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Presents

A Power-ful Piece About the PSU

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Whether you realise it or not, your computer's power supply, or PSU, is a critical part of your computer: It has to supply the exact or near exact voltage at the required wattage to all of the circuitry and component parts inside the box; as well as a limited amount to some peripherals too perhaps. The processor and memory are particularly sensitive to their power supply, and require an exact supply or as near as possible to one.

When you're building your own box, or replacing the existing power supply unit in an existing box, your choice of component is very important.

Despite sensitive voltage and current regulator circuitry on most motherboards adjacent to the processor (CPU), and/or directly regulating the supply of power to the memory (RAM) itself; the pre-regulated supply to the motherboard, particularly with respect to these components, needs to be as near spot-on as is possible. If your power supply unit (PSU) has trouble delivering the required regulated supply then strange things start to happen:-

Your computer may start acting strangely or even produce repeated stop errors (Blue screens of death. (BSOD)) The event logs may record these as being due to memory errors, and probably correctly so because the low or poorly-regulated supply of power to the memory is causing it to not function as it should. The memory errors are probably being caused by an insubstantial power supply to the RAM and/or CPU.

Why would this occur? There are a number of reasons that this may happen. The most obvious being that the PSU is wearing out and it needs replacing. - Or it's a poorly-made low-quality unit.

As is the case with most if not all other computer components, PSUs don't last forever.

How long they actually do last can depend upon the quality of the unit as well as the demands being put upon it. A cheap and nasty power supply unit may not be capable of delivering its stated overall wattage output. If you're loading it heavily by running a lot of hardware, it may actually produce a significant voltage drop across its output due to the high load.

"- So what do I do if my power supply's voltage does drop under Load?"

That's a bit of a multi-pronged question. I'll try to cover a number of those points in the hope that you can come to a conclusion based upon the information and guidance herein.

I'll start by saying that, in the case of any supply of power, the voltage will always drop to some extent under sufficient load. To clarify that point somewhat, I'll draw your attention back to Ohm's Law and the relationship between wattage (Power), current (Amperage), voltage, and resistance (Ohms) (The load):

The wattage or power (P) = the current (I) squared multiplied by the load resistance (R) in a DC circuit. It follows, then, that R divided by I squared = P.

Remember the equation for connecting resistors in parallel in a DC circuit: R= (R1 x R2/R1+ R2). Well in this case each component has its own DC resistance; therefore each component part of a computer is like a resistor connected in parallel across the supply rails; and as you connect more resistors in parallel, so the total resistance decreases.

If we give I the fixed value of 10 amps in this example, then we can see that as R (Resistance/load) decreases, so does P (Wattage). : Translated into English, this shows that as the load increases and therefore the parallel load resistance decreases, so the amount of unused power available from the supply also decreases. Why does this occur? Because as the load increases so the resistance decreases, (Remember, again, the equation for calculating DC resistances in parallel: Rt = (R1 x R2 / R1 + R2) therefore more of the available electrical power in watts is used by the load and transformed into other kinds of energy.)

We know from Ohm's Law that V = IR (Voltage = current multiplied by resistance.). Therefore, if we use the fixed figure of 10 amps as the value for I again, we note that as the value of R (The resistance) increases then so does the value of V (The voltage.). Inversely as the (load) resistance drops as extra load is added to a DC circuit, so the voltage drops proportionally.

The higher the amount of current (I) available in the circuit; the less the decrease in R (Increasing the load.) affects the decrease of V. (Drop in voltage.)

We can prove that fact by increasing the value of I to 20 amps: Do the math again and you'll see that this is true.

- Conclusion: The greater the electrical load on a given supply; the greater the voltage drop on said supply.

This is *always* true to a given extent; no matter how much current is available.

Bearing this in mind, then; how much voltage drop is too much?

In a perfect world; any voltage drop is too much. – But as we've seen above; there can never be zero voltage drop unless there is zero load. As we know; if there is zero load then there is zero computer, so the point is mute. The objective of the exercise then is to minimise the voltage drop to the greatest extent possible.

In the examples above we saw that the more components we had connected the less resistance appeared in circuit across the supply rails; therefore the more wattage was used to power the load. From that we can conclude, since, according to Joule's Law, P = IV, then the less wattage (P) there is available in circuit, given that the voltage is always the same, then the less current is available because there is more current flowing through the load as the load's resistance decreases. Therefore what is required is more current inputted into the circuit6 from the PSU and, running the equation backwards, therefore more wattage.

I'll just put that slightly differently in order to clarify it:

In Joule's Law; I x V = P (Current multiplied by voltage = power (wattage).).

