Is your Power Supply SOUR (Same Old sUpply Range) or SWEET (Super Wide and Effectively EfficienT)?

Mains electrical distribution in buildings varies by voltage levels and specifications based on factors like application needs, safety, and history. For AC distributions, nominal voltage and frequency are key, with global standards influencing the different voltage levels.

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INTRODUCTION

Determining an application's optimal power solution can be a daunting task for even the most seasoned Electrical/Analog Engineers or Facilities Architects. This is further convoluted when solutions must be proposed to not only meet the needs of an explicit system but be architected to work efficiently for an entire facility. This is where the experience can either be SOUR (Same Old sUpply Range) or SWEET (Super Wide and Effectively EfficienT) depending on the path taken and RECOM offers novel solutions to get the best out of both design ease and high-efficiency power distributions. You can make sweet lemonade from sour lemons, but RECOM suggests you make the universal factory of the future instead!

UNIVERSAL AC, WIDE INPUT, & UNIVERSALLY-WIDE INPUT

Traditional power supplies are either AC or DC input. Even so-called universal input power supply units (PSUs) are limited to 85 – 264VAC or 130 – 370VDC. Though supporting a wide range for EITHER an AC or DC input, these ranges are constrained and therefore limit what devices can be supported without extra, costly, intermediary power conversion. AC limits are at least defined to cover all ranges of mains inputs [1], but still constrains the application space because they cannot cope with lower AC or DC supply voltages.

When it comes to DC power, there is a much broader spectrum of needs because most loads ultimately require DC (some motors and inverters are the most prolific exceptions to the rule). Therefore, standards can be specific to a class of products (like the universal serial bus or Power over Ethernet, USB or PoE) or an application space or market vertical (like the high-voltage data center, HVDC). But standard or no standard, many loads and operating environments will need to support wider, perhaps even unpredictable or unknown, input supply voltage ranges. In general, support for sub-minimal voltages enable the load to operate longer in the case of line voltage sags (a.k.a. – brownout), while support for voltages above maximum ratings enable protections for equipment and users.

Regardless of AC or DC input and if trying to support extended voltage ranges above/below nominal specification, there is also consideration of driving maximum power supply efficiency (e.g. – minimal dissipated power loss) based on the loading condition. In other words, the input voltage level to a power supply or system has an impact on power conversion (a.k.a. - commutation) efficiency, even if the load was to remain static on the output side. But most loads are also dynamic in their current draw [2]. To assess true performance, one must have and study the power solution's Efficiency vs. Load curve, as demonstrated by the example in the figure below.

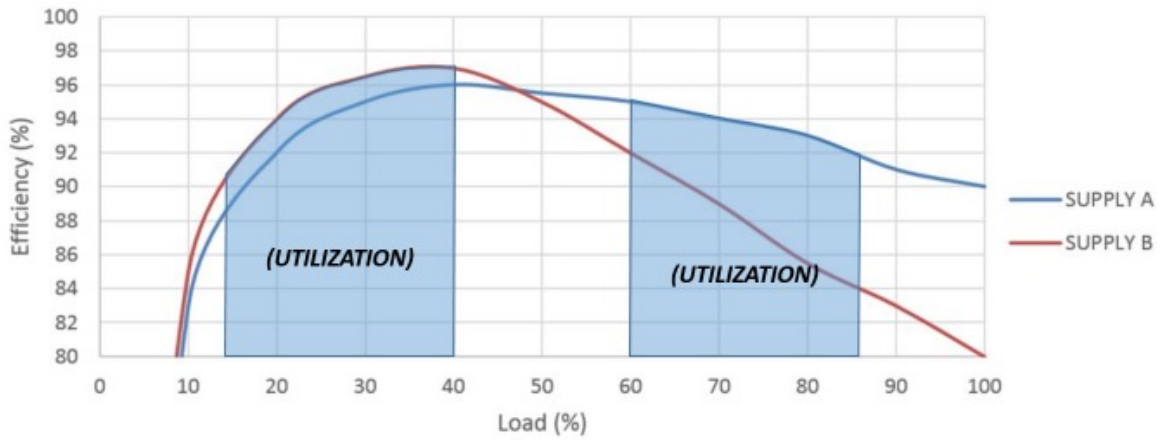


Figure 1: Comparing PSU Efficiency Curves Optimized for Different Load Rangers, Graphic: courtesy of PowerRox [3]

