common failures are the UC3843 (AS3843) 8 pin DIP power driver IC, the SMD 5V regulator, and the piece of track from the 10-way socket to the primary of the switching transformer. (Two of the electrolytics have been removed for clarity here).

You can unsolder the UC3843 the same way as the HIP4082IPZ, and again, we strongly recommend you use an 8-pin machined pin socket.

You can use an ordinary TO220 5V regulator, if you can’t find the SMD type, but note that the input and output pins are reversed from the SMD version.

If the 5 Volts is OK, then it's probably one of these two 74LVC07 surface-mount interface chips mounted near the driver chip.



The replacements we have successfully used are:

TEXAS INSTRUMENTS SN74LVC07ADR Buffer Driver 74LVC07 1.65 V to 5.5 V, SOIC-14 from Element 14.

You have to be extremely careful removing those chips as the tracks are extremely delicate. If you aren't experienced in removing chips like these, we'd strongly recommend you take the panel to somebody who is, and who has the proper equipment.

You really need a proper hot air rework station for this sort of work, and you need to be absolutely sure you have all the solder melted, otherwise the tracks will rip up when you try to flick the chip off.

Remember that you will also get the "Heatsink Over Temp" message if you forget to plug in the transformer core temperature sensor plug.

"Battery Under Volt" (assuming that the voltage is actually OK) is usually caused by a faulty **HIP4082IPZ** chip.