We know that the voltage outputs of a computer power supply are fixed ay 12v, 5v, and 3.3v. Therefore the available current (Amperage) is dependant upon the available power (Wattage): The more wattage the supply can output the more current is available; therefore the less the voltage drop will be under any given load.

- Conclusion: To minimise any voltage drop under any given load conditions; make more wattage (power) accessible.

In other words; if the voltage on your supply rails drops substantially under the load that your computer's components put on those supply rails, then your power supply isn't outputting the required wattage.

(It is possible that a malfunctioning piece of hardware is drawing far too much current from the supply; but this is unlikely: A malfunctioning piece of hardware that draws such high currents would get very hot very quickly and would probably begin to cook, causing noticeable odour and smoke. It's far more likely that the power supply itself is at fault if nothing else is frying itself.)

In the face of that; you have two choices. Either: -

1) Keep your existing power supply unit and decrease the load on it. (- By not running so many components: In other words removing something from the circuit, such as a hard-drive, graphics card, whatever.)

OR

2) Fit a new power supply capable of delivering the required wattage.

At this point you may say:

"I've checked everything and worked out that the load on *whatever* rails is X amps: That's Y watts at Z volts. My power supply's output rating on *whatever* rails is greater than that: Therefore something's wrong."

Correct. Something is indeed wrong. There is an inconsistency somewhere. The problem now is to discover exactly what that inconsistency is.

It could be three main things: -

1) The equations are wrong.

2) Your calculations have arrived at incorrect figures.

3) The PSU ratings are wrong.

Firstly there is no chance that the equations are wrong. The equations used form the basis for modern electronics theory and have done so for more than 100 years. They are an integral part of basic electronic calculus and have been proven to be correct time and time again.

Secondly, check that your calculations are correct and that you have indeed arrived at the correct figures.

If there is no fallacy in your calculations then there is now only one possibility left – That being that the PSU ratings are wrong. How can this be?

Some manufacturers; especially the manufacturers of cheapo power supplies, overrate their product. This isn't actually lies though. It's an overstatement:

A PSU rated at 500 watts is indeed capable of supplying 500 watts; but not necessarily 500 watts of continuous power. In tests done by a leading UK computer magazine in the last 2 years, a number of 500 watt PSUs failed when fully loaded. One, the second cheapest under test, even detonated! There is an old saying that you get what you pay for. Sure; a $15 PSU built in China and rated at 500 watts will supply a computer that needs 300 watts to run efficiently without (m)any problems. It's when you add a powerful graphics card that drains an extra 100 watts, plus a RAID array = another 30 watts, extra optical disk = +10 watts, and upgrade to a more powerful processor = +35 watts that things start going askew: BSODs occur, the graphics card doesn't perform properly, the power supply starts making strange noises…

- That's only 475 watts total, and the PSU is rated at 500 watts, so theoretically it should work; but it doesn't. – Because the PSU can provide 500 watts *peak,* – but not 500 watts *continuous*. – In fact probably only 400 watts or less continuous. At peaks where the power requirement is at its greatest there may be a voltage drop of over a volt causing memory failures and processor outages.

Maybe it's not that serious in your case? Maybe you're on the edge of the precipice; but are still noticing a voltage drop on measurement under load, even though the PSU is still holding up, the CPU's not having outages, and the RAM is just managing on the reduced voltage?

That's a good thing inasmuch as your computer is still working. – But it's so close to the wire that it'll only take a feather to tilt the balance. – So don't expect your computer to carry on without problems much longer in those circumstances. All you need is for the PSU to get too hot, the CPU to use a few watts more, the graphics card to draw that extra piece of polygonal shading, and things start to fail.

Get a better quality and / or higher-rated power supply unit: The sooner the better. Once it's fitted, measure the voltage drop. There will still be a voltage-drop; but it'll be smaller and your computer will be happier as a result.

"OK I get the picture. – So tell me more about cheapo PSUs."

Computer Shopper magazine tested a number of different makes and models of 500 Watt power supply for reliability during 2008. One of the tests was to run the PSU under test at full load to see if it could deliver the wattage stated on the tin. Not many of the thirty or so PSUs under test could actually do so, although over half came near to the mark, supplying only a few tens of watts less than claimed. The cheapest PSUs were undoubtedly the worst in this test; with the cheapest PSU actually failing totally with a full 500 Watt load applied to it, while another of the cheapest models literally blew up in a self-detonation!

Straining a power supply results in heat building up within its components, as does the act of simply running it come to that.

