A handy tool for testing the stability of voltage regulators

Richtek Load Transient Tool User Manual

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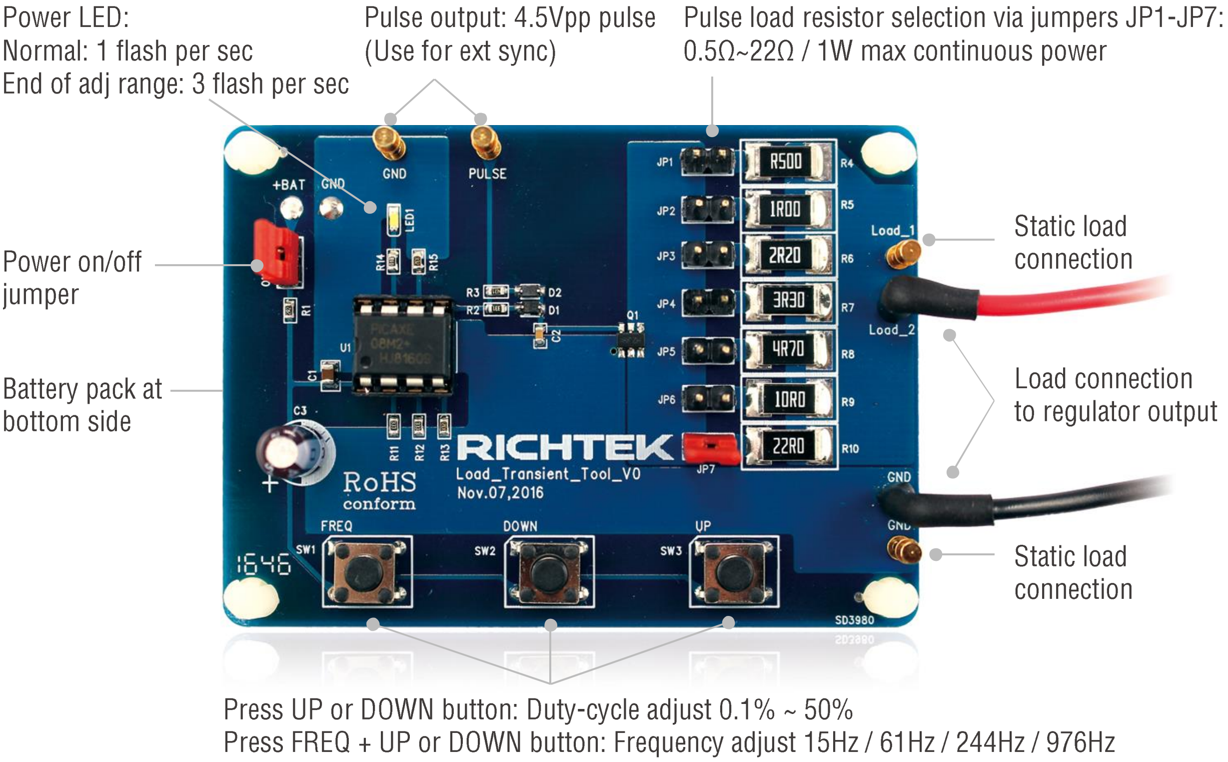

Figure 1: Richtek Load Transient Tool connections and functions

The Richtek Load Transient Tool contains a micro controller that switches a MOSFET on and off with a certain duty-cycle. When connected to a voltage regulator output, the MOSFET switches a load resistor on and off, thereby creating a fast changing pulse load. The tool can generate very fast load steps (~500nsec rise/fall times), and can be applied to any voltage regulator output in your system. My measuring the regulator output voltage during the fast load step, the regulator control loop behaviour can be observed.

