How to Read Your DC Power Supply's Data Sheet

Application Note

Introduction

If you are designing electronic devices and you need to power up a design for the first time, there's a good chance you will turn to a programmable power supply. Many vendors make programmable power supplies, and each one offers many different product lines for you to choose from. To sort through which one might be best for powering your design, you will have to turn to the power supply's data sheet.

The data sheet will give you detailed information about how the power supply will perform under different conditions. But before you dive into the details in the data sheet, you need to know as much as you can about your design. As we review the top specifications, you will see how the details of your design will influence your choice of power supplies.

No standard for data sheets

Unfortunately, there is no standard established for power supply data sheets. Descriptions of the specification and the specifications themselves are determined by the manufacturer and will vary from one manufacturer to the next. It is also up to the manufacturer whether or not a particular characteristic is even specified. Some vendors specify more than others. In this application note, we will focus on two data sheets, one for the Sorensen DLM 60-10 programmable DC power supply and one for the Agilent Technologies N6756A high-performance, auto-ranging DC power module.

Download the data sheets

The data sheets mentioned in this application note can be downloaded at:

- Sorensen:
  http://www.sorensen.com/products/DLM600/downloads/Sorensen_DLM600_Datasheet.pdf
- Agilent:
  http://cp.literature.agilent.com/litweb/pdf/N6700-90001.pdf

DC output ratings

This is the most basic information you'd expect to see on a DC power supply's data sheet, and it is more or less self-explanatory. This is where you'll go first to qualify whether or not the power supply you're evaluating will meet your power needs. You'd need to know the voltage, current, and power requirements of your device. If your device's needs do not fall within these parameters, you will need to continue your power supply search.

When V x I > P: Auto-ranging power

In most cases, a quick check of the voltage, current, and power in the DC output ratings section of the data sheet is enough before you move on to the other specifications. However, you should quickly check to see if the product of the maximum voltage and current ratings is equal to the power. If it is equal, the power supply has a rectangular output characteristic. If it is greater, the power supply has an auto-ranging output characteristic. Since auto-ranging is outside the scope of this application note , we will not go into more detail. However, Figure 1 shows a graphical representation of the two types of outputs.

A quick check reveals the Sorensen DLM 60-10 has a rectangular output, while the Agilent N6756A has an auto-ranging output.

Table 1. DC output ratings

Model	Voltage (V)	Current (A)	Power (W)	Data sheet page
Agilent N6756A	0 – 60	0 – 17	500	20
Sorensen DLM 60-10	0 – 60	0 – 10	600	25 (third page)

