



How to Choose a Benchtop Power Supply

What to look for in a benchtop power supply

Introduction

When deciding which **bench power supply** you need, it's easy to be overwhelmed by the many options available.

When selecting a general-purpose bench power supply, you should consider multiple factors and understand the important features.

For a basic power supply, you can select one based on your voltage and current requirements. For specialized requirements with source and measurement features, selecting from a set of power supplies to meet your needs is straightforward. Identifying the application you need helps you narrow down your options.

Bench power supplies come in a variety of configurations and fall into three main groups:

- single and multichannel
- bipolar and unipolar
- linear and switching

A **single-channel power supply** has one controllable output and is less flexible and more affordable. A multichannel power supply has two or more controllable outputs.

A **unipolar power supply** generates only positive voltage. To generate negative voltage, you must manually switch the terminals connected to the electricity source. However, bipolar power supplies work in both energy environments and on a wider range of applications, including developing magnetic materials for vehicle motors and testing bidirectional inverters and laser diodes.

A **linear power supply** often employs a large transformer to convert voltage from an alternating current (AC) line to a considerably lower AC voltage, which it then rectifies and filters to generate a clean direct current (DC) voltage.

Understand Bench Power Supplies

A bench power supply converts AC to DC for lab bench test equipment and provides controlled voltage for protecting circuits under test. Compared with consumer power supply systems, a bench power supply enables tighter regulation of current and voltage levels, shielding circuits under test, and multiple concurrent connections to circuits and portions of circuits.

Engineers frequently use benchtop DC power supplies to design, test, and debug electronic devices. The key specifications for a bench power supply are the number of channels and the maximum output voltage, current, and power.

The two basic modes of bench power supply operation are constant current and constant voltage.

In constant voltage mode, the DC output voltage of the power supply remains constant unless the output current or output power reaches the current or power limit settings. This process spares the circuitry from harm if anything goes wrong.

This white paper discusses some fundamental considerations for specifying and choosing a **bench power supply**.



Bench Power Supply Selection Criteria

When selecting a bench power supply, consider the following criteria:

- output and power requirements
- performance characteristics
- protection features and packaging density
- programmability
- total cost of ownership

Output and power requirements

Different types of power supplies can have different power envelopes. Consider these questions about the device under test (DUT):

- How much power do you need?
- Will the DUT require maximum power at a specific point?
- Does the maximum power require various voltage and current configurations?
- What is the power range you want to provide in your applications?

Multiple outputs are vital when testing multiple devices simultaneously. When choosing a multiple-output power supply, consider whether the outputs require isolation from each other and the supply's tracking capabilities. A single output is often enough, but multiple-output supplies offer significant advantages.

Another point to consider is the type of load you need to power resistive, inductive, or capacitive. The behavior of the load can affect the voltage programming response time. Also, consider a higher-power model for future expansion.