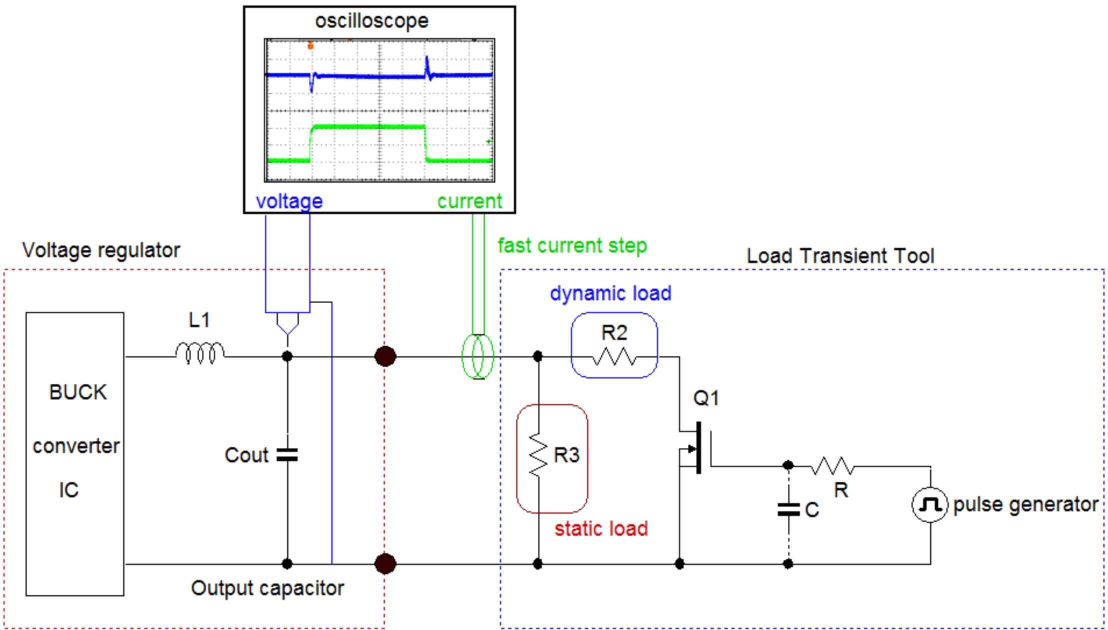

Figure 2: Basic Load Transient measurement method

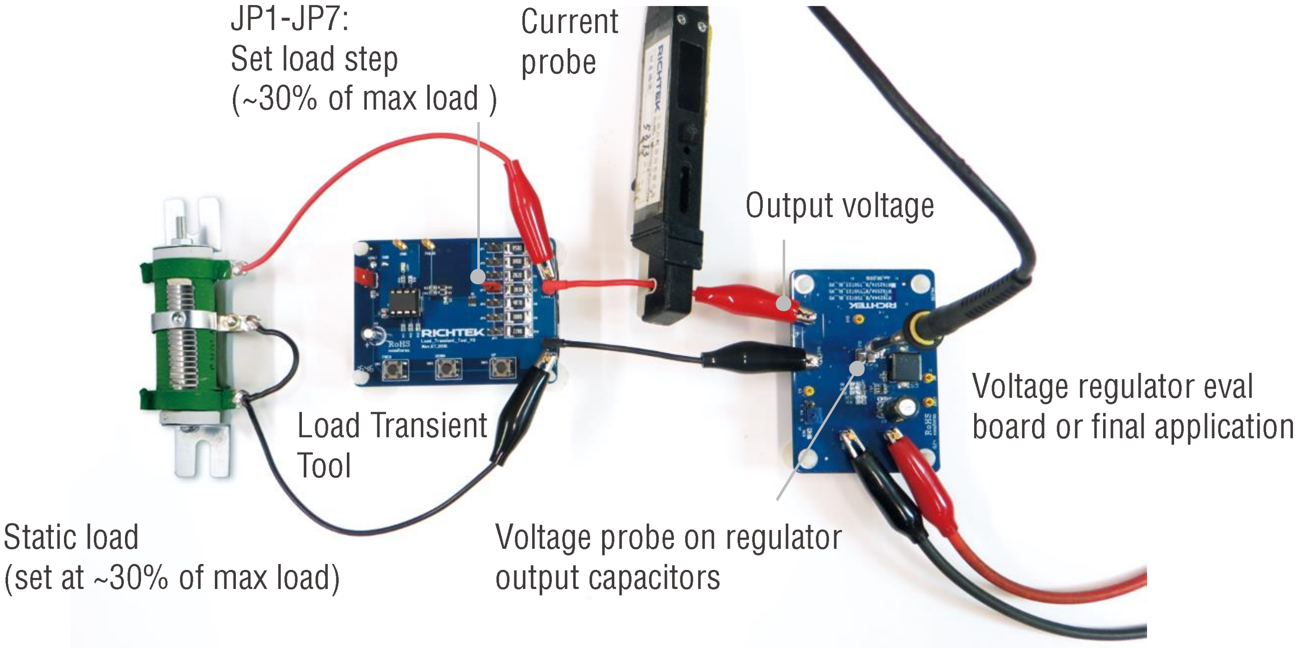

Figure 3: Practical Load Transient Tool measurement setup

A fast load step will excite the system control loop over a wide frequency range. Control loop instability or under damped response can be seen as output voltage ringing. This is only valid for CCM (continuous current mode) operation, so PSM-CCM transitions should be avoided. Always adjust the static load for CCM operation range during the load step.