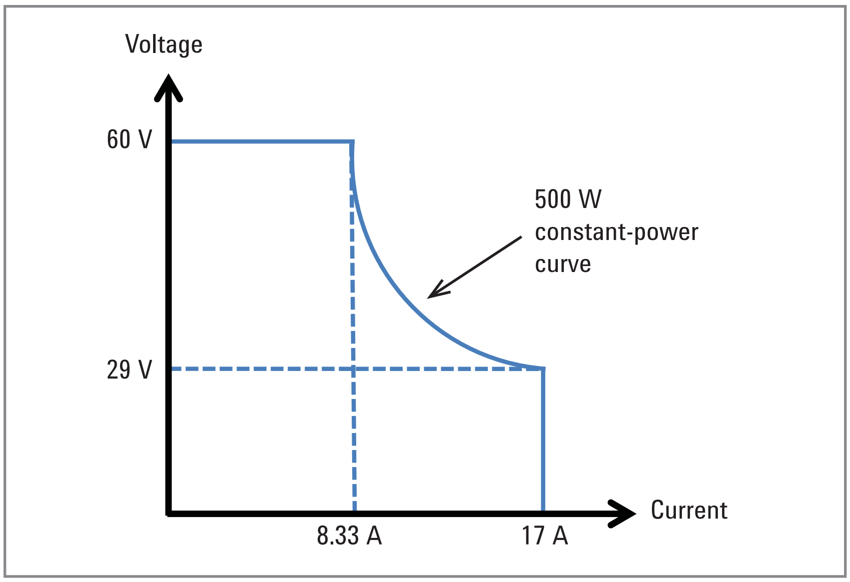

Figure 1. Autoranging output characteristic

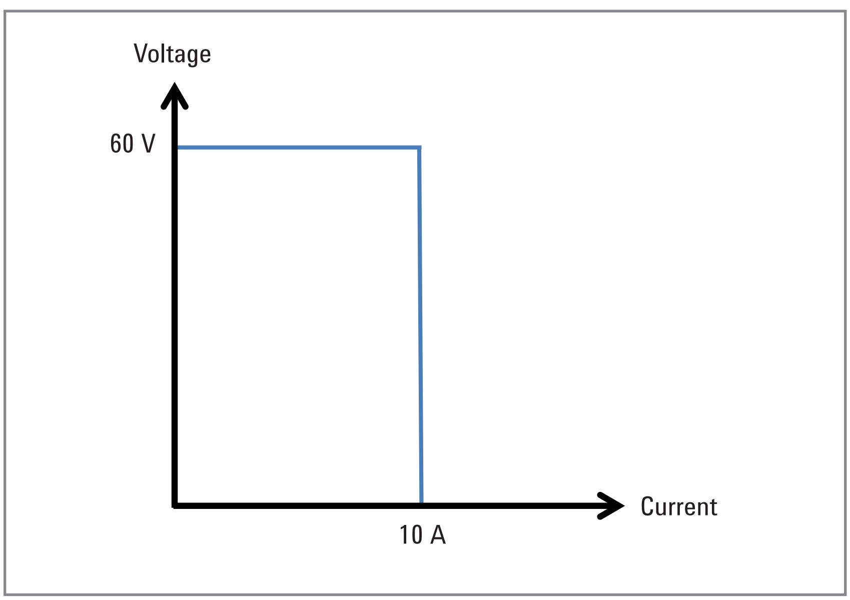

Figure 2. Rectangular Output Characteristic Voltage

Output noise/output ripple and noise/periodic and random deviations (PARD)

The output noise specification is labeled in different ways on a data sheet depending on the vendor. Output noise refers to the deviations of the DC output voltage from its average value over a specified bandwidth. It is typically measured in rms (root mean square) and peak-to-peak (p-p). It is important to note that there are two types of noise to consider: normal mode and common mode. If the specification does not explicitly state that it is common mode noise, then it is a specification of normal mode noise. Normal mode noise is the voltage deviation on the positive output terminal with respect to the negative output terminal.

The most important noise specification is the peak-to-peak voltage noise. If the peak-to-peak voltage noise specification indicates that the deviations are large, they could damage or destroy a sensitive device, such as a voltage-controlled oscillator (VCO). The rms measurement is not an ideal representation of the noise and should not be considered a good representation of a power supply's noise performance. Fairly high output noise spikes of short duration could be present despite a low rms noise specification since they do not appreciably increase the rms value. You should be wary of a power supply vendor that only specifies the rms noise value. Also, make sure you note the bandwidth over which the measurement was made. It should be in the range of 20 Hz to 20 MHz. Poor noise specifications can be hidden by changing the bandwidth over which it is measured.

Table 2. Normal mode output noise

Model	CVp-p	CVrms	CCrms	Bandwidth	Data sheet page
Agilent N6756A	6 mV	1 mV	4 mA	20 Hz – 20 MHz	20
Sorensen DLM 60-10	20 mV	2.5 mV	Not specified	20 Hz – 20 MHz	25 (third page)

Common mode noise

Common mode noise is the deviation that appears on both the positive and negative output terminals of the power supply with respect to ground. It is not usually specified, but if it is high it can be the unrecognized cause of many problems. It is specified in amperes since the current flowing from one of the output terminal to ground is easiest to measure.

Table 3. Common mode noise

Model	p-p	rms	Bandwidth	Data sheet page
Agilent N6756A	< 3 mA	750 µA	20 Hz – 20 MHz	22
Sorensen DLM 60-10	Not specified			

Load regulation/load effect

Load effect, or load regulation, describes how much the DC output voltage will change from its steady state (programmed) value due to a change in the load from open circuit to a resistance value that yields maximum rated output current, or vice versa. A small number indicates the power supply will not deviate too much from its programmed value when large load changes occur. The power supply will deviate beyond the load effect specification for a short period of time, but under steady state conditions, it will not deviate more than the indicated load effect specification.

For the amount of time it takes the power supply to recover after a fast load transient, refer to the load transient recovery time specification.

Table 4. Load regulation

Model	Voltage	Current	Data sheet page
Agilent N6756A	2 mV	5 mA	20
Sorensen DLM 60-10	5 mV	7 mA	25 (third page)

Load transient recovery time/transient response time

If your device requires fast pulses of current to power, such as a mobile phone, the power supply powering the design will be subjected to large load transients. When this occurs, the voltage may deviate greatly from the programmed value for a period of time. This specification indicates how quickly the voltage will return to within a settling band around the programmed value.

Table 5. Transient response time

Model	Settling band	Time	Load change	Data sheet page
Agilent N6756A	± 90 mV	< 100 µs	50% to 100% and 100% to 50%	20
Sorensen DLM 60-10	± 60 mV	500 µs	50% to 100% and 100% to 50%	24 (second page)

Source effect/line effect/source regulation/line regulation

A DC power supply is essentially an AC-to-DC converter. It takes the AC voltage from the outlet in the wall and converts it to the programmed DC value. For this specification, "source" and "line" both refer to where the power supply derives its power, the AC line voltage. Source effect is the change in the steady-state value of the DC output voltage due to a change in the AC input voltage over a specified range, which is usually the rated low-line to high-line and vice versa. For the Sorensen DLM on a 120 VAC line, low-line is 90 VAC and high-line is 132 VAC.

