



Introduction to Programmable Power Supplies



A programmable power supply has one feature that sets it apart: it allows remote control of its operation through an analog input or digital interface.

Why use a programmable power supply? In an automated manufacturing environment, a programmable power supply allows digital or analog control for maximum versatility. If a digital interface is selected, the control system can control and monitor the power supply output voltage and current from anywhere there is a network connection. Plant-wide automation parameters can be monitored by one central computer, and process variables can be adjusted to maximize production and quality.



(a) Gold Box "Infinity" Series

(b) 1-U Series

(c) Low Profile Series

Figure 1. A selection of Acopian linear and switching programmable power supplies

Real world application cases

As a result, programmable power supplies are used in a wide variety of applications. Here are some examples:

Automatic test equipment (ATE)

ATE enables product testing with minimal human intervention, and is widely used in the production of aircraft, spacecraft, satellites, semiconductors, automobiles, hard drives, printed circuit boards, and many other electronic products. Programmable power supplies allow for programming of hard limits to provide test and validation of products prior to installation.

Semiconductor fabrication

Manufacturing a single-cell crystal of pure silicon is the first step in the production of a semiconductor integrated circuit. Fully adjustable power sources are used to control specific processes and monitoring of the crystal growth process, including fully adjustable light sources, polyelectrolyte solutions, stirring motors, heaters & coolers, and more. The programmable power supplies provide crucial power and feedback to take control of the crystal growth environment.

X-ray generators

X-ray generators are used in multiple industrial imaging applications such as material composition and metal fatigue testing, medical and dental fluoroscopes, and other diagnostic equipment. The programmable power supply is a critical part of the testing platform. For example, they provide control of electrical power limits needed to energize x-ray tubes and allow for real-time control and monitoring of the power limits to achieve high levels of accuracy and precision.

Linear and switching power topologies

Before choosing a programmable power supply, engineers should understand a few basics. Any AC-DC power supply must convert the AC line voltage at its input to a regulated DC voltage at its output. The linear and the switching topologies are two methods of achieving this. The first stage of either topology is the same: convert the high-voltage AC into lower-voltage AC via a transformer, and then convert that into an unregulated DC voltage via a rectifier and capacitor filters. The two approaches differ in the processing of the unregulated DC voltage.



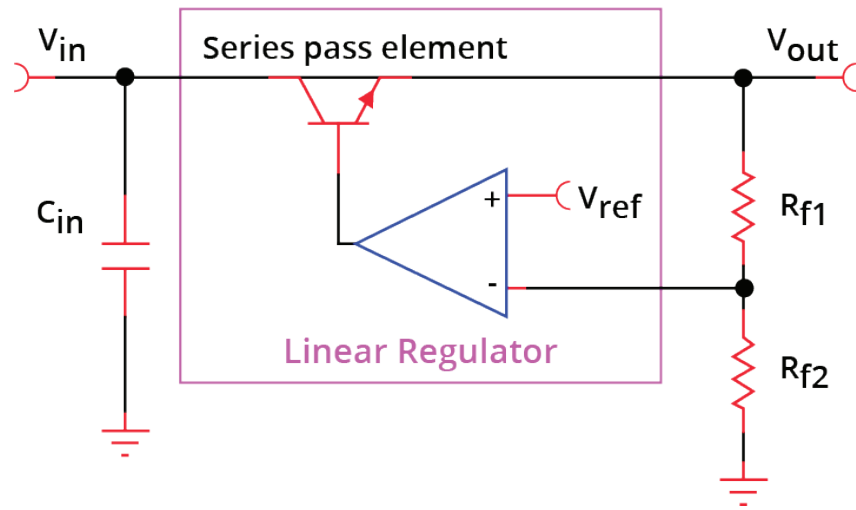


Figure 2. Linear power supply topology

In the linear power supply in Figure 2, a series pass element is connected between the input voltage V_{IN} and output voltage V_{OUT} . An error amplifier compares V_{OUT} to a reference voltage V_{REF} and adjusts the control voltage of the series pass element to maintain V_{OUT} at the desired value. The closed-loop design ensures that the supply output stays at the nominal voltage despite changes in V_{IN} or load values. The pass element is always in its active region, hence the designation “linear” supply. The voltage ($V_{IN} - V_{OUT}$) appears across the pass element and the load current flows through it; the power dissipation across the pass element is the major source of inefficiency in a linear supply.

