

## Power supplies for the next generation of CompactPCI systems



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## **1. Introduction: general tasks of PSUs for CompactPCI systems**

In order to supply the components of the system with their required DC voltages, power supply units (PSUs) are built into CompactPCI systems. The tasks of the PSUs include the following: to provide a secure galvanic isolation from the public mains, to reduce and rectify the voltage and to smooth out voltage fluctuations and interference. Also important for the system is an output current limiter for safety purposes. This prevents, for example, a damagingly high current flow in the event of a short circuit on a board. Other technical requirements for PSUs are overvoltage protection, lightning protection and electromagnetic compatibility (EMC). This concerns interference emissions and interference immunity. The characteristics stated are regulated by law (the EMC Directive and the Low Voltage Directive) and are documented in Europe by the CE mark and declaration of conformity.

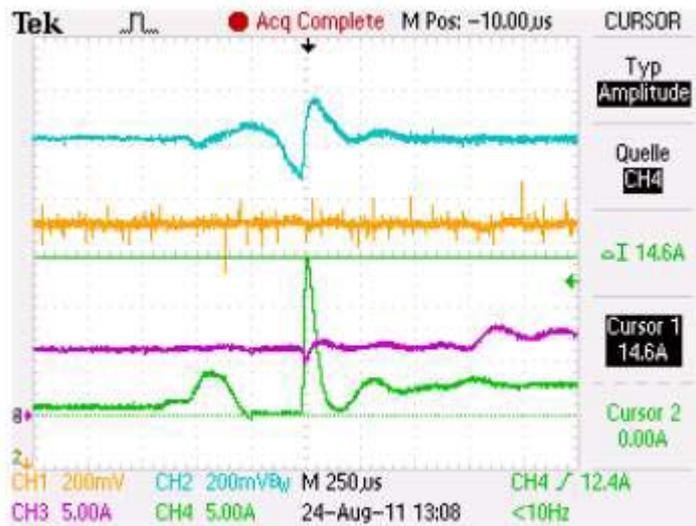
In CompactPCI systems, output voltages of 5 V and 3.3 V (for processors) and  $\pm 12$  V (e.g. for hard disk drives and fans) are required as a rule. The specifications for the individual bus technologies vary considerably in the requirements they set out for system power supply.

## **2 Additional requirements for processors**

In addition to these general requirements, the processors used by the system present particular requirements for the dynamic behaviour of the PSUs. Where Pentium M processors are used, i.e. no high-speed processors, there is a somewhat increased initial current, but then the current remains relatively stable during operation without peaks. Newer multicore processors present significantly greater demands on the power supply system. Here the initial current is very small but during operation, short current peaks of the order of 100  $\mu$ s repeatedly occur of up to 18 A.

Pentium M processors continue as before to be used in applications such as process control in industrial systems. Multicore processors, however, are used primarily in high-performance applications with large data volumes, such as telecommunications, wi-fi, passenger information systems, etc. Moreover, boards with multicore processors are generally provided with a power-saving mode, so that the processor must frequently rise from its sleep state to full power in a very short time with a steep rise in current. This is the cause of the current peaks during operation.

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Core i7 CPU, Linux Ubuntu Screen Saver

*Illustration: Dynamic load change on a i7 CPU and consequences for the supply voltage;*

*Yellow/umber = output 3.3 V, 200 mV per division*

*Blue = output 5 V, 200 mV per division*

*Green = output 5 V, 5 A per division*

*Pink = output 3.3 V, 5 A per division*

### 3 Power Supplies for CompactPCI systems

Previously, CompactPCI systems (mainly using Pentium M processors) in industry applications that did not require redundancy were fitted with ATX power supply units. Where redundancy is required, the use of 19" plug-in PSUs is recommended. Then when the PSUs are run in parallel in redundancy operation (n+1), the current share bus ensures equal division of the current between them. Increased use of multicore processors could also lead to the use of 19" plug-in PSUs.

