

Obvious approach

400 VDC for Data Centers

Converting, transforming, converting, transforming – vast amounts of unused electricity simply disappear in data centers. The idea of switching the power supply to direct current and bypassing a large proportion of these losses results in a paradigm shift.



SCHURTER GP21: 400VDC power plug according to IEC TS 62735-1 for systems up to 2.6 kW

Saving energy has many good strides. First, it is good for our ecological consciousness. Second, it leads to a more lean power system architecture that can save costs, time and effort through skillful planning.

Taking a look back

The fact that nowadays we are almost always talking about alternating current (AC) when it comes to primary voltage electricity, doesn't mean it will forever remain that way. During the "War of the Currents" at the end of the 19th century, the two opposing camps fought to the limits: the advocates of the alternating current (Nikola Tesla and George Westinghouse) versus Thomas Alva Edison, who made a strong case for direct current (DC). The formal War of the Currents was the first format war in industrial history that fought for a standard. We know how the story ends. But the outcome was not so clear at the time.

The return of direct current

But, Edison's defeat did not mean it was the end for DC. A lot of DC-operated devices are used in today's busy digital age - entertainment electronics, industrial IT, communication technology, electric vehicles and much more. At the other end of the energy supply chain, technologies quickly evolving to mimic the AC primary power chain with one that directly generates direct current, such as photovoltaics, fuel cells and wind farms. And even in the transmission of power there is an important exception to the otherwise prevailing alternating current: the high-voltage direct current (HVDC) transmission system. It enables a low-loss bulk transmission of electrical power over long distances.

The use of direct current is therefore on the rise again: More and more electricity is supplied along the supply chain at least once in DC form

in the areas of energy generation, transmission, storage and use. Although conversions are necessary for stepping down voltage at times for technical reasons, in some cases these AC voltages and frequencies are probably still used because of predetermined infrastructure built upon years of standardization of AC power. However, these conversions always cause losses in power and thus energy waste, as well as generating unnecessary heat which can be avoided.

Energy-guzzling Data Centers

According to an independent British report from 2016, data centers consume approximately 3 % of the world's electricity and account for 2 % of total greenhouse gas emissions. This ecological footprint corresponds to that generated by the often quoted and vilified airline industry. A clear picture: with a consumption of 416.2 terawatt

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hours, data centers were significantly more hungry for power than the entire UK (about 300 terawatt hours) in the last few years.

Data centers are real energy guzzlers. What is known as a PUE value (Power Usage Effectiveness) is usually used to evaluate the efficiency. The PUE value compares the total energy consumed in the data center with the energy consumed by computers. Example: a PUE value of 1.3 means that 30 % of the energy dissipates as heat. This may sound like a lot, but in actual fact this value is excellent. Values of around 2 or higher are more the rule than the exception.

Why do these losses occur?

Losses occur all over the place. For example in processors, in cooling, in airconditioning, but also in the distribution of power. Traditional data centers draw their energy from a medium voltage line (AC). This alternating voltage is first transformed down and converted to DC in order to feed the batteries in the uninterruptible power supply (UPS). After a further conversion into an alternating current, it then continues to the power distribution units (PDU). These feed the individual power supplies of the end users (servers) with alternating current, which, in turn, have to be converted since servers work off of direct current.

A lot of to and fro between AC and DC. And, during each conversion or transformation,

energy always dissipates in the form of heat loss. It gets worse because this heat loss must be cooled and discharged, which requires additional components

The DC approach

The approach of providing a data center with DC voltage is obvious. If the server is already working off DC power, it makes sense to continue using it as consistently as possible throughout the chain. From the grid to the chip. The incoming medium voltage (AC) is transformed down and then converted over a high-power rectifier to DC. This supplies the batteries for the UPS and then transfers the power to a DC switchgear for it to be further distributed.

Then the last step in the DC power supplies, which brings the final level for supply voltage for the server to the usual computer-DC supply voltages.

What's the point?

