TECHNICAL ARTICLE

Optimization of the Power Supply Architecture Comes First

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Abstract

Tools for designing a power supply architecture are not widely used compared to computational and simulation tools. Nevertheless, such tools play a crucial role during the development process of a power supply system for an electrical circuit. Serving as an initial step in the power supply development process, these tools lay the foundation for creating an optimal power supply architecture.

Introduction

Various tools are available for developing a power supply, easing the burden of tedious work for developers. One of these tools is LTspice®, a well-known simulation tool from Analog Devices. This can be used to simulate a power conversion circuit. It enables the simulation of different voltage and current waveforms to refine the circuit design and tailor it more closely to specific requirements.

Additionally, calculation tools like LTpowerCAD® are available. Unlike LTspice, LTpowerCAD is designed for calculations rather than simulations. It takes into account various specifications such as the input voltage range, the output voltage, the load current, the voltage ripple at the output, and much more, to compute and optimize the circuit. A suitable power converter IC is selected and external, passive components are suggested. Thus, a tool like LTpowerCAD is the precursor to circuit simulation with LTspice.

Another critical aspect in power supply development is defining the power supply architecture or creating a power tree. Such a complete power supply of a system usually requires more than just one power converter. Several different voltages are often required. There are different ways to do this. The differences between the architectures can be calculated and represented excellently with a power supply architecture tool such as the LTpowerPlanner® from ADI.

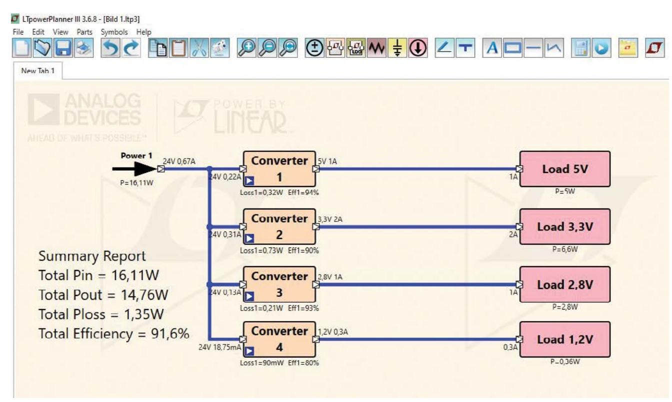

Figure 1. A power supply architecture created with LTpowerPlanner.

Figure 1 shows the interface of LTpowerPlanner with the representation of a power supply architecture using a 24 V input. From this, various supply voltages and currents are generated. The different blocks can be easily added and linked with connecting lines. Clicking on one of these blocks defines the efficiency of the respective power conversion. Once these entries have been made, the LTpowerPlanner can perform an overall calculation of the complete power conversion architecture. The architecture in Figure 1 has an overall efficiency of 91.6%.

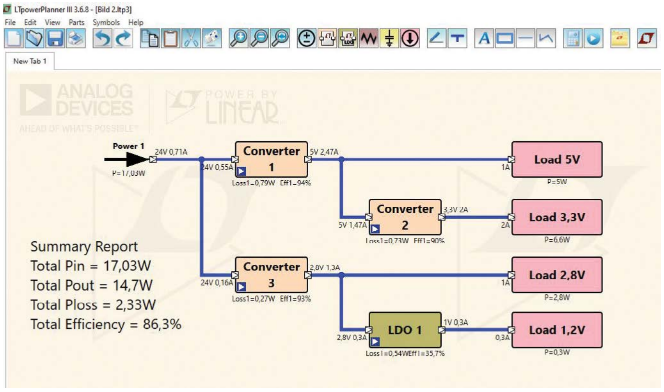

Figure 2. An alternative power supply architecture.

An architecture tool such as LTpowerPlanner allows the user to compare different power conversion architectures. Figure 2 shows a solution for the same specifications as Figure 1, but with a different structure. This second solution can now be compared to the first solution. Here, a linear regulator (LDO) was used to generate the 1.2 V rail from the 2.8 V rail. Such a solution with a linear regulator is more cost-effective than Converter 4 in Figure 1.

Another change of the solution in Figure 2 is to generate the 3.3 V voltage not directly from 24 V but from the 5 V DC link voltage with Converter 2.

Figures 1 and 2 show not only the architecture but also the calculated efficiencies. The overall efficiency of the architecture from Figure 2 is only 86.3%. This is 5.3% below the solution from Figure 1.

When deciding which architecture is best, you can compare the costs of the respective solution, the efficiency performance of the entire architecture, and the respective solution size. These considerations are difficult to make without a sketching tool like the LTpowerPlanner.

Figure 3. Finding the LTpowerPlanner within LTpowerCAD under "System Design".

The LTpowerPlanner can be used as a standalone tool for creating a power supply architecture (see Figure 3). It is available within LTpowerCAD, which can be downloaded free of charge from the ADI website. LTpowerPlanner can be accessed under the blue field "System Design".

The LTpowerPlanner tool is intended to provide a clear overview of different power supply architectures. In addition, the built-in calculation function can be used to determine which architecture offers an efficiency advantage.

Conclusion

Within the power management tool chain, the first step is the optimization of the power management architecture. A useful tool is the LTpowerPlanner from ADI. It can be used to draw the power tree in various configurations and compare them. It also includes an efficiency calculation feature that provides valuable information about each possible architecture, enabling quick architecture selection.

About the Author

Frederik Dostal is a power management expert with more than 20 years of experience in this industry. After his studies of microelectronics at the University of Erlangen, Germany, he joined National Semiconductor in 2001, where he worked as a field applications engineer, gaining experience in implementing power management solutions in customer projects. During his time at National, he also spent four years in Phoenix, Arizona (U.S.A.), working on switch-mode power supplies as an applications engineer. In 2009, he joined Analog Devices, where he has since held a variety of positions working for the product line and European technical support, and currently brings his broad design and application knowledge as a power management expert. Frederik works in the ADI office in Munich, Germany.

TA25644-10/24