PPST SOLUTIONS

APPLICATION NOTE

Benefits of Constant Power Voltage and Current Ranges on DC power supplies

1.0 Introduction

Programmable DC power supplies have historically been characterized by a point rating power output capability in Watts. Point rated implies that maximum available power output from the power supply is available only at one operating point. This power output point is where both DC voltage and DC current output are both at the maximum setting of their respective available ranges. For example, a 10kW supply with a 0 ~ 250Vdc voltage range can supply 10kW output only when the load current is 40Adc. The implication of this way of designing programmable DC power supplies for the end-user are twofold:

1. The power supply selected invariably has to be sized larger than the actual power requirement of the unit under test. Thus, most of the time the power supply is used below its maximum power, voltage and/or current rating.
2. Once selected, the range of applications where the DC supply can be used are limited by both power and voltage range. In the previous example, the 250Vdc power supply cannot be used for any application that requires more than 250Vdc output.

Because of this point rating, manufacturers of programmable power supplies offer a large number of voltage range models in a given power supply model range, sometimes as many as 20 different voltage ranges for one model series. This obviously limits their ability to benefit from economies of scale in manufacturing resulting in high product cost and thus end-user pricing. End-users have had to live with these limitations for decades but new developments in power conversion technology are eliminating some of these restrictions.

2.0 Constant Power Range Design

By using higher precision circuits and increased resolution control and measurement technology, the most advanced programmable power supply design no longer force the end-user to select from a wide range of point rated models. Instead, these new power supplies offer a wider voltage and current range – in some cases with a three to one ratio for both – at a given power level.
A good example of this is the Adaptive Power Systems DCS Series of constant power programmable DC supplies. Voltage and Current ranges on DCS supplies are not defined by the single maximum power output set point but instead available over a wide range of setting.

Figure 1: DCS360-80-4 DC Power Supply

For example, the 10kW DCS360-80 model offers a 0 ~ 360Vdc voltage range while as the same time supporting a 0 ~ 360Adc current range, all at a maximum power output of 10kW. Thus, it could easily support the original requirement from section1.0 for 250Vdc @ 40Adc, but also a 360Vdc output at 10,000/360 or 27.78Adc and a 166.67Vdc @ 60Adc requirement. Thus, the same DC power supply supports a much wider range of applications.

This capability is shown in Figure 2 below. The grey area shows the operating range of a 10kW point rated supply, which is significantly smaller than that of the equal power rated DCS model.

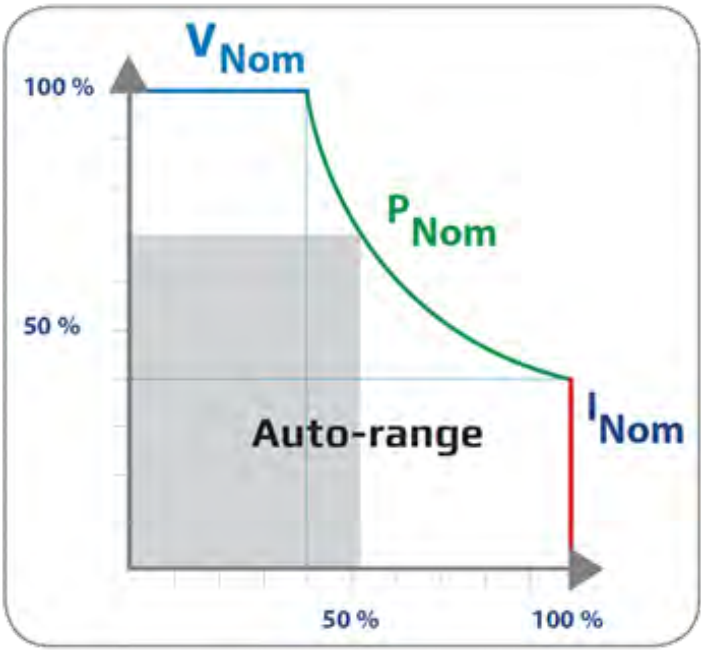

Figure 2: DCS Series Constant Power Auto Ranging

3.0 Cost Savings

This increased flexibility can result in considerable cost savings compared to using 'conventional' programmable DC supplies. This is particularly true when dealing with modern electronic EUTs such as DC/DC converters that often support wide DC input capabilities. To support development and test of such wide operating capable devices, end-user historically had to greatly oversize the rating of the DC supply used to cover all settings. This results in the DC supply being used predominantly far below its maximum capability due to its lack of flexibility. We will use an example her to illustrate this more clearly.

3.2 Example 1: Telecom DC / DC Converter Testing

Figure 3: 1600W DC/DC Converter

In the first example, we will determine what setting are required to test all DC input ranges of a typical telecom DC/DC converter. As an example, we use a Vicor Mega-PAC converter, which has seven different DC input ranges (See Figure 3). The corresponding nominal input test voltages as well as low and high limit range test values are shown in Table 1 below.

