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Pulse Injection of a Buck Converter

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Buck Converters or DC – DC converters are used throughout the electronics industry when a lower, regulated voltage is required in a system with a higher, unregulated supply voltage. For example, an electronic speed controller for a quadcopter uses a Buck converter to deliver a regulated 5V supply to other systems using a lithium polymer battery of perhaps 14.8 volts. The Buck converter is known to misbehave when the supply voltage is too high [1] or has injected interference. This behavior is of interest because the output voltage fluctuations are then injected into the more sensitive digital systems, such as the flight control system or the accelerometer. Failure or confusion of these systems can then cause the quadcopter or other system of interest to travel in the wrong direction or crash.

Earlier work on Buck converters exposed to IEMI used the SCICOS simulation code [2]. This work uses an application of the Modelica language with two GUIs (Dymola and Wolfram SystemModeler) and in some cases hardware in the loop [3]. Figure 1 shows the Modelica diagram for a Buck converter circuit above and the control loop below in the shaded area. Spurious signals can be injected into the control loop and into the voltage supply.

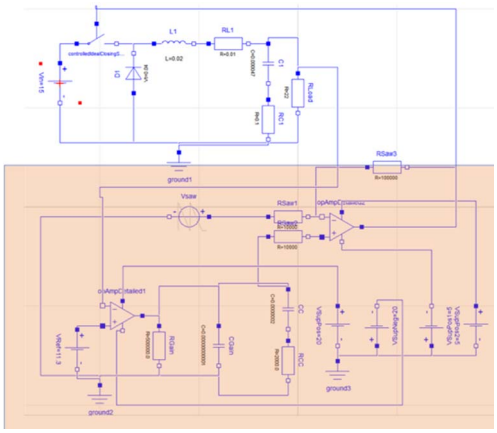

Figure 1. Modelica diagram for a Buck converter with feedback

This work will extend the previous works with several additional simulation techniques including hardware-in-the-loop as well as a variety of injection techniques. Modeling the diagram above as a feedback system will allow derivation of some of more sensitive means of upsetting the system. Full system simulation, including host systems like electronic speed controllers and quadcopters will appear later with more compete simulation tools.

1. F. El Guezar and H. Bouzahir, "Chaotic Behavior in a Switched Dynamical System", Modeling and Simulation in Engineering, Vol. 2008, Article ID 798395, Hindawi Publishing Co., 2008.

2. Gardner, R. L., "Response of a switched dynamical system to intentional EMI", in *Proc. Of the 10th Int. Symposium on Electromagnetic Compatibility (EMC Europe 2011)*, York, UK, September 26-30, 2011.

3. Gardner, R. L., "Pulse Injection of Electromechanical Systems", Proceeding of the International Conference on Electromagnetics in Advanced Applications, September 2016, Cairns, Australia.