Free Geek PSU testing guide

This guide describes how to safely triage and test an internal desktop computer power supply unit, called a *PSU* for short.

1. Safety information

⚠ Warning

Risk of electric shock and death. Handle all PSUs with extreme care. If mishandled or operated improperly, a PSU can deliver fatal amounts of electricity to you and other people in your vicinity.

The PSU is the most hazardous component inside a desktop computer. It provides a total of hundreds of watts of power (in some models over 1,000 W) across the onboard components. A damaged or faulty PSU can deliver enough energy to ignite the components, and over-delivery of current is often the cause of blown or fried parts (the resulting fumes are informally called the “magic smoke”).

★ Important

Always abide by these safety rules when testing, disassembling, or otherwise handling PSUs:

1. Always treat a PSU as a live electrical component, even when unplugged, and practice commonsense electrical safety — turn it off and unplug it when not in use, and keep it away from liquids, heat, and metal surfaces.
2. Do not disassemble or attempt to repair a plugged-in PSU.
3. Never touch the uninsulated (bare) copper wires while the PSU is powered.
4. Do put any part of the PSU in contact with ungrounded metal.
5. Do not touch any part of a PSU and separate ungrounded metal at the same time.
6. In case of electric shock to you or others, notify the Volunteer Coordinator, Build Coordinator, or Safety Officer immediately.

Violation of any of rules will result in a reprimand, and the Build Coordinator may elect to revoke your testing privileges.

1.1 Personal protective equipment (PPE)

Requirement	PPE
Mandatory	Work gloves (latex-coated or other insulation)
As needed	Dust mask

2. Station activities and volunteer track

The PSU testing station comprises two activities:

1. PSU Evaluation
2. PSU Testing

Overall difficulty rating: 3/5

PSU testing is a component task of:

- Evaluation
- Desktop Build
- Laptop Build
- Small Device Repair

Through PSU testing, you will develop the following skills:

- Electrical safety basics
- Simple electrical device testing

While Free Geek makes strides to accommodate all abilities, some stations and tasks require certain abilities and capabilities. PSU testing requires:

- The ability to lift 20 lbs
- The ability to use a screwdriver (power or unpowered)
- The ability to firmly insert plugs with locking latches into components (roughly 25 pounds of force)
- The ability to squeeze open locking latches on plugs (roughly 15 lbs of force)
- The ability to distinguish green or yellow LED indicators 3 mm in diameter
- The ability to read a monochrome segmented LED display

If you have difficulty with any of the preceding actions, speak to the Build Coordinator, and we will explore options to accommodate your abilities for this station.

3. About PSUs

A PSU is like the heart of a computer. It provides the lifeblood of the system – electrical power – which makes all the components function. A PSU in poor condition (or health) can result in intermittent failure and data loss. A broken PSU can result in a spectrum of problems, ranging from no operation to the destruction of the computer.

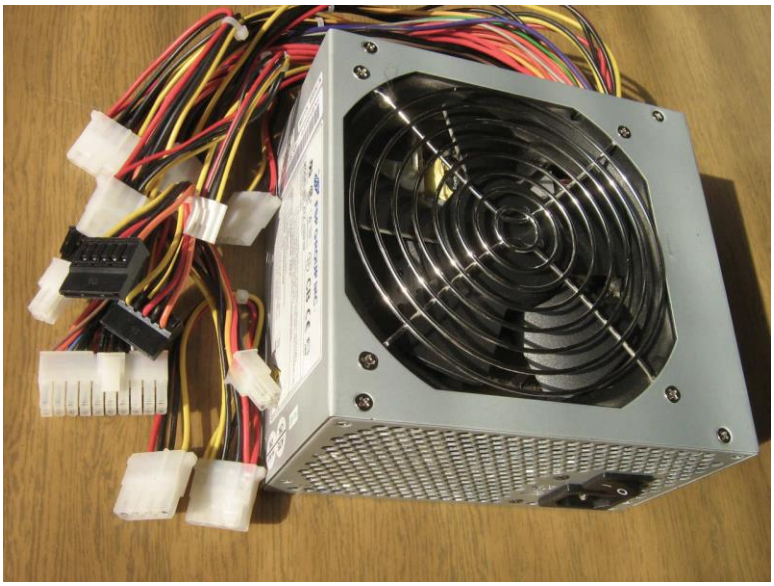
Computers need energy (electricity) to provide useful work (computation). We often characterize computers as *digital computers*, meaning they operate with pure 0s and 1s, but in a physical sense, this is just an abstraction: the fundamental unit of computation in a modern digital computer is an *electrical charge* representing 0 or 1. In the most reductive terms, computers take constant electrical power as input, break it into infinitesimal bits billions of times every second, and then compare, combine, and shift those bits around.

