Understanding the Importance of Low-Noise Linear Power Supplies

Introduction

Agilent provides a wide range of direct current (DC) power supplies, from basic to complex, that are tailored to meet your testing specifications. The E3600 Series power supplies are cost-effective bench-top power supplies that give you clean power with excellent regulation and fast transient response.

Application Note

Agilent Technologies

Figure 1. Agilent E3600 Series power supplies

Linear and switching power supplies are the most common power supplies topologies used today. Linear power supplies have been in the market for many years, while switching power supplies are becoming more widely used because of its advantages — high efficiency, small size, and low heat generation.

Linear power supplies are typically used in R&D environments and in production test systems. They provide high performance, low periodic and random deviation (PARD), that is, less voltage ripple and noise, excellent line and load regulation, and superior transient recovery time. When compared with switching power supplies, linear power supplies are relatively inefficient. Due to their design, they tend to be cumbersome. Typically, linear power supplies provide the most effective solution in low-power applications.

When choosing an instrumentation-grade power supply for bench-station testing, you must consider efficiency, size, transient time, and price, with the key factor being noise performance of the instrument. Generally, linear power supplies have less noise compared to switching power supplies. However over the years, the design of switching power supplies has improved and the noise performance for switching supplies is as good as it is for linear power supplies. However, low-noise switching power supplies are more costly. Normally, low-noise switching power supplies are mainly for high-power applications, while low-noise linear power supplies are suitable for low-power applications.

In this article, you will learn and understand why do we need low-noise linear power supplies and how linear power supplies compare to low-end switching power supplies for the same price range.

KEY ADVANTAGES

1. Low voltage ripple and noise
2. Good performance

Do we need low-noise power supplies?

Low-noise power supplies are essential in certain low-power applications, and the key advantage of linear power supplies are low voltage ripple and noise. If you use low-end switching power supplies with high output noise, or if you want to remove unwanted noise, you must add electronic filters (capacitors), electromagnetic interference filters, or radio frequency (RF) shielding to low-end switching power supplies in low-noise applications. Unfortunately, the filters and shielding add complexity and cost to the applications.

Obtaining a clean output signal when you are transmitting and receiving RF signals can be challenging. Low-end switching power supplies may contain many high frequency spectral components in their DC output, while linear power supplies normally do not have high frequency noise in their outputs and therefore will not cause interference in RF applications.

Powering active antennas, down-converters, or preamplifiers requires very low-noise power supplies. Any noise superimposed on the DC power can enter the antenna or the antenna lead and interfere with the useful signal. Also, electromagnetic interference generated by the power supply can enter the receiver input and reduce the signal-to-noise ratio of the received signal.

Figure 2 and Figure 3 show how a circuit powered by a power supply can affect an RF signal.

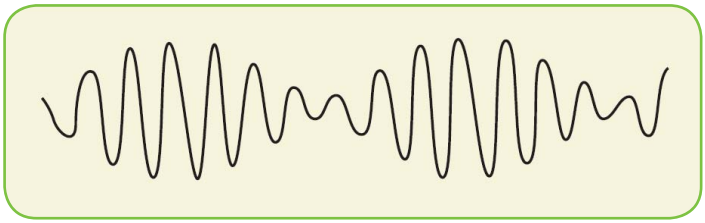

Figure 2. Circuit powered by linear power supply

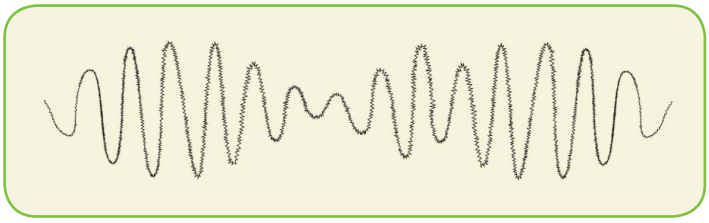

Figure 3. Circuit powered by switching power supply

Operational amplifiers (op-amps) used in analog audio circuits and high-density ICs in digital systems are highly sensitive to noise from the power supply. When an op-amp has its input referenced to the supply, any high frequency noise that exists in the low-end switching power supply will be coupled with the output.

For example, when you design a simple op-amp based headphone amplifier, noise and ripple from the power supply may affect the output measurement of the on-amp and its performance. Using bypass or decoupling elements will clean up the output, but it will increase the design complexity and product cost.

The E3600 Series power supplies address this challenge with low-noise and stable output. Figure 4 and Figure 5 compare the noise levels of the E3600 Series power supply and a low-end switching power supply used on a digital oscilloscope.

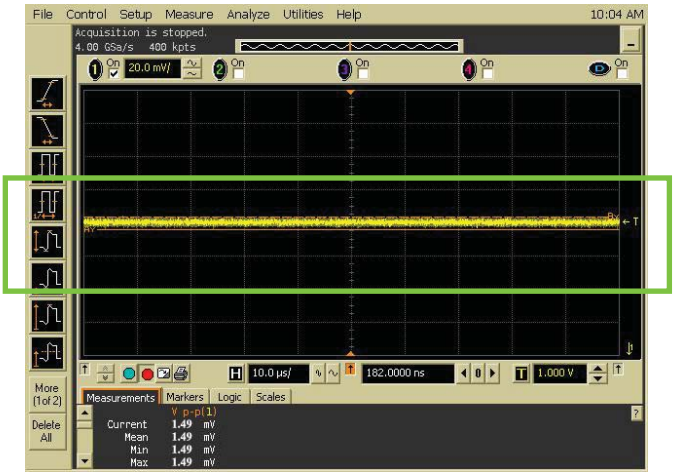

Figure 4. Agilent E3634A – Vppmean = 1.49 mV

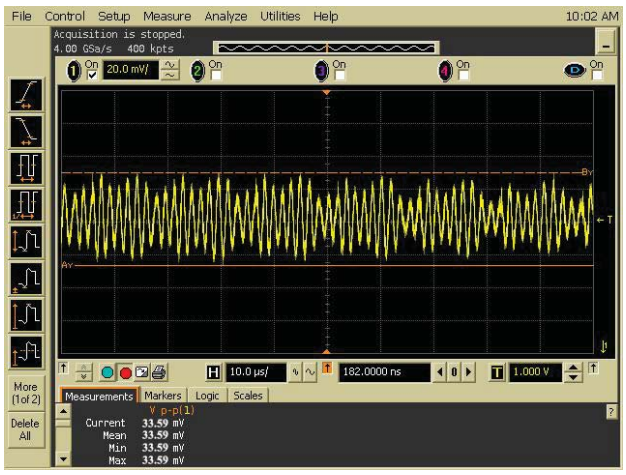

Figure 5. Switching power supply – Vppmean = 33.59 mV

CONCLUSION

Both linear and switching power supplies have advantages and disadvantages. Low-end switching power supplies are commonly used in many areas because they are more efficient and cost less, but they are not optimal for noise reduction. If you are looking for performance and noise-free power, a linear power supply or a high-end switching power supply is your best choice.

Related Agilent Literature

Please refer to the following application note for further information.

Publication title	Pub number
Understanding Linear Power Supply Operation Application Note	5989-2291EN

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