Why are Power Designs Moving to 48V?

Today's applications are increasing performance by adding:

- More processing capability
- Higher communication rates
- Longer run rates
- Added peripherals
- More torque
- Brighter LEDs

To deliver "more" requires more power to be delivered. More power typically is constrained by size and/or weight restrictions. This is why a growing number of industries are moving to higher-voltage, 48V distribution versus conventional 12V distribution.

Why 48V?

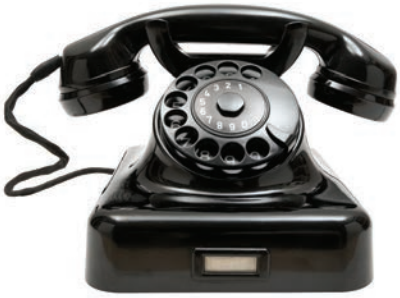
I^2R losses in a system can be detrimental to system efficiency and can reduce the power flow to the load effectively given cable, connector and/or PCB limitations.

As an example, processor power in servers has increased from sub-100W to 200W, 300W and even higher. Distributing this increased power to multiple server processors creates more losses unless mitigated by higher voltage distribution or larger copper bus bars if possible. Not just servers, but any design with increased power will have increased losses to the square of the current.

Higher-voltage distribution of power reduces the I^2R losses. For example, a 48 vs. 12V power distribution scheme creates a 16x in power loss reduction. With such a reduction in loss, why would anyone use a low voltage (like 12V) power distribution scheme?

The answer is a higher-voltage distribution scheme that can actually lower overall efficiency, create a higher cost and increase size / weight when the higher voltage converters are compared to the lower voltage ones.

But these drawbacks in the converters are largely historical. Today, engineers can reduce I^2R losses and utilize higher-voltage converters that enable efficiency, cost and size / weight metrics comparable to or superior to those of lower-voltage converters.



Telephony started it all…

We can thank the development of the modern telephone and telephone exchanges for the earliest use of 48V. As you would expect, the communication industry standardized to and still uses 48V today.

Why? It was more efficient because of lower voltage loss over distance (as a % of the operational voltage), smaller-gauge wire requirements, simple battery backup (also the reason for negative reference 48V) and a voltage level considered to be safe.

What is the new 48V and is it safe?

Many consider the usage of 48V outside the communication space as the "new 48V" since it is positive referenced, has no lightning or surge requirements and has a more limited range of 30 – 60V typically.

Voltages below a $60V_{DC}$ limit are considered Safety-Extra Low-Voltage or SELV, referring to their handling requirements compared to 12V usage. The 48V distribution scheme minimizes I^2R losses without creating SELV issues.

Where is 48V being used today?

Today, it is widely documented that 48V is used in such areas as data centers, automobiles, LED lighting, industrial equipment and even power tools. It is impossible to go through a typical day and not see / use several 48V applications – 48V is the new 12V.

Data centers blazing the "New 48" path

Data centers and supercomputers are demanding power at the levels of small countries and efficiency is critical to these high-performance computing centers. With surging interest in artificial intelligence, computing solutions are requiring processors that can keep pace with the increasing power requirements.

However, delivering the higher processor power presents physical challenges to power delivery and in trying to maintain efficiency using traditional 12V. Therefore, engineers have turned to 48V distribution to enable the higher levels of power distribution and overcome these challenges.

Google adopts 48V

One example of 48V usage is by Google. Google engineers openly discussed the merits and cost savings of 48V within their data centers at APEC2017 (Applied Power Electronics Conference, 2017) and OCP2017 (Open Compute Project, 2017).

Another example of 48V adoption was highlighted at Supercomputing 2017, when the recent Green500 ranking was announced.

The Green500 ranks the most efficient high-performance computer systems. This year, four of the top five rankings were systems designed by PEZY, a Japanese company that deployed 48V distribution throughout their computer systems.

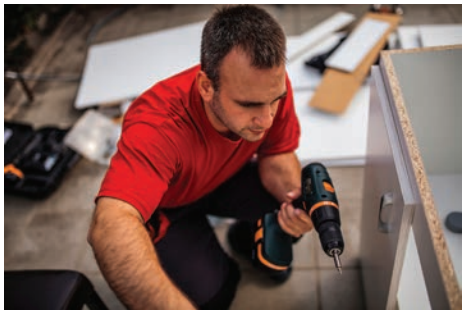
Commercial LED panels get brighter, cost less

Ever wonder how much it costs to illuminate Times Square for a night? The size and power demands of those enormous outdoor LED screens have grown exponentially in the last decade.

LED panels continue to increase in performance, delivering higher LED pixel density and brightness. Engineers designing these new panels are moving to 48V distribution, reducing the power cable size and weight while also increasing the efficiency.

In addition to enhanced efficiency, these larger installations are benefiting from reduced weight and ease of installation. Today a matrix of smaller panels are assembled together to create a single brighter, longer-lasting display — which is easier to transport and install.

48V power distribution also provides lower cost and a safer alternative to AC distribution schemes used in retail store wall displays and transportation hub informational displays.



Power tools clamor for more torque

Consumer and professional battery-powered tools are following a similar trend, moving to higher voltages for more power. More power enables longer run times and higher torque for tools. Cordless-tool batteries have progressed from ~9V to ~12V to ~18V to ~20V to ~24V, to now 48V and 60V.

Walk into any home center and you will find 60V battery tools from such well-known companies as DeWalt to lesser-known newcomers like Greenworks. Likewise, you will also find lighter-weight yard tools like Snapper's high-performance 60V chainsaws and mowers.

Automotive is driven to adopt 48V

Mild hybrids are increasing fuel efficiency by 10% or more in vehicles with a modest addition to existing combustion-based vehicles. Automotive engineers, like those at Delphi, are using 48V power distribution schemes for mild hybrids to take some load off an internal-combustion engine by powering accessories during the "stop" phase of start / stop operation. Initial designs deployed a 12V-only battery scheme, but the system couldn't adequately power all the cabin features during the stop phase. 48V has proven to be the most efficient alternative.

Powering robotics and industrial equipment

Industrial equipment covers a wide range of products and 48V is being leveraged here for the same reason — more power.

- Kiva Systems, a robotic fulfillment system for large warehouses, is using 48V to support Amazon's warehouses.
- Advantest uses 48V to minimize wire size (more power through a smaller wire) within their ATE products.
- CAT offers 48V warehouse lift trucks. Process control, manufacturing equipment and factory-automation equipment are additional examples of 48V applications.

48V is the new 12V

If more power is needed, consider 48V. Engineers are finding the losses attributed by simply increasing power with 12V distribution are limiting their systems. Enhanced 48V converters / regulators today enable efficiencies, cost and size / weight performance comparable to 12V counterparts. Many power designs are capitalizing on the additional benefits of replacing intermediate stage regulators with a single regulator that converts directly from 48V to the load voltage instead of first regulating to 12V.

48V DC-DC has increased over the past few years with several component suppliers offering 48V solutions. Vicor enables 48V DC-DC regulators and isolated converters pushing efficiency, density and cost performance through several design assets including:

- High-efficiency switching topologies like zero-voltage switching
- 3D-packaging technology enabling high-density power packing like the SM-ChiP™ package

In addition, engineers designing their 48V systems have access to Vicor online selection / design tools, reducing design time and ensuring an optimized solution.

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