Allow me to rephrase that: Heat builds up within a power supply when it is being used, and straining a supply causes excessive heat to build up in its components. Heat is an electronic component's enemy. It causes chemical changes within an electronic component's chemical structure over time, which causes the individual component(s) to become less effective. of course there is heat which is produced from the components inside your PSU, and this has the same effect. Overloading a supply will wear it out much more quickly. Bearing in mind that many PSUs are unable to actually supply their stated Wattage, your PSU may be overloaded without you actually realising it, especially if you've added new hardware such as an SLI graphics-card or similar.

Even if you've not added anything and aren't overloading the PSU in any way; power supplies don't last forever, as I stated earlier. If you're experiencing random frequent crashes it could be that the power supply requires replacement. (It could also be due to a phenomenon known as "capacitor plague".)

Power supplies aren't immune to power surges from the electricity grid, either. A large voltage spike, or even a brownout, where the mains voltage drops and fluctuates wildly, can in rare cases damage them - as well as, more likely, your other hardware. That's why it's always a sensible idea to run your mains power through at least a surge-protector, or better still a UPS, before connecting it to your system. See below for more on UPSs.

Uninterruptible Power Source (UPS)

Due to the way that it's built, Windows tends to keep data in RAM while it's working, which it would otherwise write to disk. When Windows is shut down properly it flushes any such data in the RAM and writes it to the hard drive. If the power suddenly goes out unexpectedly before Windows has had any chance to shut down properly, then any data residing in RAM is lost forever. Windows is constantly swapping data between RAM and the hard disk; hence the appropriately-named "Swap-file". If the power goes out while windows is writing data from the hard-drive to RAM or vice-versa, then whatever's either been written to or not yet removed from the disk stays on disk. – Any data stored in RAM, be it half a file that was being removed from disk to be processed, whatever, is lost. End of story.

The consequences of this could be anything between unnoticeable and tragic: meaning that it might be that your computer won't even boot any more. Even if you get a result that's seemingly unnoticeable, there's a very large chance that something somewhere has become corrupted.

There have been cases where not only data but also hardware has been damaged by a power outage; such as cheap USB flash drives. Hardware damage is quite rare though.

All the same; who wants corrupt data? Not anyone I know.

This is where a UPS comes into its own:

What is a UPS?

UPS stands for Uninterruptible Power Source; and it's just what it says on the tin: If your household and/or office electricity supply gets interrupted in any way at all, be it a voltage-spike, brownout, fraction-of-a-second-outage, or a total power cut; the UPS's output will remain constant until, in the case of a total prolonged outage, its battery runs out: During that period of time, (Usually 10 minutes or more.) you have the option to shut the computer down properly.

I currently have a setup running 2 computers: (Showtime: I can tell you all about my latest setup.)

One is a machine running a dual-core AMD Athlon 64 X2 4200+ Socket AM2 (2.2GHz) Energy Efficient CPU, 2 GB DDR2 667MHz RAM, 512 MB Asus nVidia graphics card, on a Gigabyte GA-M61PME-S2 GeForce 6100 Socket AM2 motherboard, Hitachi 250GB Hard Drive SATA II 7200RPM 8MB Cache HDD. (500 GB external HDD extra.), 350W PSU. Also includes a Samsung SH-S183A SATA DVD-RW drive, universal card reader, customary floppydrive, and 3 extra front USB ports. I built this machine in December 2008. It's currently running XP Professional 32-bit as an operating system.

Machine number 2 is running an AMD Phenom X3 Triple Core 8650 2.3GHz Socket AM2+ CPU on a Gigabyte GA-M720-US3 AMD nVidia 720D Socket AM2+ 7.1 channel audio ATX Motherboard with 4 GB DDR2 800MHz/PC2-6400 RAM fitted, 250MB Asus nVidia graphics card.. There are 2 x 250 GB SATA2 HDDs fitted (Not RAID.), (One is another Hitachi.) 400W PSU. Samsung SH-S182D IDE DVD-RW drive, Fire Wire on mobo, and 2 extra front USB ports. I built this machine in April 2009. It's currently running Windows 7 Ultimate Build 7100 RC 64-bit.

I have 2 (Different) UPS's. The wiring configuration is somewhat non-standard due to the small load-bearing of one of them: The smaller UPS controls the power to the 17" TFT monitor for the XP computer, both sets of speakers, the BT Home Hub router, and the desk light. The larger UPS keeps watch on the power to the 17" CRT monitor, (Yes; I still have a CRT monitor, and am still loving the extra colour response of it.) both computers, and the test-bench supply. I run almost my entire system from them so that I can carry on working should there be a short power outage.