#### 3.1 ATX PSUs

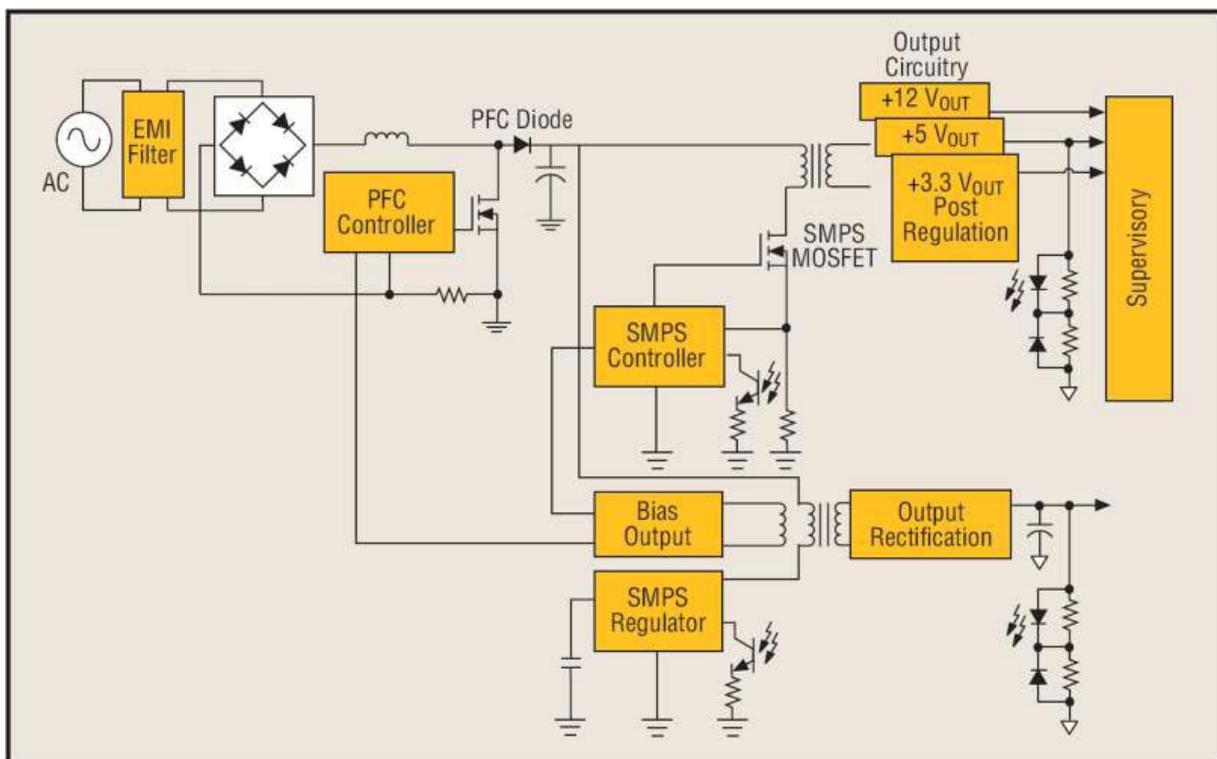
ATX stands for "Advanced Technology eXtended" and generally offers a rated output of some 350 watts. ATX PSUs are primarily used in office PC systems but are also suitable for many industrial applications. ATX units are designed for the mass market, which makes them relatively low-cost. An ATX PSU is housed either in a simple metal casing or indeed without

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any housing, as a PCB-based unit with heat sinks, integrated into a system. The mains power input and the outputs to the backplane are via wired cables. This means that an ATX unit is tied into the system and cannot be easily or quickly removed and replaced when the need arises.

Since these PSUs are not mounted in the defined airflow of the board cage, additional measures are also often required to cool the units. ATX PSUs provide the following voltages:

- +5 V standard voltage for most circuits
- $\pm 12$  V for drive motors (HDD, CD-ROM, floppies) and fans
- +3.3 V main supply voltage for the processor