The DC power architecture contains significantly fewer components than that of alternating current. According to calculations and studies by, for example, ABB, Amstein + Walthert or Stulz, by eliminating various transformations and conversions there is already an increase in efficiency of 10 % from the supply to the server. In terms of investment costs for the electrical infrastructure, one



DC-powered data center of green.ch in Lupfig, (Source: Securiton)

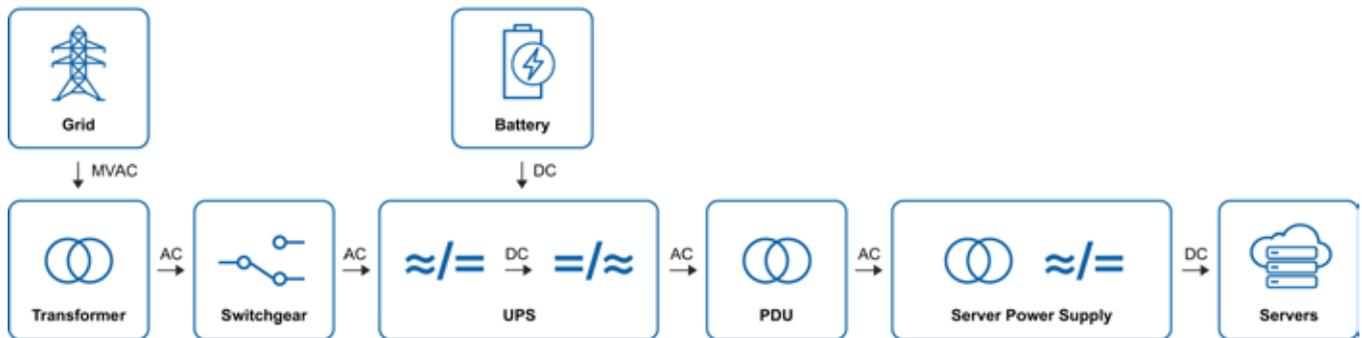
should work off the basis of a reduction of around 15 %. Less space is also required for the electrical infrastructure. In fact, considerably less. 25 % should be expected.

Fewer components are installed quicker. Fewer components are serviced faster and cause fewer errors. This makes them more reliable and therefore cheaper. Both in terms of the purchase and the maintenance. According to a study conducted by NTT (Nippon Telegraph and Telephone), the reliability is expected to increase tenfold due to the system being less complex!

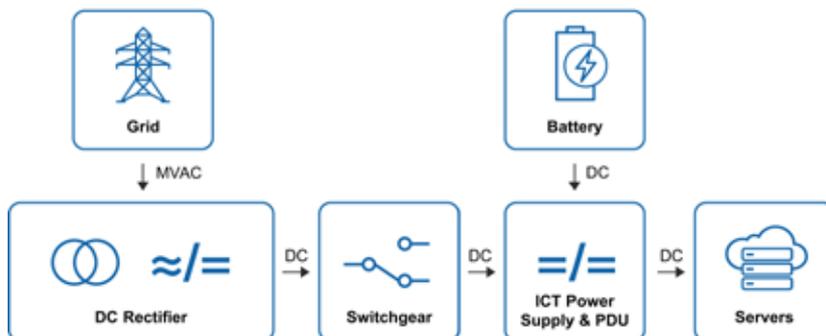
Quality of the supply

Direct current improves the quality of the power supply. It eliminates problems with unwanted harmonic waves and harmonic

AC Architecture

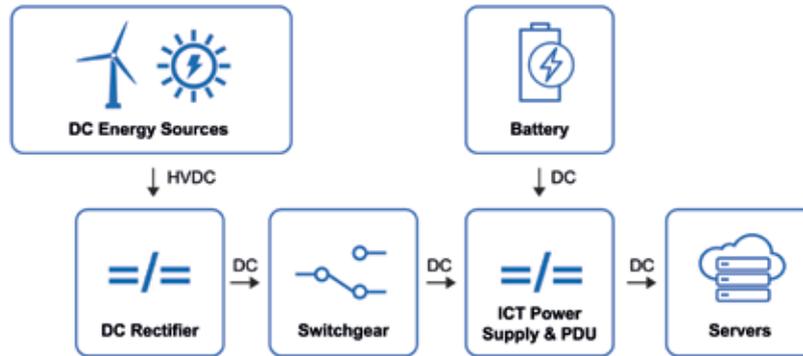


DC Architecture



AC (top) versus DC (bottom) approach. The DC architecture uses far less components.