So far the UPS's have saved everything from possible damage and/or data loss from at least 3 voltage-spikes, a brown-out, and 2 full-outages, in the last 2 years. (That includes the 3 previous computers I've had while I've had those UPS's installed.)

UPS's are relatively inexpensive; anything from £25 up to about £750 for the most expensive available, and last for around 3-4 years before they might need replacing. I intend to run lighting, a TV, radio, etc, from the existing UPS's when they are replaced next year, after they've passed their prime: So there's always a use for even the retired units.

A UPS is extra expense; but it will possibly save you a lot of time and hassle down the line, and is well worth investing in.

Don't leave it until it's too late: Get at least one for your computer as soon as you can if you don't already have one.

*Note: Laptops & netbooks already have a battery backup in a sense of the term, and so don't need to necessarily be connected via a UPS. Connecting them to the main supply via a surge-protector would be a good idea, nevertheless.

UPS Strategy

Firstly, a UPS that is able to handle a lot of throughput in terms of wattage, as well as to hold a decent charge, (Around 600VA +. – These might be a bit expensive, but well worth the investment nevertheless.) is able to run and protect not just the computer itself, but also the monitor, sound system, modem, printer, scanner, any other peripherals used, as well as a low-wattage desk light. (Somewhere around 5 to12 watts.)

On the event of a power-failure, the UPS will ensure hassle-free operation of the entire system until either the power supply is restored, or the UPS gives a warning due to running out of charge, before shutting down the computer.

In the case of prolonged or extended power-loss, the UPS will put the computer and monitor into standby mode; therefore at least halving the wattage which they use. Although there won't be much charge left in the UPS at this point, if the user switches off the computer, which is already shut down, as well as most of the peripherals such as monitor, scanner, etc, there will be enough charge left in the UPS to power the desk light and to run the router for quite a considerable period of time. Therefore, a laptop or netbook can be run on the charge of its battery whilst maintaining internet access via the router a while longer.

If, like me, you run more than a single system, it would be an idea to purchase 2 UPS units and run each system separately via an individual UPS. You may like to set the UPS that runs the secondary system to power down the system, in the event of a power-failure, after a couple of minutes. – In which case, after the primary UPS unit has almost run out of charge and shut down the primary system, you can then reactivate the secondary system if the power's not back on by then, set the UPS to power down as it gets low, in the same way as with your primary system, and continue working, – using the secondary system as a backup and almost doubling the working time while the power from the power socket remains inoperative.

Shared peripherals such as a router should continue to operate well on the remaining charge of the first UPS as the charge in the second UPS unit is utilised.

Your personal tastes and setup may vary according to your needs and desires; but such a setup or similar should virtually negate any loss of productivity due to all but a prolonged power outage.

Quite obviously this will only provide a solution for a couple or three hours in all probability. – However around 49 out of 50 power-outages in rural areas and around 4 out of 5 outages in urban areas, in the UK at least, last only minutes. Many last literally seconds, and a few even less than that: Probably causing a voltage-spike as the supplier's equipment switches automatically to its backup circuit and calls the control centre for assistance. – The UPS protects *all of* your equipment from any voltage-spike too in this scenario.

That ends the UPS section. – Back to PSUs: -

When you're building your own computer, or replacing the PSU in an existing box, then my advice to you is to calculate the combined wattage used by all your hardware, and buy a power-supply unit that's rated around 200 watts or more greater than that figure. That way, providing you don't buy the cheapest PSU available, you should have a certain amount of wattage to spare if your computer's components require extra power at any point.

Diagnosing PSU faults

If your computer won't power up when you press the power button, the fault is probably one of three things:-

1) The power button itself is faulty.

2) The motherboard is faulty.

Or, more than likely;

3) The power supply unit (PSU) has failed.

Did you notice a burning smell last time you powered up your computer? Did you see smoke and/or flames at the back of it?

If so it's likely that your PSU has burned out.

Is the power supply's fan still working?

If not then it's most likely that your PSU has burned out.

If this is the situation with your computer, then I'll be 100% honest with you from square 1: Your computer may or may not be seriously damaged.

The PSU supplies power to each component part of your computer. Most of those component parts are very sensitive. There is a chance that a high-voltage spike from the PSU as it died has fried something critical inside your computer: The CPU, for example, or the RAM. 'Maybe even the graphics processor on the graphics card?

- So it's always a good idea, if you have definite suspicions that your power supply unit is playing up, to replace it, in order to prevent this situation from happening. Normally if you catch and replace a PSU before it fails there is a lot less chance of it damaging other components.