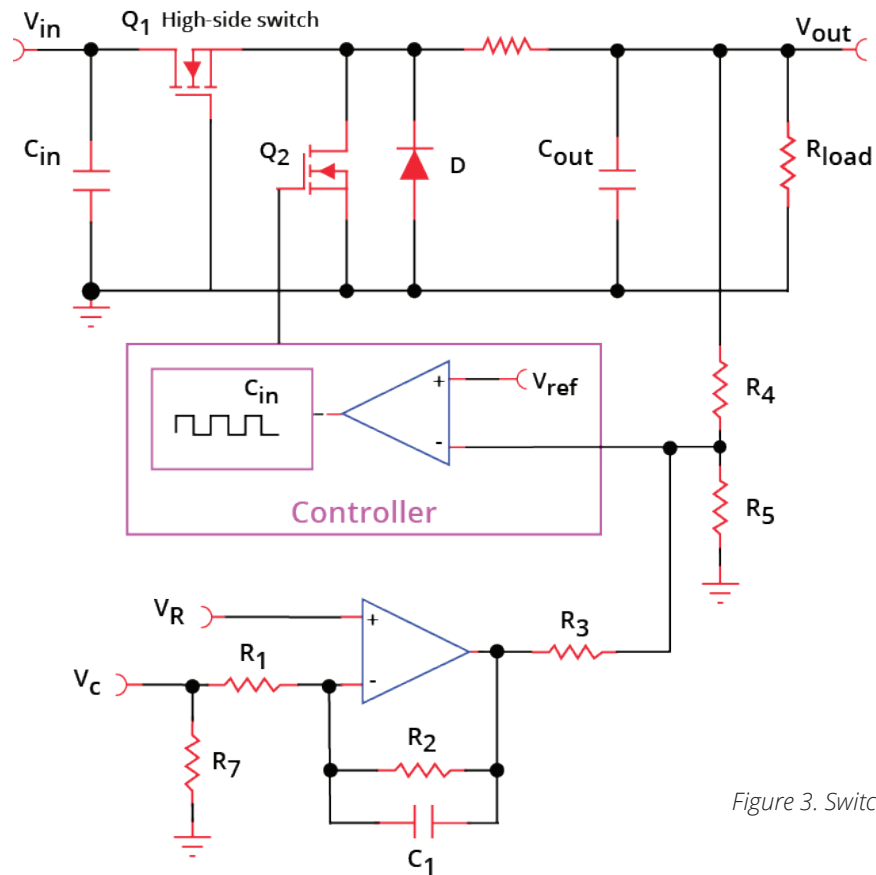


Figure 3. Switching supply topology

In a switching supply in Figure 3, the line AC is first converted to unregulated DC as before. In contrast to the continuously-varying operation of the linear design, though, the switching design delivers power to the load in bursts; the pass element switches off and on at a high rate that can range from hundreds of kilohertz up to megahertz. The pass element spends most of its time in either the on or the off state where power dissipation is minimal, so the switching design is much more efficient than its linear equivalent. The output pulses are filtered to produce low-ripple DC and the resulting waveform becomes the DC voltage output.

The size of the switching supply is also a function of its switching frequency: higher switching frequencies reduce the size of magnetic components such as inductors and transformers.

Comparison of the two topologies

The differences in the two topologies drive differences in performance. Here's a quick summary:

Metric	Linear Power Supply	Switching Power Supply
Size and Weight	✗ (continuous operating mode → large transformers, heat dissipation issues)	✓ (high-frequency switching → small magnetic components)
Efficiency	✗ (continuous operating → power loss across pass element)	✓ (on/off switching → low-loss operating modes)
Noise	✓ (no switching noise)	✗ (switching causes noisy output → EMI issues)
Transient Response	✓ (analog feedback loop → fast response to line & load changes)	✗ (digital feedback loop → slow response to line & load changes)

Contact the factory to help decide which topology is best for a particular application.

Acopian programmable product lines

Acopian produces a wide range of programmable linear and switching power supplies. The product family includes AC-DC single output, AC-DC adjustable output, DC-DC converters and high voltage power supplies.

Depending on the model, an Acopian programmable power supply allows control of the output through a variety of methods:

- Resistive control programming – using a potentiometer or switching fixed resistors.
- Voltage control programming – using a variable voltage to control the power supply output. This voltage is usually derived from a control circuit or a D/A converter. The control voltage can be at a 1:1 ratio to the power supply's output or can have a range such as 0V to 5V or 0V to 10V.
- Digital control programming – programming from a computer or controller.