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The DC architecture allows the integration of renewable energy sources directly without any need for conversion

distortions. A phase compensation is also no longer required. In addition to this, a synchronization is no longer required for coupling the various sources and networks. Even rectifiers and inverters are not required as the batteries are connected directly to the DC supply.

Integration of renewable energy sources

No sane person would think of building a data center in the middle of a big city. The high price of the land alone makes such a choice impossible. So, it's out into the countryside we go, where we can find some interesting additional perspectives. It is so much easier to integrate renewable energy sources such as photovoltaics, fuel cells or wind energy as these sources of energy can already provide the electricity as a direct current.

Standards

Some data centers around the world already use DC technology. In China, Japan, the USA, Germany and also in Switzerland. However to date, there have been no binding standards to adhere to. The IEC (International Electrotechnical Commission) has set out to create the missing link with standardized plug and socket devices according to TS 62735. The standard IEC TS 62735-1 has been adopted since August 2015 for systems up to 2.6 kW relating to the distribution of power. The standard IEC TS 62735-2 was approved in December 2016 for higher outputs of up to 5.2 kW - which can no longer be separated when under load.

The device-side equivalent should also be approved in a next step. Efforts are currently being made to create solutions for DC plug connections on the previous AC standard IEC 60320.

So far there are different approaches for DC connectors, but they have not been able to prevail due to the pending standards. That is why various providers are working together in the IEC standardization body in order to replace the proprietary approaches with an internationally recognized standard.

The conversion of the voltage supply must however be gradual. It is only in this way that all the devices will not need to be switched from an AC to a DC supply at once. Solutions are being sought that can feed the device with both an AC and a DC supply. The power supply units of the devices can process both supply voltages. However, it must also be ensured that all the safety-relevant precautions are taken.

Disadvantages?

Where there is light, there is also shadow. This also applies to the 400 VDC data center. On the one hand, there is of course a lack of long-term experience values. These skills and knowledge need to be collected and prepared in the coming years.

The availability of DC components is still in its infancy. It needs a new approach. The use of a DC supply requires integral planning from the grid to the chip. And everything in between!

Because there are still losses here - e.g. heat loss. This means: There needs to be cooling systems with a DC supply. Also needed are air-conditioning systems, fire protection systems, access control systems as well as building control systems and much more. All of these components should be equipped to operate with direct current.

There also needs to be cooperation. Cooperation is the fastest and most effective way to achieve defined and established standards. Namely, when all will benefit from this cooperation potential; not the least of which the data center operator.

Outlook

The supply of a data center using direct current has enormous potential. Not only does it offer the potential for saving energy, but also, to the same degree, savings on costs, space, resources and time. Furthermore, the supply of renewable energy sources offers the possibility of providing electricity directly for the data center as a direct current, without additional transformation or conversion processes. In addition to the cost reduction factor, another

factor must be clearly emphasized, which should be given at least the same weight: The quality of the DC-level power is better. This will result in the use of fewer components and, ultimately, greater reliability.

Availability is the keyword in the digital age. Everywhere, at any time.

Company

SCHURTER continues to be a progressive innovator and manufacturer of electronic and electrical components worldwide. Our products ensure safe and clean supply of power, while making equipment easy to use. We offer a broad range of standard products including circuit protection, connectors, EMC products, switches and input systems, as well as electronic manufacturing services. Moreover, SCHURTER is ready to work with our customers to meet their application specific requirements, not covered in our standard range. You can rely on SCHURTER's global network of companies and partners to guarantee a high level of local service and product delivery.

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