TECHNICAL NOTE:
AUTO-RANGING : THEORY OF OPERATION

Elektro-Automatik

AUTO-RANGING DC SUPPLIES

ABSTRACT

With the rising penetration of energy-consuming native direct current (DC) loads in commercial and residential applications, and the increasing focus on the adoption of energy-efficient systems to fulfill ambitious national goals, the debate over the relative merits of AC- versus DC- based systems has intensified.

The components include converters (central rectifiers and DC-DC converters), DC circuit breakers, DC power distribution units (PDUs), and DC power management systems (monitoring and control) installed for building-level, floor/room-level, and device-level conversion.

INTRODUCTION

Programmable DC power sources are an essential tool in product development and production testing of a wide range of electronic devices and systems. In many instances, functional test requires submitting the device-under-test (DUT) to a wide range of operating conditions. In some cases, the DUT draws constant power under variable input conditions. Common examples are DC motor drives and regulated DC/DC supplies. In such circumstances, the ability of the programmable DC source to provide increased current at reduced output voltage is valuable. This ability is known as "Auto-Ranging". DC supplies without Auto-Ranging often requires users to oversize or use multiple supplies to test the DUT under varying input voltage conditions.

Picture 1: 5-15 kW PSI 9000 3U

PRINCIPLE OF AUTO-RANGING

"Auto-Ranging" is a term when a programmable DC source automatically offers a wide output range of both voltage and current to maintain full power output across a wide operation range. The below diagram depicts both traditional square and Auto-Ranging operating

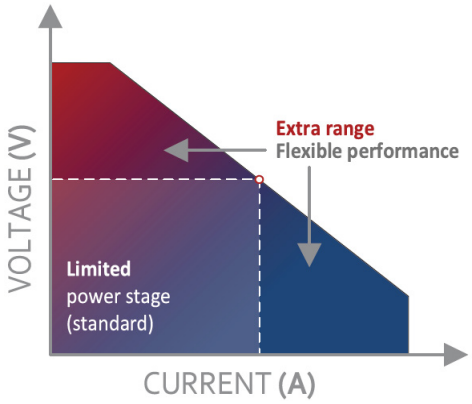

Figure : Auto-Ranging Power Profile

The principal of operation is simple. The source automatically offers increased current at lower voltages which maximizes flexibility. This type of solution allows the use of a single source to address multiple voltage and current combinations.

Traditional DC supplies output base on a "square", limited operating curve. Meaning full power is achieved only at full scale voltage since current is limited to a specified value. Applying the programmable DC supplies' full scale voltage to a DUT is rare which means in most cases, the DC source is not utilized to the full power potential.

Application Example:

The trend of 380 VDC power distribution for server farms has been suggested as an efficient method of power delivery within a data centers. Top manufacturers like Cisco and Juniper adopted such technology since it's believed the simplified conversion result in significant energy savings.

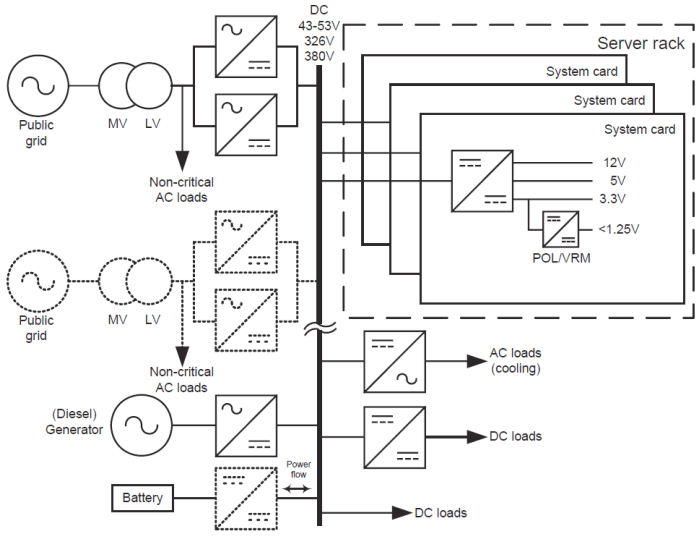

Figure 2: Typical DC distribution architecture

APPLICATION EXAMPLE

For the purposes of this example, the Cisco Nexus 9500 Platform of Series Switches power specifications is a total of 3,000W with an input voltage range of 192 VDC - 400 VDC. This wide range of operation means the switch pulls considerably more current at low voltage operation.