3.1 Types of PSUs

Historically, there have been several PSU design standards, however the most common and only relevant one remaining is the *ATX* standard. All ATX PSUs share the same width, height, and mount points, and comply with connector interfaces dictated by the ATX standard.

There are three main configurations of ATX PSUs:

- **Non-modular**, which has permanently affixed output cables. The cables typically provide a variety of connector types at all of the rail voltages, but the user must contend with the selection provided by the manufacturer.

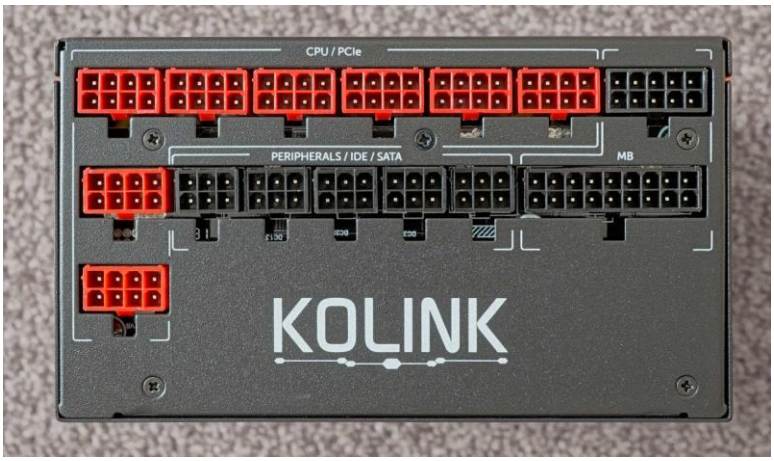


A non-modular PSU with all cables permanently fixed.

- **Semi-modular**, which has at least one permanently affixed output cable (typically terminating with the +12 V motherboard and CPU plugs), rounded out with modular cable sockets. The user can opt to occupy these sockets with as many *modular cables* as they need for their system.

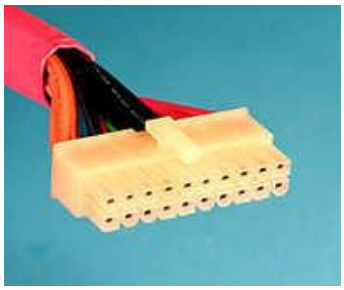
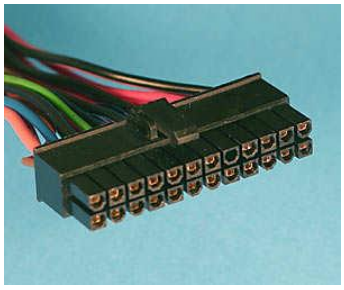
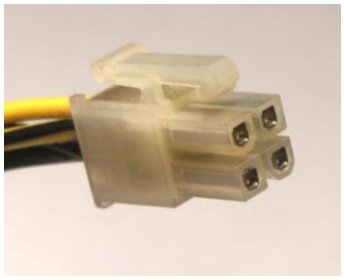
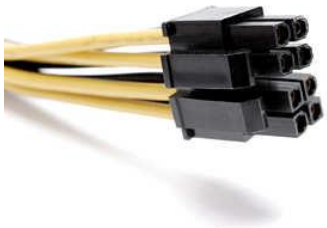
A semi-modular PSU with permanently fixed motherboard and CPU cables.

