

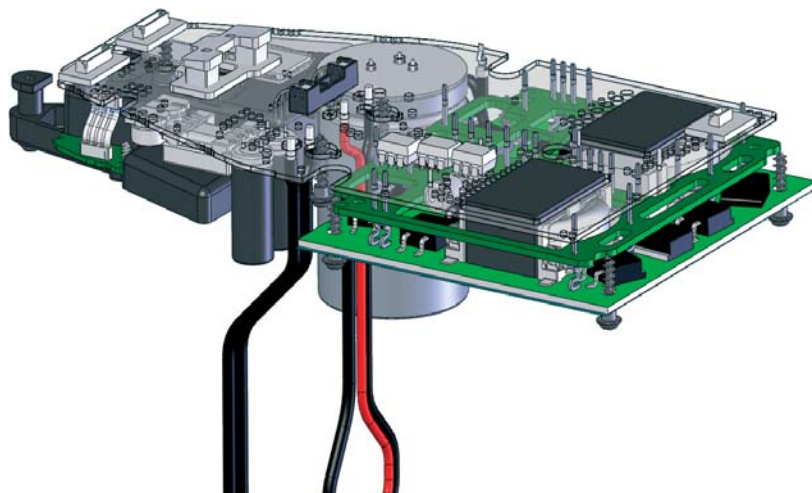
PLECS Helps Reduce EMI Emissions of Power Tools

Panasonic is one of the largest electronic companies in the world. Located in Lüneburg, as part of the German Electronic Technology Center, the Power Supply Business Group provides customer related development of intelligent switch mode power supplies and motor controls for professional use in home appliances and machine tools.

PLECS

For a heavy mobile power tool, Panasonic engineers developed a three-phase interleaved boost power-factor correction (PFC) circuit that reduces line current distortions and therefore EMI problems. Without this PFC circuit it would not be possible to operate such heavy power tools from a single phase mains supply because of power factor regulations.

Panasonic significantly improved development time and cost using PLECS for circuit simulation. „PLECS is a very intuitive, high-speed tool, which gives us a quick and robust survey of the general aspects of a circuit“, says Dr. Oliver Woywode, leading R&D engineer in the Power Supply Business Group. „At the same time it enables us to study the circuit in detail and to respond flexibly to changing customer requirements.“



■ The challenge

To ensure power quality, common EMC standards require line current conditioning. Line current harmonic distortion must be limited, and the line current should be in phase with the line voltage to minimize reactive power consumption.

In case of high power applications, a basic single-phase PFC circuit is not sufficient: the power semiconductor devices would require unnecessarily high current and voltage ratings, and larger inductors would be needed to avoid saturation.

By splitting the PFC circuit into three parallel channels, each one needs to be dimensioned for only one third of the power. Additionally, phase modulation between all three channels gives the chance to reduce the current ripple generated by switch mode power supplies.

While the basic circuit topology is relatively simple and well known, the phase synchronization, i.e. the control of the semiconductor switches in each circuit, is sophisticated. In addition to the phase correlation, the stress of the circuit devices has to be surveyed carefully.

■ The solution

In order to find the best control algorithm for the semiconductor switches in a restricted time and cost regime, Panasonic engineers needed a powerful simulation tool.

Otherwise they would have had to rely on lengthy calculations by hand, which involve setting up a state variable representation for every switch configuration. „This would have been very labor-intensive and time-consuming“, considers Oliver Woywode.

Convinced by the performance of PLECS, it was a straightforward decision for him

Development Time Cut by Half

Oliver Woywode:

„As a very intuitive, high-speed tool, PLECS is an irreplaceable part of my every-day business that helps to reduce development time and cost.“

Panasonic

and his colleagues to use this software for modeling the power electronics part of the problem. „Since it is a very comfortable, intuitive and high-speed tool, PLECS has been part of my every-day business for more than 3 years now“, says Woywode.

Using the PLECS schematic editor, Panasonic engineers could easily implement the electrical circuits by drag-and-drop of circuit components and connections. The component library provides special power electronic devices, such as a diode model for the reverse recovery effect. Based on MATLAB/Simulink, PLECS automatically calculates currents and voltages in the circuits, making use of ideal switches and the piecewise linear structure of power electronic systems.

„We could easily model the interaction of the three circuits and read out the stress for each device“, says Oliver Woywode. The data can be displayed in extra windows and easily be extracted and transferred to other programs or for customer documentation.

The fact that PLECS is based on MATLAB/Simulink is one of the great advantages, Panasonic engineers experienced in their work. „For us MATLAB/Simulink is a well-known, powerful tool that we rely upon and

that we use for example to control the semiconductor switches“, remarks Woywode.

„The seamless connection of PLECS and Simulink allowed us to focus on the switch-control strategy.“

The engineers also benefited from the PLECS concept of ideal switches that makes the software very fast and comfortable to use. „These ideal world conditions provide a very good first step on the way to a realistic system“, explains Woywode. „It enables us to quickly see whether a design is feasible or not.“ To move to more realistic scenarios at a second stage, the engineers might add snubbers or parasitic inductances, which are also available within the PLECS environment.

„PLECS provided us with fast, reliable and comprehensible simulation results“, summarizes Oliver Woywode and adds: „The whole performance of the software shows that its roots lie in power electronics.“ Based on these results, Panasonic was able to cut the development time of the three-phase interleaved boost PFC by almost 50%. Now, the newly developed PFC circuit is already a standard-production component for the mobile power tool of the customer.

■ The results

Reduced development time & cost

„Using PLECS for simulation of the three-phase interleaved PFC circuit, we could significantly speed-up development time and thereby reduce development costs“, says Oliver Woywode.

Optimized line current harmonics

„Without PLECS it would have been very hard work to develop the control algorithm for the three semiconductor switches“, remarks Woywode. „We now get fast and reliable simulation results as a crucial basis for the optimization of the line current harmonics.“