Some representative models are:

Linear power supply: Gold Box “Infinity” series

The Gold Box series is a single-out AC-DC linear power supply family that features an “infinite” selection of configuration options. Standard features include:

- Any slot voltage from 1.5V to 150V is available
- Remote sensing
- Open sense protection
- Isolated output
- Short circuit and overload protection with enhanced surge capabilities
- No minimum load required
- Internal EMI Filtering
- Pluggable connectors

Configuration options

Programming: there are two output programming options for voltage or current. The output voltage and current may be programmed from 0 to full rating using control voltage inputs of either 0V DC to +5V DC or control voltage inputs of 0V DC to +10V DC. Voltage and current monitoring terminals provide signals scaled to the output voltage and current selected.

Acopian recognizes that no two applications are the same, and customers don't want to pay for features they aren't going to use. The Gold Box “Infinity” series is aptly named. The list of options runs to eleven different categories, each one with multiple choices, giving a practically “infinite” selection of possible configurations. Customers can tailor their power supply to their precise specifications. Contact the factory for details or order online.



Switching power supply: 1U series

The 1U family of programmable AC-DC switching power supplies offers 720W power levels with single output voltages ranging from 3.3V to 135V and current capabilities up to 70A. Operating at a switching frequency of 110kHz (typical), 1U power supplies are designed to meet FCC Part 15, EN61326-1 and EN55022, Class A EMI standards.

The series is available in rack mounting or benchtop versions.

Standard features include:

- Universal input
- Power factor correction
- Constant voltage and constant current modes
- Short circuit and overload protection
- Thermal protection
- No minimum load required
- Adjustable down to 0 V ('Wide Adjust' models)
- Internal EMI filter and RFI shielding
- Pluggable connectors for input and control wiring
- Remote sensing
- 'Soft start' operation
- Output programming ('Wide Adjust' models)
- Voltage and current monitors
- Output inhibit (or enable)
- Vok (single output models)

The front panel provides linear controls for fine adjustment and optional digital LED voltage and current meters. Numerous other options are available.

Programming: The 1U series features a choice of digital interfaces to monitor or control output voltage and current. Two options are available: the standard Ethernet/USB/RS232 digital interface; or an enhanced Ethernet/USB/RS232/RS485 digital interface. Both options include isolated Ethernet (10/100 Mbps), RS232, and USB interfaces; the RS485 interface utilizes 16-bit DACs and ADCs.



Switching power supply: Low-Profile series

Perfect for space-constrained applications, Acopian's Low-Profile series switching power supplies can supply up to 720W of power in a case as small as 7.7 inch x 5.5 inch x 1.0 inch (WL7).

Wide Adjust models are programmable with output voltage ranges from 0V to 5V up to 0V to 135V. The output voltage and current may be programmed from 0 to full rating using control voltage inputs of either 0V DC to +5V DC or control voltage inputs of 0V DC to +10V DC.

Like other Acopian power supplies, the Low-Profile series offers a long list of standard features, plus many options for an optimized solution.

Custom power supplies

Acopian can design custom power supplies that meet the most exacting specifications. A long list of successful projects includes military, industrial, telecom and medical designs. Contact the factory for more details.



About Acopian

With locations in Pennsylvania and Florida, Acopian has been building power supplies with 3-day delivery for over fifty years. The company offers 24/7 product support with custom power supply configuration via their Online System Builder. Power supplies can be ordered direct from the factory and all Acopian products are made in the USA.

Acopian: An ISO 9001:2015 Certified Company

Acopian has been designing and manufacturing power supplies since 1957. Our products include AC-DC power supplies, DC-DC converters; redundant & multiple-output power systems. Capabilities include shipping most models within 3 days and redundant and multiple output systems in 9 days. Standard power supplies are available in all voltages from 0v to 30 kV and up to 1200W. Standard models include single, dual, triple and wide adjust output power supplies; switching, linear, regulated & unregulated power supplies; programmable, high voltage, universal input & mini power supplies; & NEMA 4X Enclosed & UL508 listed configurations. Redundant and multiple-output power systems are available for rack, wall or DIN rail mounting and in modular configurations. Customized solutions are also available to meet special customer requirements. Our products are made in the USA.