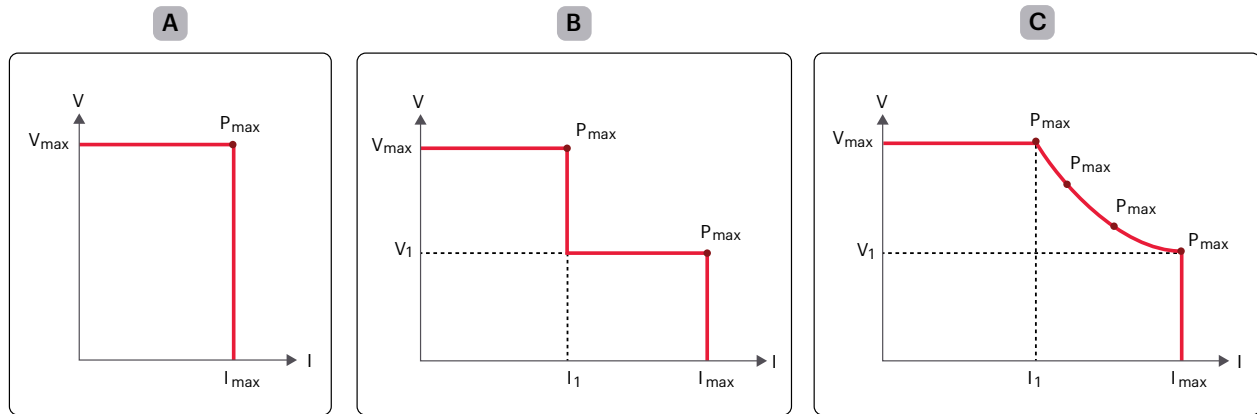


Figure 1. Power supply output characteristics (left to right): single range, dual range, auto-range

Figure 1 shows three common power supply output architectures: single range, dual range, and auto-range.

A **single-range power supply** is the most straightforward architecture because maximum output power occurs at only one setting — maximum voltage and current. If you plot the maximum voltage and current, the results form a rectangle on a V-I graph. All valid voltage and current combinations reside within the rectangle.

A **dual-range power supply** increases the number of voltage and current combinations for the same maximum power. This combination offers a high and a low voltage range, with the low range supplying more current.

An **auto-ranging power supply** provides more current at higher voltages, resulting in more usable power. For example, the DUT draws constant power under variable input conditions such as DC motor drives and regulated DC-to-DC supplies. In such circumstances, the auto-ranging power supply source provides more current at the reduced output voltage. An auto-ranging power supply increases testing flexibility and enables you to use only one power supply to create voltage and current combinations.

Performance characteristics

Power supply specifications vary depending on the application. There are two types of specifications: guaranteed and typical.

A manufacturer determines a guaranteed or warranted specification through a complete product test analysis. The manufacturer is accountable for any uncertainty that can affect the performance of its products.

A typical specification is the average or standard value of the product's capability. The test results are from the predetermined set of measurements taken from several product units.

Understanding key characteristics such as load, and line regulation is crucial when selecting a bench power supply.

Load regulation determines whether the output channel can remain constant during changes in the load. As the impedance of the DUT changes, the regulated parameter should not change significantly.

Line regulation is a measure of the power supply's ability to maintain its output voltage or output current. In contrast, the AC line input voltage and frequency vary over the complete allowable range. Line voltage and frequency affect the available power to feed the output, especially when drawing maximum current from the supply.

Readback accuracy determines how close the internally measured values are to the theoretical value of the output voltage after applying the setting accuracy: $\pm$ (% of measured value + offset).

Setting resolution represents the smallest change in voltage or current settings selected on the power supply. The resolution specification, defined by a combination of user interface digits available and the number of bits in the digital-to-analog converter, limits the number of settable discrete levels.

Response time is the amount of time it takes for the output voltage to return to the programmed state after a disruptive change in load current. Response time is critical if you are running tests with rapidly changing voltages or loads. The transient recovery time is the time it takes for the output voltage to return to the programmed state after a disruptive change in load current.

Sense connections are the local and remote sense capabilities of the power supply. Ripple refers to periodic variations in voltage, and noise refers to random variations in voltage.

Protection features

Safety always comes first. A power supply safety feature and DUT protection are essential in the event of a failure to avoid damaging the DUT. Protection circuits can limit the voltage or current flow in the circuit, and they will shut down the power supply when overvoltage or overcurrent occurs.

Extra care is necessary when working with devices that use higher power, are reactive, or store energy. These devices are notorious for damaging themselves and the surrounding equipment. Fortunately, modern bench power supplies can protect against this damage.

When working with high power, choose a bench power supply that can protect the DUT when the voltage or current level exceeds a certain safety threshold. When the output exceeds a safe level, the power supply must be able to recognize the event and properly disable the output. Overvoltage and overcurrent protection are two common features that can do this.