If you will be using the power supply in an environment that has very stable AC line voltage, this specification may not matter to you. However, if your AC line voltage is not "clean" and fluctuates, this specification is very important because it lets you know how much the output might vary due to these fluctuations.

Table 6. Line regulation

Model	Voltage	Current	Data sheet page
Agilent N6756A	1.2 mV	2 mA	20
Sorensen DLM 60-10	5 mV	3 mA	25 (Third page)

Programming accuracy

When you set the output of a programmable power supply to a specific voltage, say 10.000 V, what do you expect the output to be? Will it be 10.000 V or 9.900 V? The programming accuracy specification is where you go to figure this out.

This specification is sometimes shown as a percentage of full-scale voltage, such as "0.1% of Vmax" (DLM 60-10 with LAN interface), or as a percentage and an offset, such as "0.06% + 25 mV" (N6756A). The latter gives a better representation of actual results throughout the entire voltage range. Both represent a "±" accuracy band. However, the "±" is typically not shown.

Table 7 shows the results of calculating the programming accuracy bands by using the specifications from Table 8.

We can see that the "percentage and an offset" specification is a much better representation of accuracy. It also shows that the vendor has spent extra time verifying the accuracy across the entire range of output voltages. At 60 V, both yield an error band of 0.1%. However, the comparison is much different at low voltages, such a 0.5 V. Here, the former yields a 12% error, while the latter yields a 5% error.

Be sure to look at whether or not the programming accuracy is dependent on the interface being used, such as GPIB, USB, or LAN. Many vendors have different specifications based on the interface. For example, the Sorensen DLM 60-10 has a programming accuracy of 0.1% of Vmax when using the Ethernet interface and 0.2% of Vmax when using the GPIB interface. The Agilent N6756A's specifications are not affected by the interface used.

Table 7. Programming accuracy bands

Programmed output voltage	Sorensen DLM 60-10	Agilent N6756A
60.000 V	59.940 V to 60.060 V (±0.1 % error)	59.939 V to 60.061 V (±0.1% error)
10.000 V	9.940 V to 10.060 V (±0.6% error)	9.969V to 10.031V (±0.3% error)
0.500 V	0.440 V to 0.560 V (±12 % error)	0.475 V to 0.525 V (±5% error)

Table 8. Programming accuracys

Model	Voltage	Current	Interface	Data sheet page
Agilent N6756A	0.06% + 25 mV	0.1% + 12 mA	GPIB, USB, and LAN	20
Sorensen DLM 60-10	60 mV (0.1% of Vmax)	25 mA (0.25% of Imax)	LAN	25 (third page)
	120 mV (0.2% of Vmax)	50 mA (0.25% of Imax)	GPIB	25 (third page)

Measurement accuracy/readback accuracy

If the power supply you are evaluating has a built-in measurement system, there will be a measurement accuracy specification. Similar to programming accuracy discussed above, this specification can be represented as a percentage of full scale or as a percentage and an offset. Again, the latter shows a better representation of accuracy throughout the power supply's entire range. Also similar to programming accuracy, the measurement accuracy may depend on the interface being used to acquire the measurement, so make sure you know which interface you will use prior to making a final determination of the specification.

In our example, the Sorensen DLM 60-10's measurement accuracy is specified as being the same as the programming accuracy. The Agilent N6756A's measurement accuracy is 0.05% + 25 mV, so slightly better than its programming accuracy. Each of these examples has only one measurement accuracy range.

There are some precision power supplies available that have multiple measurement ranges. The accuracy in these cases will depend on which measurement range the power supply is using to make the measurement. Measurement accuracy bands can be calculated in the same way we calculated the programming accuracy bands shown in Table 7.

Table 9. Measurement accuracy

Model	Voltage	Current	Interface	Data sheet page
Agilent N6756A	0.05% + 25 mV	0.1% + 8 mA	GPIB, USB, and LAN	20
Sorensen DLM 60-10	60 mV	25 mA	LAN	25 (third page)
	150 mV	50 mA	GPIB	25 (third page)

Conclusion

We could discuss many other power supply specifications. However, the ones discussed here are the top specifications that should be considered by designers who want to power and test their electronic devices with a programmable DC power supply. Remember that it is most important to start by knowing your design and how you plan on powering and testing it. What voltage, current, and power will be required? Is your device's power consumption dynamic? Will you make measurements with the power supply? Once you know the answers to these questions you will be ready to start evaluating a power supply's data sheet and be on your way to making the right choice for powering your design.

Note: All specifications mentioned in this application note were accurate as of 2/11/13.

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Agilent N6700 Modular Power System Family – Specification Guide

Sorensen DLM 600 Series – Product Specifications

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