*Illustration: A lower-cost single-converter solution (source: ONSem)*

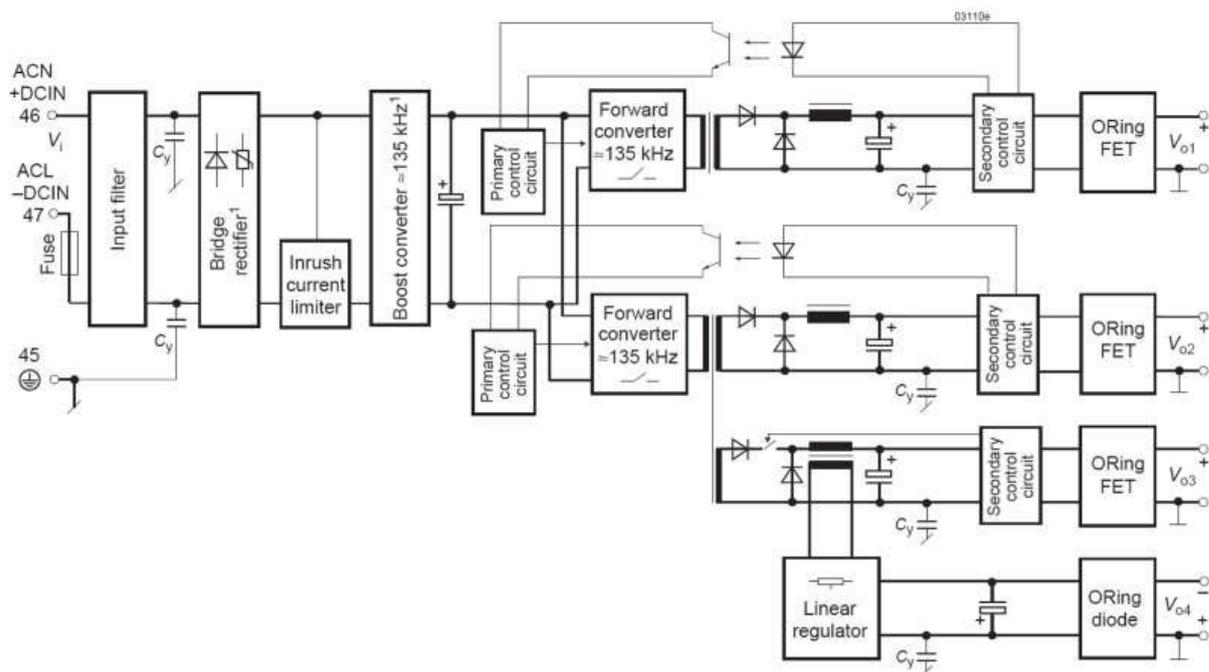
### 3.2 19" plug-in PSUs

Pluggable PSUs with a 19" form factor generally have a rated output of 250 W. They are easy to integrate into a system, since they can be simply inserted into a suitable slot on the front, like any other plug-in module. No further wiring, etc., is necessary. This simple

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pluggability is also an important feature for rapidly exchanging units and thus for assuring high system availability in applications that require this. Additionally, placing the PSU within the board cage is an advantage in terms of system cooling. Cooling, using fans or fan modules, is specially designed for this arrangement of the boards, and so no additional measures are necessary. The PSU is cooled by the defined flow of cold air. However, the special dimensions of 19" PSUs are fixed by the standards and the designer is often obliged to use costly components in order to maintain conformity. Plug-in 19" PSUs supply the following voltages:

- +5 V standard voltage for most circuits
- $\pm 12$  V for drive motors (HDD, CD-ROM, floppies) and fans
- +3.3 V main supply voltage for the processor



*Illustration: Two-converter solution (source: Power One)*

### 4 Dynamic behaviour of PSUs

Since ATX and 19" plug-in PSUs have different designs of regulation system, they exhibit different dynamic behaviour patterns. The low-cost ATX units are less technologically sophisticated than 19" plug-in units. An ATX power supply has, for example, only one converter, which is responsible for all the required voltages. It must supply all four voltages

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and at the same time evaluate the current status. Should a situation arise in which, say, the 5 V or the 12 V rail experiences a sudden change in load, the reaction time of the converter is somewhat slow. Another negative factor here is the inductance of the lengths of cable used in the ATX unit. The result is that the slow reaction of the PSU causes an excessive voltage drop to the processor. The processor board includes a voltage monitoring function. The voltages are checked, and whenever even one of the voltages is not correct, the processor receives a reset command. It can thus happen in some circumstances that a processor running a high-speed application and powered by an ATX power supply unit performs repeated resets and the application is unable to run.

In 19" plug-in PSUs there are generally two separate converters that act as a pair to supply the output voltages. Since the work is shared between the two converters, they can smooth out extreme dynamics more easily. In addition, in 19" units the 12 V rail is also monitored, i.e. a separate line is run to the location of the event and checks whether the voltage is still within the prescribed range. Thanks to these measures and a generally more expensive technology, even sudden load changes do not present a critical situation for these power supplies and the processors they supply.