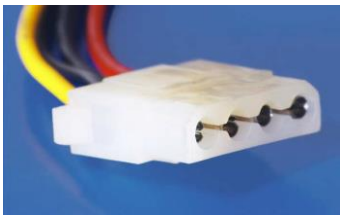
- **Fully-modular**, which provides connectivity entirely through modular cable sockets.



The sockets of a fully-modular PSU.

3.2 PSU connectors

Plug	Socket labels	Voltage	Example
20-pin motherboard[1,2]	ATX ATX_POWER_20P EATX_PWR	+12 V	
24-pin motherboard[1,3]	ATX PWR1 ATX_POWER_24P EATX_PWR	+12 V	
4-pin CPU[4]	ATX12V PWR2 ATX_POWER_4P	+12 V	
8-pin CPU[4]	ATX12V ATX_POWER_8P EATX_12V	+12 V	

Plug	Socket labels	Voltage	Example
6- or 8-pin PCI-E	-	+12 V	
15-pin SATA	-	+5 V with +12 V	
4-pin IDE (“Molex”)	-	+5 V +5 V with +12 V	

[1] A PSU can only provide enough power for a single motherboard connector.

[2] A 20-pin motherboard plug can be connected to a 24-pin motherboard socket. The remaining four pins in the socket can safely remain unoccupied.

[3] Some 24-pin motherboard plugs have detachable 4-pin blocks for the four additional +12 V wires. The blocks are optional, and aren’t necessary for normal operation.

[4] A PSU can only provide enough power for up to two CPU connectors.

4. Activity 1: PSU Evaluation

Activity parameters	
Prerequisite stations and activities	Large Dismantle Small Device Testing
Is a prerequisite for	PSU Testing
Required shifts before assessment	3
Evaluators	Build Coordinator Volunteer Coordinator

Workstation	
Work areas	Build workbench 5 Evaluation Large Dismantle Wire Sorting
Input bins	**#3 PSUs** at Large Dismantle **#2 PSUs** at Evaluation **#12 PSU cables** at Build workbench 3
Output bins	**#7 Eval'd PSUs** at Build workbench 7 **#12 PSU cables** at Build workbench 3 **#3 PSUs** at Small Repair workbench 2

4.1 Tools and equipment

- Pen
- Permanent marker
- Rubber bands

- Yellow dot stickers
- 1.5” white labels
- PSU voltage tester
- Electric duster
- Standard C19 power cable
- (As needed) Modular cables

4.2 Pass and failure indicators

Result	Indicator
Pass	Yellow dot sticker on PSU label
Needs repair	White label with written symptom affixed to PSU enclosure
Fail	Large, conspicuous X in permanent marker on PSU label

4.3 Step 1: Sort incoming PSUs

Location: Large Dismantle (workbench 2 recommended)

At Large Dismantle and Evaluation, volunteers remove PSUs from desktop computers and place them into the bins (marked **PSUs**). The Warehouse Coordinator and Recycling Coordinator make sweeps and empty the bins at the start of each shift, but throughout your shift there can be an influx of PSUs that need sorting.

1. Remove all incoming PSUs from the bins marked *PSUs*.
2. Mark the PSU as failed if it meets any of the following criteria:

Reason for failure	Criteria
Damage	One or more permanent power cables are cut or show exposed copper.

Reason for failure	Criteria
Non-ATX PSU	PSU enclosure doesn't fit ATX dimensions. Lacking 20- or 24-pin motherboard power plug.
Cleanliness	The PSU has major spill damage, shows obvious signs of being in the presence of tobacco smoke, or is repulsively dirty.
Biohazard	Live or dead insects present inside enclosure.
Old or low power	Main output rating lower than 400 W. This figure is typically indicated as **Total Power**, **Combined Power**, **Max Combined Wattage**, or some variation thereof.