**I have to say it just to cover all the bases: -*

If your computer appears dead; check the following before you do anything else: -

*Is the power cable plugged into both the wall socket and the power supply?

*Is the fuse in the UK 13 amp plug (*BS1363*) (If you're in the UK.) working?

*If you're using a power strip or surge protector, is it turned on and working?

*Is the on/off switch on the rear of the power supply switched on?

*Is the 110/220 Volt switch set to the correct setting? **In** Europe **it should *always* be set to 220** volts. If it's set to 110 volts in Europe it'll destroy your PSU and probably fry most of the other circuitry too in the process. In the USA, it should be set at the 110 volt setting. This is due to the Americans using 110 volt AC mains voltage; whereas most of the rest of the world uses approximately 220 volts AC.

What to look out for

Is the CPU fan extremely dusty/dirty/manked out with dust and/or making unusual noises? If so then, whilst it's possible to remove the PSU, open it up, and clean it out + lubricate/replace the fan; I wouldn't recommend this for anyone who is not familiar with the innards of a PSU. Why? Because there are high voltages inside the PSU, even when it's switched off and disconnected after operating. These charges are stored in the capacitors inside the unit, and can, in some instances, take days to discharge. Also it's very fiddly precision work that could take up a lot of time. It's always a better idea to replace the PSU completely.

If the fan fails to turn properly the PSU can and will eventually overheat and burn out. This could be anything between the same days and possibly next year; but you can rest assured that it'll happen, and probably at the most inconvenient time.

Does your computer shut down unexpectedly at times? If so then there may be any of a number of issues affecting it. First check that the issue isn't software-oriented: A file-system error may be the cause, or possibly data corruption, even a malware issue perhaps? (*See this article* for details of how to fix file system and data corruption issues.) If it's not a software issue then quite probably the cheapest one of the hardware issues to rectify will be the PSU. Even if replacing it doesn't solve the problem, at least you know that you now have a brand new PSU installed. If it does solve the problem then it probably cost you less than replacing the RAM and/or the motherboard would have done; which would have been the next steps.

How do I replace a PSU?

Fortunately doing so is not as difficult as you may imagine: Just be sure that the unit you replace it with is as good or better quality than the unit you replaced. Some cheap and nasty power supplies are not what they seem. *See this article*. I suggest that before you replace a PSU that appears to have already burned out, you check its output first, before replacing it, as the reason that your machine appears dead my not always mean that the PSU is the faulty component part.

You can see where the PSU sits inside the case before you open it: Look on the back of the case and you'll see the electricity mains power input and the opening for the power supply fan in close proximity. Now open up the case and identify the PSU: – A metal box with coloured wires that connect to the motherboard and other components. Make a note of where each one is connected: It'll make it easier to reconnect then efficiently later, when you've replaced the PSU unit.

Ensuring that the computer is disconnected from the mains electricity, remove all the plugs on the ends of the bunches of wires that issue from the PSU from their sockets on the computer's components. Be gentle and don't force anything: if it won't budge then there's probably a clip holding it in, or it might need a bit of gentle coaxing. (It would be a good idea to connect your body to electrical earth with an antistatic earthed wrist strap before starting this entire operation; just to be on the safe side.)

The power supply is normally mounted in the case and secured with four screws on the back of the case. Remove the screws and gently urge the PSU out of the case, ensuring that any of the trailing coloured wires don't catch on anything and damage it. You might in some cases find that the PSU's removal is obstructed by (an)other component(s). if this is the case it may be necessary to remove those components also. Don't freak here: if you don't feel able to continue you'll have to ask a geek for help. Don't lose the screws; put them somewhere safe. (I have screws lurking in every corner of the room where I neglect to keep them safe at times.) Having got the old unit out, discard it. Recycle it if at all possible. (ROHS)

Most PSUs these days are ATX type. If you have an old AT type PSU fitted to your computer then I suggest that you simply bin the computer and get a new one due to its age, or you give or sell it to a museum if you can. (Remember to delete the data on the hard-drive first.)

You'll need to buy a replacement PSU with identical or higher ratings than the old one. Higher ratings would be a good idea in case of future expansion.

(Adding more components.) I suggest ordering online, as shops and department stores may add extra cost simply to help keep their plush showrooms running.

Installing the New PSU

Insert the new unit into the space from which the old unit came and screw it into place using the four screws you took from the old unit's mountings. You'll normally need a Phillips screwdriver to do this; just as you would have required removing them in the first place.