Overvoltage protects the DUT when the power supply exceeds the preset voltage limit. You can determine this preset voltage and program it on the front panel. When the power supply's output exceeds the preset voltage limit, the output will disable, and an overvoltage indicator will appear. Most power supplies ship from the factory with overvoltage protection enabled. Set and turn on overvoltage protection as a safety feature in your test setup.

Power supplies also have an overcurrent protection feature that works similarly. Instead of monitoring voltage, overcurrent protection monitors the current that flows out of a power supply and disables the output if the current exceeds a preset threshold. It does this in a slightly different way than that of overvoltage protection.

The preset overcurrent protection limit is the current limit setting itself. Once the current flowing through a power supply reaches the limit, it enters a constant current operating mode. The voltage usually goes down in constant current mode, and the current remains at the current limit setting. If overcurrent protection is enabled, it will shut down the output to prevent too much current from flowing out. Typically, overcurrent protection is off by default, and it is in that state when shipped from the factory. When necessary, use the overcurrent protection feature to safeguard your setup.

Consider a programmable power supply

Many devices require multiple bias or rail voltages. Devices such as microprocessors, field programmable gate arrays, and complex circuits require the voltages to turn on and off in a set sequence. If you are working with devices that have specific timing requirements, you must use a power supply with power sequencing. Power supply sequencing enables you to automatically set voltage outputs and delays according to a scripted pattern of your choosing. This means you do not have to manually turn on channels or set output voltages — helping you avoid accidental damage. Not only is power-up bias sequencing important, but power-down sequencing can help ensure proper DUT shutdown.

Manually changing voltage values and current limit settings for long and complex tests such as chamber / reliability tests can cause load or voltage changes. For example, product reliability testing uses temperature chambers. This type of testing involves heating the chipsets at a range of temperatures for up to 1,000 hours. The reliability test lab has about nine temperature chambers. The test uses various power output configurations, with test engineers manually logging data every two hours. They must adjust the voltage manually at every temperature change that causes load or voltage changes.

Most modern bench power supplies have a built-in output sequencing function that enables programmability. Using the test sequence feature, you can program voltage values, current limit values, and time per step. Using the bench power supply programmable with the test sequences feature enables precise control over power-up and power-down sequences and reduces test setup complexity.

Packaging density

How much space do you have for your bench power supply? Power supplies come in many sizes and weights. Each one offers significant advantages based on the intended application. The advantages of a linear power supply include the following:

- low output noise
- fast transient response
- high-programming speed

A linear power supply has some disadvantages, one of which is that a higher level of low-frequency magnetic radiation causes flicker in cathode ray tubes. Other disadvantages include the following:

- low efficiency
- more required cooling
- larger size

Power supplies that are compact, are lightweight, and have smaller footprints are preferable, especially if they come without the typical trade-offs of higher output noise and slower transient response.

Total cost of ownership

After assessing the required features and capabilities, price is the next factor to consider. However, the purchase price is just one part of the cost. The total cost of ownership includes the following:

- Production downtime for calibration and repair if the power supply fails.
- Cost of repairs and services (in-house versus by manufacturer).
- DUT and test instrument protection.
- Size and weight for freight and lab footprint.
- Training costs for new operators.
- Integration costs based on control interfaces and automation needs.

Seamless integration of the power supply into your application is another important factor. Look for a manufacturer that can provide maintenance and dedicated support during setup and daily product use.

Conclusion

A bench power supply must deliver stable, clean, and precise DC power output. Ensure that it is affordable, easy to use, and will not damage your DUT. A compact footprint gives you more room to work on your benchtop. In the event of a failure, you want a reliable, efficient, and committed service and support team to get the power supply up and running as soon as possible.

Not all bench power supplies are the same; consider your key requirements when purchasing new equipment.

Keysight has more than 150 power supplies, each with its own advantages to meet your requirements.

Learn more about [DC power supplies](#) and [bench power supplies](#).