3. If the PSU fails, remove any modular cables connected to it, then bundle them together with a rubber band.
4. After all PSUs are inspected, place all the failed PSUs into a spare bin, and bring the bin to Wire Sorting.
5. Gently place the failed PSUs in the main wire sorting bin. Do not throw the PSUs or swing them by their cables.
6. Bring the empty bin back to the workbench, and use it to transfer the remaining PSUs and any salvaged modular cables to Build workbench 7.
7. Place all the salvaged modular cables into bin **#7 PSU cables** under Build workbench 3.

The remaining PSUs are ready for *4.4 Step 2: Triage the PSUs*.

4.4 Step 2: Triage the PSUs

Location: Build workbench 7

In the second half of this activity, perform a simple power-on test followed by a voltage test of all rails and plugs.

First, perform a power-on test. This verifies whether the unit supplies standby power without issue.

8. Remove any obstructions or nearby loose objects from the bench.
9. Place the PSU on the workbench.
10. Set the power switch to the **Off** position. If the PSU has an input voltage switch, make sure it's set to **115**.
11. If the PSU is modular and is missing cables, retrieve fitting cables from bin **#7 PSU cables** under Build workbench 3 and connect them to all ports.
12. Connect the PSU to AC mains power with a standard (C19) power cable.
13. Flip the power switch **On**. The PSU should enter standby mode.
14. Inspect the unit for any of the following faults:
    - Visible sparks from inside the enclosure
    - Sounds of arcing electricity
    - Constant high-pitch whine or low-pitch (60 Hz AC) buzzing
15. If any of the above faults occur:
    a. Mark the PSU for repair. Make sure to describe all symptoms on the white label.
    b. Flip the power switch **Off** and disconnect the power cable.

Next, provide a low-current voltage test of the PSU. This ensures that there is basic throughput and connectivity from all its output rails.

1. Test the motherboard and CPU power output:
    a. Prepare the motherboard and CPU power plugs:
        - If the PSU is fully modular, connect the 20- or 24-pin modular motherboard cable and the 4- or 8-pin CPU plugs.
        - If the PSU is semi-modular or non-modular, locate the 20- or 24-pin motherboard plug and the 4-pin or 8-pin CPU plug.
    b. Connect the motherboard plug into the corresponding socket on the voltage tester. The voltage tester simulates a motherboard, so the PSU should turn on fully.

> **Note**
> The cooling fan might start spinning, but that isn't essential to the correct functioning of the PSU at low power output.

2. Check for any of the following fault indicators:

- One or more motherboard indicator LEDs on the voltage tester are dim, pulsing or strobing, or extinguish after a short period.
- The voltage tester emits a continuous high-pitch tone.
- There's no activity, even after toggling the power switch **Off** then back **On**.

3. If any of the above indicators occur:
    a. Mark the PSU for repair. Make sure to describe all symptoms on the white label.
    b. Flip the power switch **Off** and disconnect the power cable.
4. Connect the CPU plug into the corresponding socket on the voltage tester. If the CPU +12 V indicator LED on the voltage tester is dim, pulsing or strobing, or dark, mark the PSU for repair.
5. Test the remaining fixed cables and modular sockets:
    - Fixed cables: Test all plugs on all cables, one after the other. Skip any legacy plugs not listed in *3.2 PSU connectors*.
    - Modular sockets: Retrieve a cable with the 15-pin SATA plug, and test for +5 V and +12 V in each modular output.
6. If any of the plugs or modular sockets fail to keep the corresponding status LEDs on the tester lit, or cause the tester to emit a warning tone, mark the PSU for repair.
7. If all cables or modular sockets pass, place a yellow dot sticker on the PSU label to mark it as passed.
8. After you complete testing, flip the power switch **Off** and disconnect the power cable.

To clean up, place the PSUs that passed, failed, and need repairs into their corresponding bins, then park the bins at their home workbenches.