Figure 4 shows an example of a poor and a good load step response of a 3.3V / 3A converter. The example on the left side shows that the regulator output voltage has severe ringing after a load transient, indicating that the control loop has marginal stability. In most cases this is related to the converter feedback loop compensation in combination with the output capacitor value.

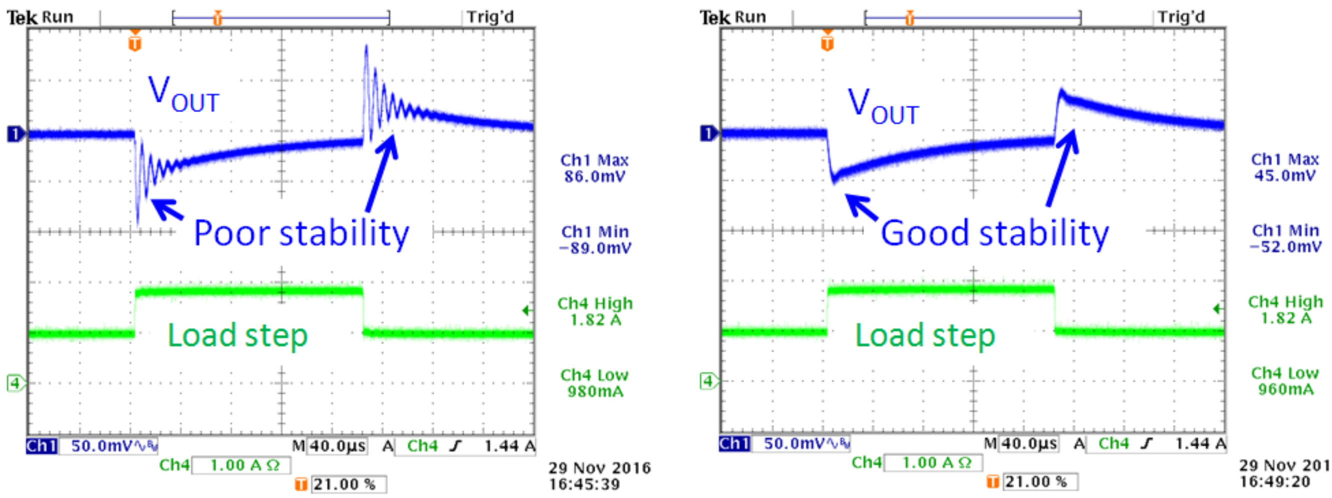

Figure 4: example of poor and good load step response

Besides control loop stability issues, other resonance effects due to layout parasitic trace inductance, input supply ringing etc. can also be quickly identified with the fast load transient tool.

