Engineer Guide: How to Dynamically Adjust the Right Output Voltage

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Power supplies are usually set to a fixed output voltage to supply an electrical load with energy. Certain applications, however, require a variable generated voltage. For example, in some cases, a microcontroller can be operated more efficiently if the core voltage is adjusted according to the respective operating state. This article will show how output voltages of a power supply may be adapted on-the-fly using dedicated digital-to-analog converters (DACs) developed for such purposes.

The output voltage of a voltage converter is usually set via a resistor voltage divider. This works very well for fixed voltages. However, if the output voltage should be varied, one of the voltage divider's resistor values must be adjusted. This could be done dynamically with a potentiometer. Figure 1 shows one such simple circuit with a switching regulator IC with a buck, or step-down, topology.

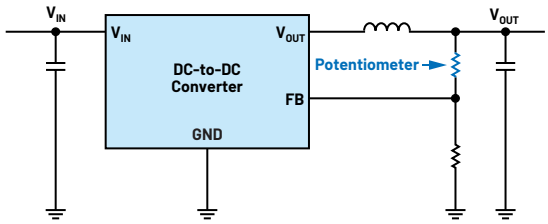

Figure 1. Switching regulator with potentiometer in the resistor path for adjusting the output voltage.

Unfortunately, in many applications, a circuit with a potentiometer, as is shown in Figure 1, is not very practical. Oftentimes the voltage must be set with a digital signal. One good option is to feed a small positive or negative current into the FB node. A small DAC that has been developed especially for dynamic adjustment of output voltages can be used for this.

Figure 2 shows an example circuit with an unspecified voltage converter and the LTC7106 DAC inserted into the wiring of the feedback path. In principle, any voltage converter with an external, accessible feedback pin can be operated in this way.

The LTC7106 has a current output that feeds current into the resistor voltage divider so that for different output voltages, the reference voltage of the switching regulator IC appears at the FB pin of the switching regulator. The output voltage is thus set while the FB pin receives the required regulation voltage.

Unlike many other DACs with current outputs, the LTC7106 is designed to have no current flow at the IDAC pin as long as no valid digital command is present. As a result, there are no unwanted voltages set during circuit startup.

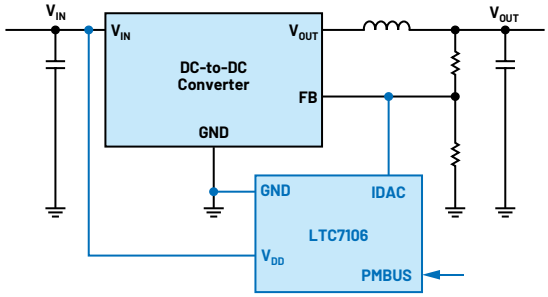

Figure 2. An LTC7106 DAC for dynamically adjusting the output voltage of a switching regulator.

The LTC7106 is a 7-bit DAC that can be operated with 1 µA per LSB or with 4 µA per LSB, depending on the application. The highest resolution is achieved with 1 µA per LSB. It is recommended that the switching regulator's resistor voltage divider be set for 1 µA per LTC7106 LSB.

The output of the current DAC has an accuracy of ±0.8% in the positive range and ±1.5% in the negative range, each over the entire permissible temperature range.

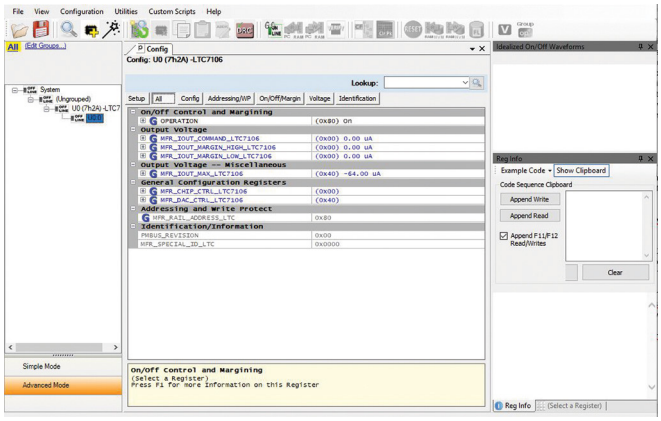

Figure 3. The LTpowerPlay graphical user interface for controlling the LTC7106 via a PMBus or I²C.

Figure 3 shows LTpowerPlay®, a graphical user interface that can be used to easily program the LTC7106.

Of course, even in a circuit with an LTC7106, there are limits as to the extent to which the output voltage can be adjusted. The switching regulator, or linear regulator, can only generate the voltages for which it is intended. A linear regulator, or step-down switching regulator, can only generate an output voltage that is lower than the input voltage. It is also advisable to perform a check of the voltage conversion circuit to ensure that the control loop stability and the output voltage ripple are within reasonable ranges for the desired output voltages.

Dynamic adjustment of an output voltage is very easy with a small current DAC such as the LTC7106. The function is designed to ensure reliable operation with minimal wiring.

About the Author

Frederik Dostal studied microelectronics at the University of Erlangen in Germany. Starting work in the power management business in 2001, he has been active in various applications positions including 4 years in Phoenix, Arizona, where he worked on switch-mode power supplies. He joined Analog Devices in 2009 and works as a field applications engineer for power management at ADI in München. He can be reached at frederik.dostal@analog.com.