Next; find the ATX (P1) power connector and firmly plug it into the motherboard's ATX receptacle.

Plug the SATA or Molex power connectors into the hard drive, cdrom drive, and all other components, as appropriate, (See your notes that I advised you to take previously.) that were previously connected to the power supply's outputs.

If a component has *both* a SATA and a Molex power connector, *only connect one or the other*. Connecting both will destroy the component and probably your new PSU also when you power up.

Make sure that there are no unused power connectors hanging around in the case where they could be touching a fan or anything metal. Use twist-wires or cable-ties to secure any such connectors securely to the case without allowing them to electrically connect with the case. *See this article*.

Replace the case panel and reconnect the monitor, keyboard, mouse, speakers, etc.

Check the On/Off and 110/220 switches (if present) on the back of the power supply to make sure they are in the correct position – Remember: 220 volts in Europe; 110 if in the USA or anywhere else where the mains input voltage is 110 volts. *If in doubt; start with the switch set at 220 volts and if it doesn't work, try 110 volts. – *unless you're in Europe*, in which case something somewhere's not connected if it doesn't work. ****I repeat: DO NOT attempt to set the switch to 110*** *volts* ***in*** *Europe.* – Otherwise you will hear a bang and your computer will be toast.

Insert the power cable's "kettle plug" into the socket on the back of the power supply, plug the other end into your wall socket or power strip, and power up as normal. Everything should work properly and your PSU is no longer dodgy.

Testing A PSU

A voltmeter seems a good place to start. – And where's a good place to find one of those? On a multitester or multimeter, no doubt.

OK so I have the (ATX) power-supply that I want to test on my test-bench in front of me, all wired up to the mains power and switched on. – But there's absolutely no response – or possibly only the 5V rail is powered on. Why?

On an ATX power supply there's a wire which goes to the motherboard which allows certain pieces of hardware, including the "Power on" button on the front of the case to bring the power-supply out of standby. Some PSUs go to +5V standby, where only the 5V rail remains powered up, others switch everything off. (Some of the much older PSUs would go to +12V standby; but not any recent models built within the last 5 years.)

That wire is the green wire on the P1 connector. (The 20 / 24-pin connector that plugs in to the motherboard.) To fire up the PSU it needs to be grounded. Fortunately the wire either side of it is a ground wire; so all you need to do is short out either way on the connector, (Short green and black.) using a short piece of wire or a paper-clip or something, and voila: Power-up has been achieved.

If it doesn't happen; connect a DC voltmeter across green and black: Positive to green and negative to black. You should read 5V. If you don't get a reading, or you read anything less than 2V, the PSU is faulty. Bin it.

*Power supplies can be fixed. I fixed one myself by cannibalising spare parts from 2 identical dead units. The drawbacks are:

1) Its dangerous unless you're trained and experienced: There are extremely high voltages present in the circuitry when the power's on.

2) You need to know what you're doing; which can take up to 4 years training to achieve.

3) Its very time-consuming: Even if you know what you're doing; it can take hours to trace and diagnose multiple faults and repair them.

It's easier and usually more cost-effective to bin the faulty unit and buy a new one.

Now, having powered up; check the voltages of all the connectors.

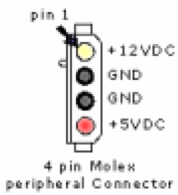
The pinouts are as follows: -

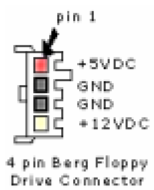
24-pin ATX12V 2.x power supply connector
(20-pin omits the last 4: 11, 12, 23 and 24)

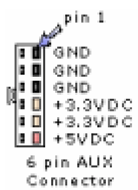
Color	Signal	Pin	Pin	Signal	Color
Orange	+3.3 V	1	13	+3.3V	Orange
				+3.3 V sense	Brown
Orange	+3.3 V	2	14	−12 V	Blue
Black	Ground	3	15	Ground	Black
Red	+5 V	4	16	Power on	Green
Black	Ground	5	17	Ground	Black
Red	+5 V	6	18	Ground	Black
Black	Ground	7	19	Ground	Black
Grey	Power good	8	20	−5 V (*optional*)	White
Purple	+5 V standby	9	21	+5 V	Red
Yellow	+12 V	10	22	+5 V	Red
Yellow	+12 V	11	23	+5 V	Red
Orange	+3.3 V	12	24	Ground	Black

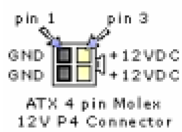
(Image above from Wikipedia.org)