### **5 Recommendations for use**

In applications in which large data volumes are processed and thus multicore processors are used, the use of a 19" plug-in PSU is recommended. This also applies to existing CompactPCI systems that have been upgraded with new CPU boards featuring multicore processors. Here, the existing ATX PSUs should be replaced by 19" plug-in units. In CompactPCI Serial systems, 19" plug-in power supply units are used from the outset. In comparison to the system overall, the cost of the PSU is relatively small, but it nevertheless ensures the reliable operation of the system. Where there is the desire or requirement for a CompactPCI system that conforms to the specification, there is no alternative to using 19" PSUs, since these systems are always designed for redundancy and all components must be removable.

19" plug-in power supplies satisfy these requirements; they can be operated redundantly and can be inserted into the system from front and rear. By contrast ATX PSUs cannot be operated with redundancy and are hard wired into the system. Another advantage of using 19" plug-in PSUs is that even where two of these units are fitted (for redundant operation), these require about one third less space than a single ATX unit.

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*Illustration of a CompactPCI system: on left with ATX power supply unit, on right with 19" plug-in PSU*

Schroff has been offering 19" plug-in power supply units in addition to ATX units for smaller CompactPCI systems for a number of years. 19" PSUs are offered as standard in two system series. The systems are equipped with a monolithic backplane, into which the PSUs are inserted directly. Currently Schroff is developing a new 19" plug-in power supply module specially for CompactPCI Plus IO and CompactPCI Serial systems which will supply the following voltages as required by the specification: the so-called payload voltage of 12 V and the management voltage of 5 V. All other voltages are derived via DC/DC converters on the relevant application boards. This will make the PSU less elaborate and bring its price closer to that of an ATX unit, despite having improved technology.

### **6 Summary**

ATX PSUs continue to be sufficient for many industrial applications, e.g. using M processors. With multicore processors and high dynamic demands, however, there is no alternative to a plug-in 19" PSU to ensure functional reliability of the system. The somewhat higher cost of 19" PSUs should also not discourage the user, particularly since this forms only a relatively small proportion of the overall cost of the system. It is also prudent to invest a little more money in the power supply arrangements from the start, particularly where high-speed applications are concerned, so as to avoid problems and downtimes.

## **7 Company portrait and notes on the author**

Schroff ([www.schroff.co.uk](http://www.schroff.co.uk)) is a leading developer and manufacturer of electronics packaging systems for electronics, automation, IT and communications technologies. The company's standard products range from cabinets, enclosures and subracks through power supply solutions and backplanes to microcomputer assembly systems. With its extensive integration service, Schroff is capable of offering complete plug-and-play systems for 19" technology to its customers. Schroff, based at Straubenhardt, Germany, is a Pentair Technical Products company and employs some 1300 people in Europe. The group is a part of Pentair Inc. (headquarters in St. Paul, Minnesota, USA) with over 15,000 employees in 50 locations worldwide.

Pentair Technical Products, a global business unit of Pentair Inc., is a leading provider of product and service solutions in the area of housing, cladding, protection and cooling of electronic systems. With its industry-leading brands Hoffman, Schroff, McLean Cooling Technology, Calmark, Birtcher, Aspen Motion Technologies and Taunus, Pentair Technical Products offers an extensive selection of standard products and also modified and custom-built solutions for trade and telecommunications, energy systems, general electronics applications, industrial systems, railway and traffic engineering and medical, defence and security systems.

Oliver Kistner, Dipl.-Ing. (FH), studied telecommunications at the Fachhochschule Wiesbaden, Germany. He started working for Schroff/Pentair Technical Products in 1992 as a design engineer for power supply systems and today is principal engineer for power electronics, with responsibility for development of assemblies in the areas of power supply, AdvancedTCA power entry and control electronics for fans.

Martin Traut, Dipl. Wirt. Ing. (FH), studied industrial engineering at the Fachhochschule Karlsruhe. Since 1990 he has acted as product manager for various Schroff products. In 2004 he changed to product manager for integrated systems (CompactPCI, VME, AdvancedTCA) for Schroff/Pentair Technical Products and since then has exerted considerable influence on the design of the integrated systems product platform.

## **8 Links**

[www.schroff.co.uk/powersupplies](http://www.schroff.co.uk/powersupplies)