5. Activity 2: PSU Testing

Activity parameters	
Prerequisite stations and activities	PSU Evaluation
Is a prerequisite for	Small Device Repair Desktop Build Desktop Evaluation
Required shifts before assessment	3
Evaluators	Build Coordinator

Workstation	
Work areas	Build workbench 5
Input bins	**#7 Eval'd PSUs** at Build workbench 5 **#12 PSU cables** at Build workbench 3
Output bins	**#8 Tested PSUs** at Build workbench 7 **#3 PSUs** at Small Repair workbench 2

5.1 Tools and equipment

- Zeus test computer
- Pen
- Blue and green dot stickers
- 1.5" white labels
- Watt meter
- PSU test system
- Electric duster

- (As needed) Modular cables

5.2 Pass and failure indicators

Result	Indicator
Pass primary test	Green dot sticker on PSU label
Pass stress test	Blue dot sticker on PSU label
Needs repair	White label with written symptom affixed to PSU enclosure

5.3 Step 1: Clean the PSU

Location: Cleaning zone

Before you can perform a full test of the PSU, you must blow all the dust out of it.

1. Put on a dust mask.
2. Transfer the PSU and the electric duster to the cleaning zone.
3. With the head of the duster held 0.5” from the surface of the enclosure, swirl and swipe the head across the intake and exhaust of the PSU, for 30 s each or until you’re satisfied that there’s no more dust.

5.4 Step 2: Perform the primary test

Location: Build workbench 7

Next, test the PSU in the Zeus test computer. Zeus is a skeleton system with essential parts, and draws a high amount of power with its workstation CPU and GPU. The primary test assesses whether the PSU can pass POST and boot into Ubuntu.

1. Flip the power switch on the PSU **Off**.
2. Connect the following plugs into the system, in order:

Connector	Component
20- or 24-pin motherboard	Motherboard
4- or 8-pin CPU	Motherboard
2 x 6-pin PCI-E	GPU
15-pin SATA	SSD

> **Note**
> As in *4. Activity 1: PSU evaluation*, if the PSU is semi or fully modular, you must source compatible cables from bin **#12 Modular cables**.

3. Flip the power switch on the PSU **On**.
4. Turn on Zeus's monitor and make sure the keyboard and mouse are plugged in.
5. Press Zeus's power button to turn it on.
6. If the PSU fails to POST and boot to the Ubuntu desktop, flip the power switch on the PSU **Off**, disconnect all PSU plugs from the components, disconnect all modular cables from the PSU, disconnect the power cable, and mark the PSU for repair.
7. After the PSU boots into Ubuntu, let it idle for 30 seconds.
    - If Zeus is still stable after 30 seconds, power down the system and affix a green dot sticker on the PSU label.
    - If not, mark the PSU for repair.
8. If you're only performing basic tests on your shift and won't proceed with *5.5 Step 3: Perform the stress test*:
    a. Power down Zeus, flip the power switch on the PSU **Off**, disconnect all PSU plugs from the components, disconnect all modular cables from the PSU, and disconnect the power cable.
    b. Place the PSU into the appropriate bin.

To clean up, park the input and output bins at their home workbenches, and return all tools to their storage bins.

5.5 Step 3: Perform the stress test

Location: Build workbench 7

Lastly, perform a stress test to assess whether the PSU can sustain a high power draw and is thus suitable for reuse.

1. With the Zeus system still running, launch the Uniengine Heaven utility (double-click the **Heaven** shortcut on the desktop). The on-screen status bar shows time elapsed.
2. Let the test run for 15 minutes.
    - If the system is still stable after 15 minutes, affix a blue dot sticker on the PSU label, next to the green and yellow stickers.
    - If not, mark the PSU for repair.
3. Flip the power switch on the PSU **Off**, disconnect all PSU plugs from the components, disconnect all modular cables from the PSU, disconnect the power cable.

To clean up, park the input and output bins at their home workbenches, and return all tools to their storage bins.