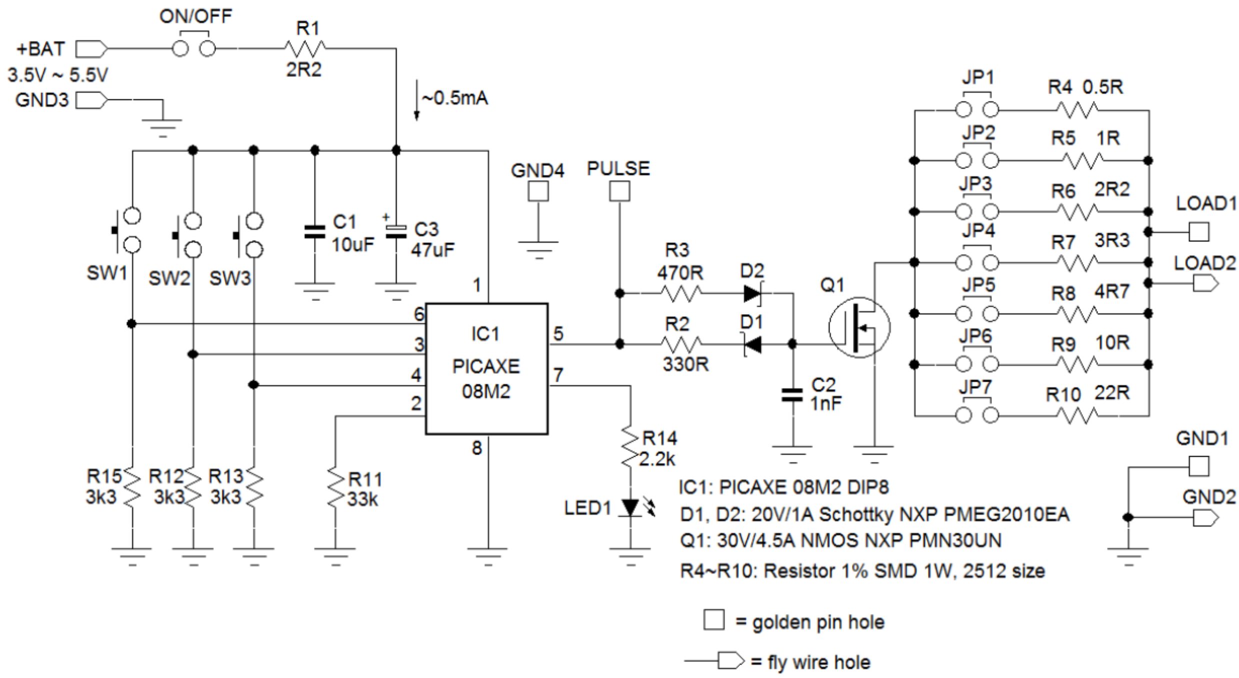

Figure 5: Load Transient Tool schematic

The schematic in figure 5 shows the the micro controller which drives the MOSFET switch. The MOSFET gate drive is designed to generate equal switching speeds with ~500nsec rise/fall times. Reducing or removing C2 can increase the switching speed, but the actual load current transient speed will be mostly determined by the wiring inductance between the tool and the application. Especially when testing low voltage supplies (< 2V), it may be necessary to use short, thick wires between the tool and the application to minimize inductance, see figure 6.

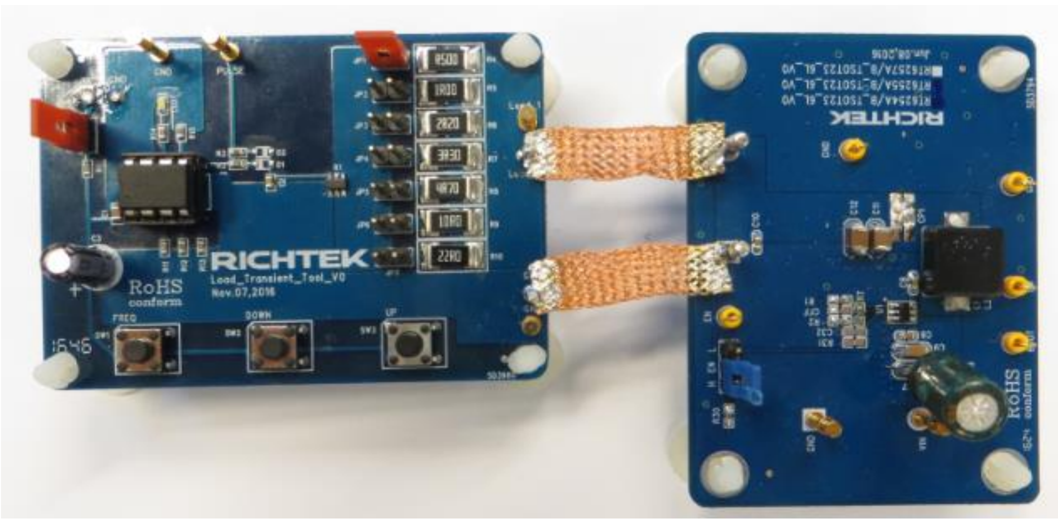

Figure 6: Reducing wire inductance between transient tool and application for faster load step speed.