4-pin Peripheral **4-pin Berg** **6-PIN AUX** **ATX 4-pin Molex 12V P4:**









Pin	Signal	PSU Color Wire
1	+3.3VDC	orange
2	+3.3VDC	orange
3	+3.3VDC	orange
4	GND	black
5	GND	black
6	GND	black
7	+5VDC	red
8	+5VDC	red
9	+5VDC	red
10	GND	black
11	GND	black
12	GND	black
13	+12VDC	yellow
14	+12VDC	yellow
15	+12VDC	yellow

<<<Serial ATA

The above procedure doesn't test the PSU under load. Below I'll show you a way of testing the PSU's voltages under full load; including a circuit that'll fully load any PSU up to 350W: -

Giving it Load

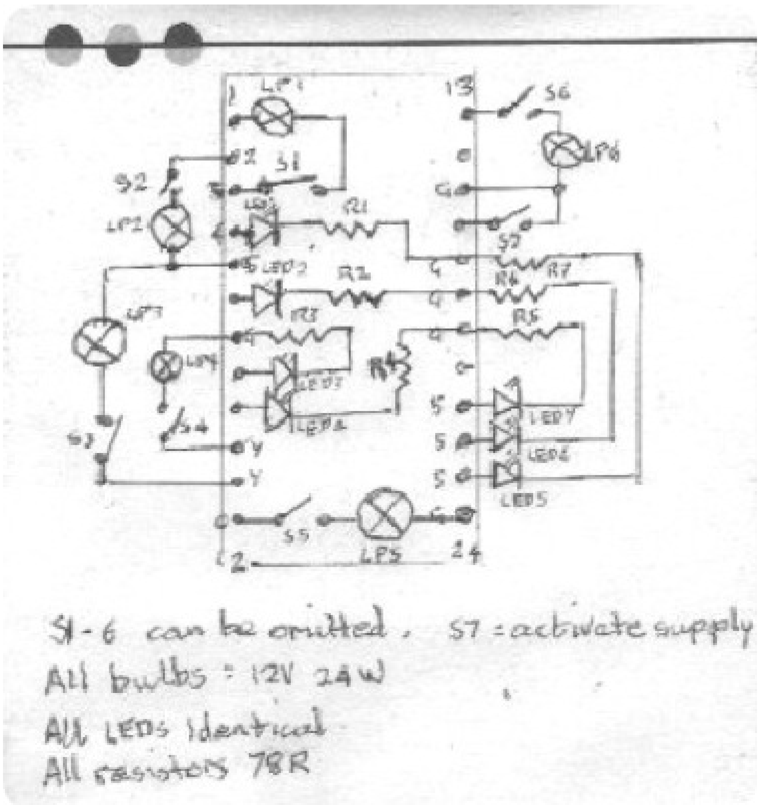
Above we looked at measuring the voltages while the PSU had no load attached to it. In this article we're going to give it a number of loads to run. We'll put a total load of around 364 Watts on the unit. If the unit is rated below that figure then it'll be fully loaded. If the unit is rated above that figure then it'll still be fairly heavily loaded.

We'll load the unit using five small circuits which I've set out in circuit-diagrammatical form below. The smaller circuit, consisting of a bulb, a resistor, and a light-emitting diode, needs to be built four times, the larger one, consisting of six bulbs, seven light-emitting diodes, and seven resistors, only once.

Why bulbs, resistors, and LEDs? The resistors are in series with the LEDs to prevent them from overloading. The LEDs are to indicate that the 5V lines are all working; also that the PSU is lighting the Power OK LED as it should. We're not loading the 5V lines much because it's ideally the 3V3 and the 12V lines that we need to test under load; because they're the ones through which the main wattage is drawn from a modern PSU by modern computers.

