

Monolithic Switching Regulator—When Everything Is on a Chip

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A switching regulator can be constructed either monolithically or via a controller. In a monolithic switching regulator, the respective power switches, usually MOSFETs, are integrated within a single silicon chip. With controllers, in addition to the controller IC, the power semiconductors must be selected and positioned separately. The selection of MOSFETs is time-consuming and requires a certain understanding of the parameters of a switch. Designers do not need to deal with this when using a monolithic design. Also, controller solutions usually take up more space on the board than solutions that are highly integrated. Thus, it is no wonder that over the years ever more switching regulators have been executed monolithically so that today there is a large selection of suitable solutions available, even for higher power. Figure 1 shows a monolithic buck converter on the left and a controller solution on the right.

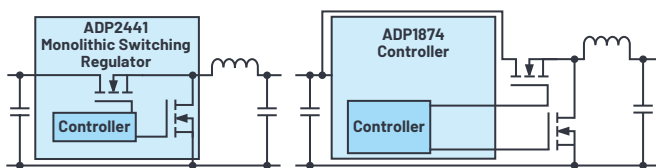


Figure 1. Monolithic buck converter (left); controller solution with external switches (right).

While monolithic solutions require less space and the design process is simplified, one advantage of a controller solution, on the other hand, is more flexibility. A designer can select optimized, application-specific switches for a controller solution, and there is access to the gate for the switches, enabling the switching edges to be influenced with clever employment of passive components. Furthermore, controller solutions are fit for high power since large discrete switches can be selected and switching losses dissipate with thermal separation from the controller IC.

However, in addition to these well-known arguments for and against a monolithic solution, there is another aspect that is not often considered. In switching regulators, the so-called hot loops are decisive for low radiated emissions. In all switching regulators, the EMC should be optimized as much as possible. One of the basic rules for accomplishing this is to minimize the parasitic inductances in the respective hot loop. In a buck converter, the path between the input

capacitor and the high-side switch, the connection between the high-side switch and the low-side switch, and the connection between the low-side switch and the input capacitor are part of the hot loop. They are the current paths in which a current flow changes at the speed of the switching transitions. Through the rapid current changes, a voltage offset forms via a parasitic inductance and can couple into different circuit segments as interference.

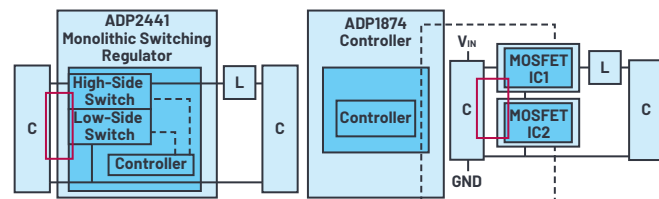


Figure 2. A monolithic switching regulator (left) and a solution with a controller IC (right), each with the geometrical arrangement of the hot loop.

Thus, these parasitic inductances in the hot loops must be kept as low as possible. Figure 2 shows the paths of the respective hot loop in red for a monolithic switching regulator on the left and for a controller solution on the right. We can see there are two advantages with the monolithic solution. First, the hot loop is smaller than in the case with the controller. Second, the connection path between the high-side switch and the low-side switch is very short and only routed on the silicon. In comparison, for a solution with a controller IC, this connected current path must be routed through the parasitic inductance of the packaging, usually with parasitic inductance from bonding wires and lead frames. This causes a higher voltage offset and, accordingly, poorer EMC behavior.

Conclusion

Monolithic switching regulators thus offer an additional, lesser-known advantage with respect to EMI. How high this interference is and how it affects a circuit depends on many other parameters. The basic idea that there is a difference between monolithic switching regulators and solutions with controller ICs in terms of EMC behavior is, however, worth considering.

About the Author

Frederik Dostal studied microelectronics at the University of Erlangen in Germany. Starting in the power management business in 2001, he has held various applications positions including four years in Phoenix, Arizona, working on switch-mode power supplies. He joined Analog Devices in 2009 and works as a field applications engineer for power management at Analog Devices in Munich. He can be reached at frederik.dostal@analog.com.

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