Table 6. N9K-PUV2-3000W-B Universal High-Voltage AC/DC Power-Supply Pro

AC/DC Power-Supply Properties	Cisco Nexus 9500 Platform
Power	3150W
Input voltage	200 to 277V AC or 240 to 380V DC (nominal) 192 to 400V DC (min - max)
Frequency	47 to 63 Hz
Efficiency	90% or greater (20 to 100% load)

Figure 3 : Nexus 9500 Power Specifications

Input current is:

At 192 Vdc is 3,150W/192Vdc = 16.4 Adc

At 420 Vdc is 3,150W/420Vdc = 7.5 Adc

When selecting an appropriate programmable power source for test, Engineers must account for both the worst case voltage of 400 VDC and current of 16.4 ADC. Keep in mind that most design verification test is more extreme and could test down to a low as 180 Vdc. In that case, current would increase to 17.5 Adc.

Let's look at a square or dare we say, legacy Programmable DC Supply. Most manufacturers offer a 500 Vdc output model. For sizing a to the application would mean:

500 Vdc x 16.4 ADC = **8,200 W**

In this case, a square operating source of at least 8.2 kW is required to serve both corner cases of test. Most manufacturers offer a 5, 10, 15 kW solution so Engineers would be forced to select a 10 kW solution. just to test a 3,150 W product... Below is an example that the 8/10 kW supply provides a maximum of 20 Adc.

Output: Voltage and Current Ranges			
	3U		
Power	4/5 kW	8/10 kW	12/15 kW
Voltage	Current		
500	10	20	30

Table 1: Square Operating Power Specifications

AUTO-RANGING ADVANTAGE

In the previous example, a 8.2 kW minimum supply is required to test the corner cases of the DUT requirements.

The EA PSI 9500-30 3U is rated at 5,000W and provides 0-500 Vdc and up to 30 Adc.

Technical Data	PSI 9500-30 3U
Rated voltage & range	0...500 V
Rated current & range	0...30 A
Rated power & range	0...5000 W

Table 2: PSI 9500-30 3U Auto-Ranging Power Specifications

With a power rating of 5,000W, the source is capable of providing:

At 192 Vdc is 5,000W/192Vdc = 26.0 Adc

At 420 Vdc is 5,000W/420Vdc = 11.9 Adc.

In this case, the Elektro-Automatik Auto-Ranging supply is rated at just half the power of the legacy square supply, yet provides more current and allows ample headroom, even the DVT case down to 180 Vdc.

In general, power supplies are $X / Watt. The higher the power, the higher the cost. An Auto-Ranging power supply could be as much as half the cost of the legacy supply.

One thing to consider when selecting an Auto-Ranging power supply is to plan for the future or leverage into other applications. What if instead of 400 Vdc, the input voltage increased to say 600 Vdc? Why not use a 750 Vdc source?

The PSI 9750-20 3U is again rated at 5,000 W and provides 750 Vdc and up to 20 Adc. The source still meets application requirements, yet offers the benefit of higher voltage output. In the Auto-Ranging diagram, that's the "Extra Range".

Automated Test Systems

ATE Integration is often simplified using Auto-Ranging DC supplies. ATE designs usually contain multiple DC supplies to address various DUT requirements or a single oversized supply to meet high power, voltage and current requirements.

Using an Auto-Ranging source could provide both cost and valuable space savings in ATE designs.

Example of Intepro System ATE

Digital Remote Interfaces

Most Elektro-Automatik's solutions offer industry leading selection of digital remote interfaces called "Anybus". The modules simply plug into the rear panel for play-and-play operation. The vast selection of interfaces avoids the need for unstable and costly digital converters.

Available Interfaces

- RS232
- CAN Open
- Profibus
- ProfiNet I/O 1-2 Port
- Ethernet (1/2 Port)
- ModBus TCP
- CAN
- EtherCAT

Picture 2: Anybus Modules

High Power Solutions

Elektro-Automatik's Auto-Ranging solutions start at just 160W and extend through 480 kW. We offer complete turn-key integrated solutions that can be customized to your requirements.

Picture 3: 30 kW to 480 kW Pre-Racked Solutions

SUMMARY

Auto-Ranging can be a valuable feature in today's test environment. The benefits are easy to see. If you have questions or need assistance in specifying a solution, please contact us at sales@elektroautomatik or give us a call. We're happy to help!

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