Why should designers limit themselves to the SOUR (Same Old sUpply Range) when there is so much more to be had? The ability to have maximum flexibility for an application in terms of cost, uptime, efficiency, and sustainability in nearly any situation, even where the supply voltage is unpredictable or unknown, is a very powerful tool for any Design Engineer, Factory Manager, or Facilities Architect. For instance, a single power supply (not a product family or options of a common design, but a truly common and universal, single part number) supporting a range from 24V to 240V AC OR DC really opens the door to ACTUAL universal support and unprecedented levels of energy optimization.

RECOM is the first to bring such an advanced product to the market and redefine what is meant to be "universally-wide-input" compliant. How the RAC15-K/WI will permit SWEET (Super Wide and Effectively EfficienT) solutions to power the facilities and applications of tomorrow is discussed in further detail later on.

STREAMLINING POWER SOLUTIONS FOR EFFICIENT DEPLOYMENT

The concept of wanting to power the same systems or loads off both an AC and DC input is not new. Below is a dated figure from an open industry collaboration on "Architectures for the Modern Data Center" demonstrate this, but note the separate, independent PSUs in a single system.

RECOM has now taken this hybrid AC/DC concept and created the industry's first, fully-integrated, AC or DC universally-wide-input PSU. Consolidation of power subsystems enables modular system design to stretch non-recurring engineering (NRE) resources and maximize return on investment (ROI) for those looking to support many different varieties (i.e. – stock keeping units or SKUs) of a similar system. For example, an electrical cabinet may contain an AC feed or operate from 24VDC (very common in DIN rail [5] applications). Two different types of power supply would normally be needed, but in the case of the RAC15-K/WI, one part can do both.

Figure 2: RAC15-K/WI series

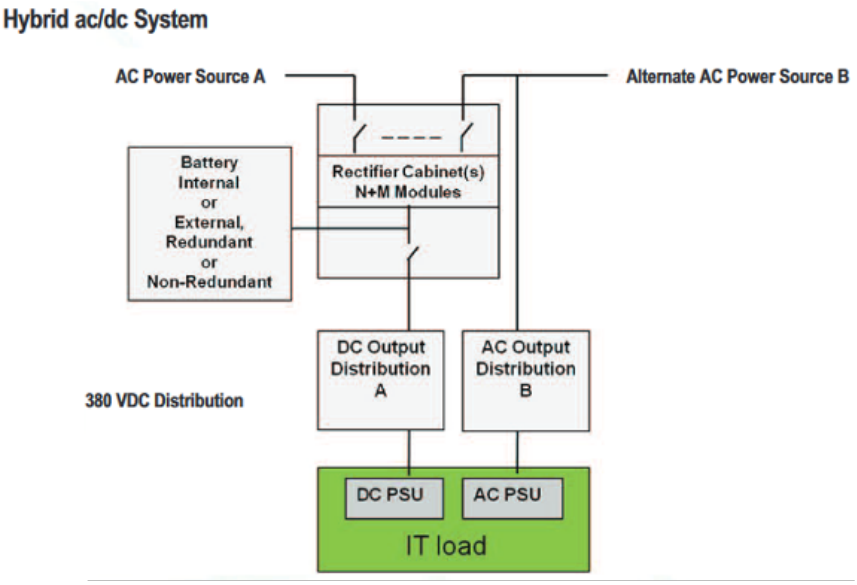


Figure 3: Hybrid AC/DC System Input Architecture, Graphic: [4]

Power sent down long cables suffers from I^2R losses than can mean that the nominal supply voltage is outside the range of standard power supply inputs [6]. For example, signaling systems alongside railway tracks and motorways, or remote power for monitoring stations in green energy (offshore wind farms), and smart grid applications, often use supply cables that are several kilometers long. The impact of this effect can be assessed using the equation below. Even a low-power load (30W) will suffer from a 25V drop along a 5km long, 1.5mm^2 120VAC mains cable (>20% loss in supply voltage)!