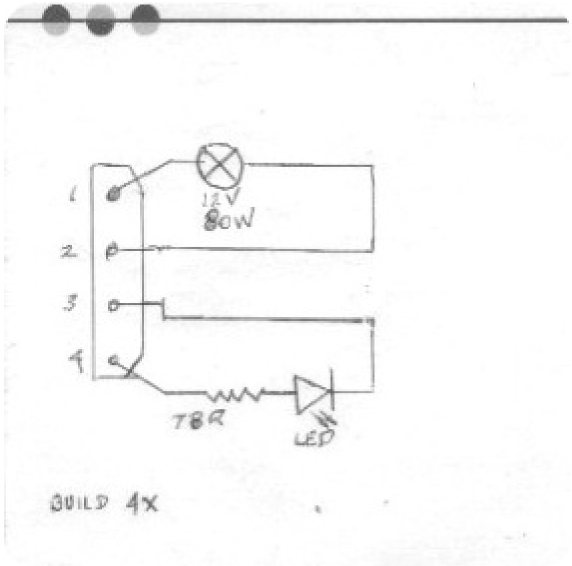
Which leaves the bulbs: It's the bulbs that provide the heavy loading. Incandescent tungsten-filament bulbs are notorious these days for using too much wattage and producing too little light and too much heat. Were intending to use those negative properties of them to "waste" the PSUs output. Well be buying products from the automotive industry too, which might help it on its way to recovery; as the bulbs we're using are car headlamp and tail light bulbs. They are made to work on a voltage of 12 Volts; which means they could be bright and very hot when in operation. – Especially so with the 80 Watt bulbs in the 4 small circuits that test the 12V lines. When you are building the circuits please bear this in mind, as it is possible that looking directly at them for more than a second could result in at least temporary blindness. Also touching them during or shortly after operation could result in severe burns, and if they come into contact with flammable objects or materials they could start a fire. Be warned, and design appropriate safety parameters into the housing for the bulbs when you design the test units built from the circuit-diagrams provided.

Ok so let's take a look at the first circuit diagram: -



This circuit is built around the P1 motherboard connector socket. The pin-out numbers used correspond to the P1 plug and not the socket, so please bear that in mind. 4 of the 24-Watt car-bulbs load the 4 x 3V3 lines to almost 7.273 Amps each, total almost 29.1 Amps; that's 96 Watts at 3V3. – The same as the average power-drain from a processor. (These particular bulbs aren't expected to get particularly bright; but nevertheless could get rather hot, so beware.) The other 2 bulbs provide load of 2 Amps on each of the 12V lines: Total 48 watts. (These two bulbs **WILL** get both bright and hot. Bear this in mind when designing the circuit layout and component housing.)

The next circuit is fairly simple, and is built around a 4-pin Molex socket. You will need to build four identical of these circuits. Please do bear in mind that the 80 Watt bulb is burning 6 and 2/3rds of an amp: That's a lot of current, a fair amount of power, and a lot of energy. Energy doesn't vanish. – Rather it radiates and it changes form> – In this case into heat and light. The bulb will be bright and **very hot**. (You might even be able to light a cigarette from it given time?) Be careful to protect eyes from it, and beware of the fire risk posed.



Note once again that the pin-out numbers correspond to the peripheral power "Molex" plug and not the socket.

These four bulbs; one on each circuit, will load the 12V lines to another 320 Watts in total; making a grand total of 320 + 96 + 48 Watts load = 364 watts; plus a couple of Watts loading by the LEDs with their series resistors.

What should happen?

When you build and connect the circuits to a known-working PSU; the following should happen:

All the LEDs should light up. If they do it shows that all the 5-volt lines are working and that the PSU is in better health than not. The 80W bulbs will produce a lot of light and heat. All but 2 of the 24W bulbs will be rather dim; but could still get quite hot.

What do these circuits accomplish?

They put a reasonable load on the PSU, so that you can test its performance under near-normal working-conditions.

You could check the output voltages again under load to see if there is any significant voltage-drop under such conditions.

Another thing to bear in mind: -

It is well documented that when some of the cheap and nasty PSUs are fully loaded to specification they can fail or even explode. Therefore if you happen to be testing out £10 worth of cheapo Chinese unknown-label 250 Watt PSU for example; ***expect*** it to explode under the full-load that these circuits will give it. If it doesn't, and it still works afterwards, then you were lucky. A good-quality 250 Watt PSU will strain and maybe complain in some way, but will easily survive a minute or so of full load.

Yes the above is a bit Heath-Robinson I admit. – But if you're on a budget you really don't want to shell out for the proper professional test-loads that can cost anything up to a small fortune. This is the scrub-round-it approach to the matter. – And it works; so why knock it? (Just keep an eye on; or should I say keep an eye off, those hot bright bulbs.)

Now that we've loaded it we can do the same measurements that we did in Part 1. The two readings will be slightly different. The difference corresponds to the voltage-drop under load. This amount will depend upon the power-rating of the PSU as well as the quality of the unit.

Ideally the voltage-drop should be less than 5% of the voltage-rating of that rail. If it's any more then the unit is either wearing out or wasn't particularly good quality to begin with. If it's over 10% then replace the unit.

I think that just about wraps up this report. I do hope you've found it informative and that it's solved some issues for you.

If you'd like to see more articles with a similar technological flavour, don't forget to visit my blog; "Beyond", at http://kkomp.com.