

Power supply - Correct comparison of efficiency between a brick solution and a ready-to-use DC/DC converter

Autronic has been part of Fortec Elektronik AG since 2007 and is currently planning far-reaching changes that will be implemented by 2025:

By merging the Group's various power divisions, we will offer a comprehensive power supply product portfolio from a single source. In addition to selling products from well-known manufacturers, our strength lies in providing value-adding and customized solutions that meet all our customers' requirements without compromise.

For system suppliers, a frequently arising and important issue when designing-in a power supply component is the cooling of the overall system. In a customer application, considerable heat can be generated by the CPU, semiconductors, radio modules and other active components. If the power supply unit is also installed in the application, even more attention must be paid to heat dissipation. With many components, the developer has no influence; a processor is a processor, a Mosfet is a Mosfet, so the possibilities for thermal optimisation are severely limited here.

The situation is quite different for power supply units. Maximum efficiency is required here, as additional heat has to be "handled" if the efficiency is low. Information on efficiency can be found in the data sheet of the power supply unit, so that the basics can be quickly understood.

Now the questions arise:

Which power supply do I use?

How can I directly compare the efficiency of a PCB mounting solution and a plug-and-play solution?

How can a comparison be made so that an assessable statement on efficiency can be made?

When selecting the PSU, there are of course many challenges that need to be considered by the people responsible, here are some examples:

- which product standard do I have to fulfil?
- what EMC requirements do I have?
- what installation space is available to me
- how can I mount the device
- what budget is available to me
- do I have my own developer resources available
- what efficiency do I expect (i.e. what heat do I need to dissipate)
- availability/schedule
- and there are many other topics that need to be addressed

How do you compare what correctly?

When it comes to power supplies, we differentiate between a plug-and-play solution and a partial solution, such as components/DC-DC converters that are mounted on PCBs. We also differentiate between COTS power supplies and so-called customized solutions.

The efficiency of three products in the finished application is compared in order to obtain a fair comparison:

- ✓ fully filtered plug-and-play solution for defence (60 W)
- ✓ and two brick solutions (one industrial converter and one converter for defence applications).



A PCB-mountable module (often referred to colloquially as a brick) can only ever be a partial solution for a power supply. Existing filter modules can also be used, which then take over parts of the filtering.

What are the requirements in addition to high efficiency?

- Filtering:
 - MIL-STD-461G (Navy Mobile and Army)
 - MIL-STD-1275E, including
 - Load dump according to DEF STAN 61-5 Part 6.
- Reverse polarity protection
- Inrush current limitation

In this case, the brick only converts the voltage from 24 V to 12 V on its own. However, circuit elements are required here, otherwise the converter will not start working. The circuit elements are required to protect against surge and burst interference. This means that appropriate capacitors must be provided in the circuit. Furthermore, the circuit to be developed requires filter measures to reduce interference emissions via the lines and the housing, and interference immunity must also be considered.

The following components are required for filtering:

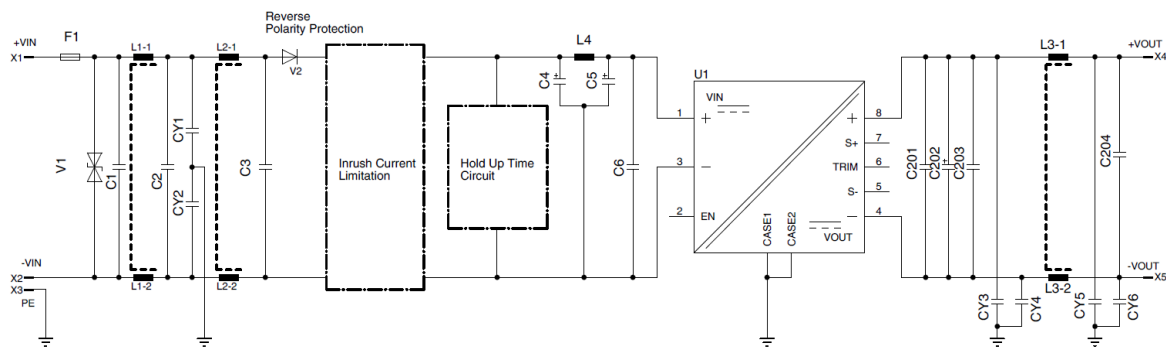
3 current-compensated chokes are required to suppress the high and low frequency interference via the cables and the housing. A snubber and Mosfets with high resistance values are used for a flat switching edge to guarantee good EMC optimization. A series choke helps to further reduce the EMC level.

Efficient filtering for surge pulses in accordance with MIL requires additional components that require approx. 1-1.5 watts of power. Active reverse polarity protection with an efficient transistor solution, which is preferable to a diode, should not be underestimated.

Summary:

Filtering	Power loss	reason
Additional filtering Input	2 W	Mosfet with high RDS(On), incl. load dump
Current-compensated chokes	3,6 W	3 with 1.2 W loss each
Two Mosfets	2,5 W	Mosfet with high resistance values
Linear choke	0,8 W	filtering
Other components	0,4 W	Add. material
Total	Approx. 9,3 W	Total loss due to filtering

Sample circuit of simplified filtering:



The efficiency of a modern, industry-standard brick is 92.5 % at 100 % load and 25 °C. Newer PCB-mountable MIL converters have an efficiency of between 86 % and 87 %. Small ready-made filter modules, used as partial filtration, have an efficiency of approx. 98 %.

The result of the efficiency of a brick including partial filtering is 90 % (0.925 x 0.98) for the industrial converter and 85 % (0.87 x 0.98) for the MIL converter.

The efficiency of the ACM60 is 84 %.

In comparison, the complete filtering looks as follows:

Wandler	Efficiency DC/DC	Efficiency Filter Module	Losses due to additional filtering	Efficiency total
Industry-Brick	92.5 %	98 %	approx. 5.5 W	84 %
Mil-Brick	87 %	98 %	approx. 5.5 W	80.5 %
ACM60	84 %	Not needed	Not needed	84 %

Conclusion:

Just looking at the data sheet, i. e. without any further thought about the effort required, the original 84 % efficiency of a finished solution now looks completely different! From an economic and physical point of view, the 84 % is what can be achieved in terms of optimised efficiency.

If you are now faced with the decision of choosing the right power supply, i. e. a plug-and-play DC/DC converter, or would you prefer to work on your own power supply solution with bricks, filter modules and your own circuitry, this means in detail:

- In-house development capacities can be tied to a power supply solution for a long time
- A ready-made solution offers identical or even better efficiency, with proven technology
- The responsibility for the products in a ready-made solution is transferred to the supplier
- With an in-house solution, you are free to decide on the placement of the components and may also have production and price advantages

Sachsenheim, 29.02.2024-Giovanni Rodio-