$$V = 2 \times l \times I \times R \times 10^{-3}$$

where,

V voltage drop (in Volts)

l conductor length (in meters)

I input current (in Amps)

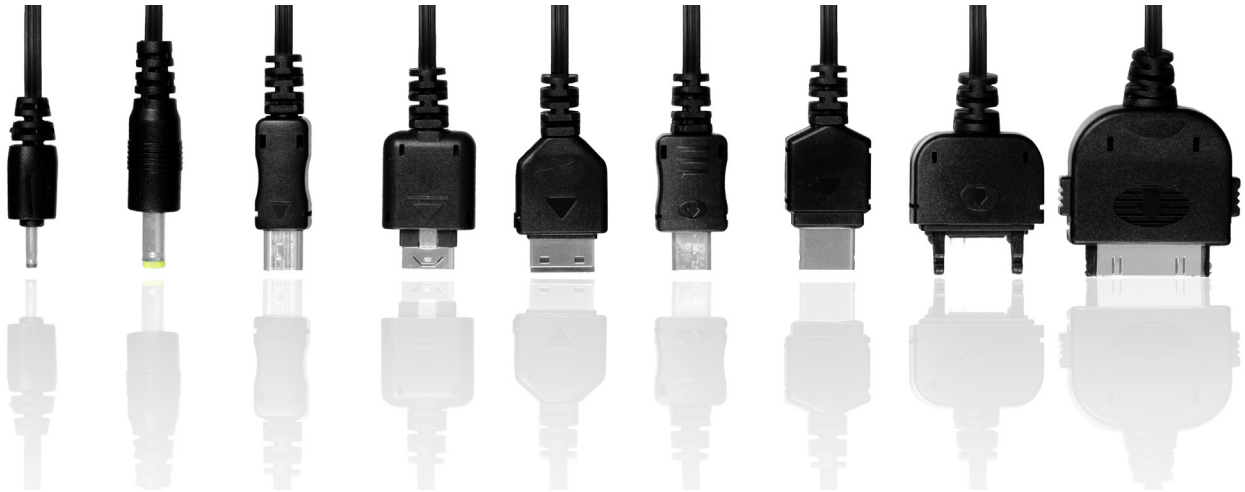
R total cable resistance (in Ohms)

Equation 1: Calculation of Voltage Drop (I^2R Loss)

For off-grid, third-world, or remote monitoring stations, the option to be able to use AC mains or DC back-up batteries allows non-interruptible power security and high-reliability emergency power. Add the ability to use DC sources such as solar photovoltaics (PV) or fuel cells, then even some military applications can be covered. This same concept applies to any number of hybrid grid, microgrid, and other distributed energy resource (DER) architectures.

Implementing Industrie 4.0 requires creatively adapting legacy infrastructure to new standards and compatibility with flexible solutions. While many applications/markets can benefit, many cannot implement these changes overnight. A very modular line of high-efficiency solutions facilitates a smoother transition of perpetual improvement. Engineers can easily create a product family compatible with several different operating scenarios, which carries huge savings from minimizing manufacturing overhead to streamlining supply chains to improving time-to-market (TTM).

SUMMARY/CONCLUSIONS & FOLLOW-ON INFO



Power solutions should have the same look and feel for ease of design and familiarity for effortless leverage and reuse yet be able to support a variety of input/output/power ranges. The operational savings from optimal utilization of energy consumption in a facility typically also yield significant savings in Supply Chain and Manufacturing operations due to the consolidation of PSUs required.

In factories and other plants powering many small electronic devices, having commercial-off-the-shelf (COTS) solutions to quickly and inexpensively support fast and effective replacement when necessary separates industry leaders from followers. A truly universal AC- and DC-input power supply enables agile adaptation to equipment resource reconfigurations and effective allocation of resources from one purpose to another. Get the responsiveness, while maximizing sustainability objectives.

RECOM is an innovative power supply company that does not just follow the market, but pushes the boundaries. Learn more about the SWEET RECOM RAC15-K/WI series here: RAC15-K/WI. RECOM also provides numerous other solutions to fit various application needs for isolation, protection, power levels, and challenging environmental use cases.

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