DC Input Voltage Ranges			
Range#	**Nominal Vdc In**	**Min. Vdc IN**	**Max Vdc IN**
0	12 Vdc	10 Vdc	20 Vdc
1	24 Vdc	21 Vdc	32 Vdc
W	24 Vdc	18 Vdc	36 Vdc
2	36 Vdc	21 Vdc	56 Vdc
3	48 Vdc	42 Vdc	60 Vdc
N	48 Vdc	36 Vdc	76 Vdc
4	72 Vdc	55 Vdx	100 Vdc

Table 1: DC/DC Converter Input Voltage Ranges

The most cost effective way to test is to use a single programmable DC power supply that can support all input test voltage and current setting. This means we need a 100Vdc power supply that can support 160A of current.

This is evidenced by the low line test limits for the various ranges in Table 2.

Test DC Supply Settings		
Power Rating	Vdc IN	Current
1600 W	10 Vdc	160.0 Adc
	24 Vdc	66.7 Adc
	36 Vdc	44.4 Adc
	48 Vdc	33.3 Adc
	100 Vdc	16.0 Adc

Table 2: Required Test Voltages and Current by Range

Most programmable DC power supply manufacturers offer a 100Vdc model but we need to make sure we can get 160Adc at 10Vdc, which is at 10% of the supply's voltage range. A 15kW power supply as offered by several manufacturers only supports 150Adc max so we have to pick the next available power levels which is generally 20kW. This leaves us with some possible conventional point rated DC power supply choices shown in Table 3.

Programmable DC Power Supply Options					
Brand	Model	Power	Voltage Range	Current Range	Rack Height
S	SGI100-200	20 kW	0 ~ 100 Vdc	0 ~ 200 Adc	6U
M	TSD-100-200	20 kW	0 ~ 100 Vdc	0 ~ 200 Adc	6U

Table 3: Available Point-Rated 100V DC Supplies

The large 20 kW DC supplies are expensive and clearly oversized for the 1600W test application but this is the only way to use on one test supply. When we compare this to a constant power range DC supply, we can reduce the power rating to only 15kW, which saves around 40% on the cost of the power supply and provides twice the required test voltage and an extra 50A of DC current at the lowest test voltage. Also oversized but less and far less expensive. Furthermore, the DCS200-210 takes up half the rack space of these competing supplies. See Table 4 for comparison.

APS DCS100 Series Programmable DC Power Supply Option					
Brand	Model	Power	Voltage Range	Current Range	Rack Height
APS	DCS200-210	15 kW	0 ~ 200 Vdc	0 ~ 210 Adc	3U

Table 4: APS Constant Power DC Supply

3.2 Example 2: PV Inverter Testing

Figure 4: 6800W PV Inverter

Another typical test required is testing of PV inverters. Rather than use actual Solar Panel to provide the DC input voltage during development of product test, a programmable DC power supply is generally used to drive the PV inverter input. Since environmental conditions can vary widely during a given day, PV inverters are designed to operate over a wide input voltage range to accommodate shading, solar angle and the sun's intensity as if moves across the sky during the day. Thus, testing PV inverters requires a wide range of test voltages. The specifications for the PV inverter used in this example are shown in Table 5 below.

Input Side (DC)	Specifications
Number of independent MPPT Channels	2, programmable for 1 MPPT
Maximum usable power for each MPPT Channel	6800 W
Absolute maximum voltage (Vmax)	520 Vdc
Start-up Voltage (Vstart)	200 Vdc (adj. 120 Vdc min)
Full Power MPPT voltage range	200 Vdc ~ 470 Vdc
Operating MPPT voltage range	0.7 x Vstart ~ 520 Vdc
Maximum current (Idc max) for both MPPT in parallel	48 Adc
Maximum usable current per MPPT Channel	24 Adc
Maximum short circuit current (Isc max.) per MPPT Channel	29 Adc
Maximum short circuit current (Isc max.) for boht MPPT in paralllel	58 Adc

Table 5: PV Inverter DC Input Specifications

Again, to cover the 520Vdc max PV input voltage as well as the 50Adc max input current, a point rated DC power supply would have to be rated at 30kW. See Table 6 below for some examples of available models.

Programmable DC Power Supply Options					
Brand	**Model**	**Power**	**Voltage Range**	**Current Range**	**Rack Height**
S	SGI600-50	30 kW	0 ~ 600 Vdc	0 ~ 50 Adc	9U
M	TSD-600-48	30 kW	0 ~ 600 Vdc	0 ~ 48 Adc	6U

Table 6: Available Point-Rated 600V DC Supplies

As you can see, these are even larger and again very costly. Contrast this to using the DCS750-70 shown in Table 7. Not only is it half the power and less than half the cost, it takes up only ½ or 1/3 the required rack space in your test system.

APS DCS100 Series Programmable DC Power Supply Option					
Brand	**Model**	**Power**	**Voltage Range**	**Current Range**	**Rack Height**
APS	DCS750-60	15 kW	0 ~ 750 Vdc	0 ~ 60 Adc	3U

Table 7: APS Constant Power DC Supply

4.0 Summary

Modern design constant power DC power supplies like the APS DCS Series save money and space in may test applications. They also provide more flexibility in R&D labs as the same DC supply can support a much wider range of voltage and current combinations than conventional point-rated DC power supplies.

For technical information and overview of available voltage, current and power combinations of DCS Power Supplies, see the product information page at https://adaptivepower.com/products/dc-supplies/DCS-series/ or call Adaptive Power Systems toll free at +1 (866) 517-8400.

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