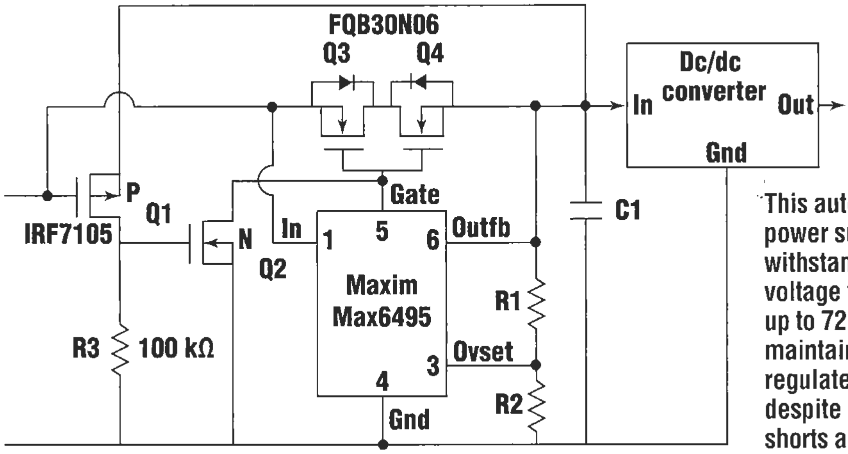
Automotive protection circuit "rides through" supply-voltage interruptions and 72-V transients

Many applications in automotive electronics need a supply voltage that remains uninterrupted during momentary power failures. The accompanying circuit maintains power to the load regardless of momentary shorts or opens in the supply voltage. The low-current overvoltage-protection IC (MAX6495) also protects the load against transient voltages up to 72 V.

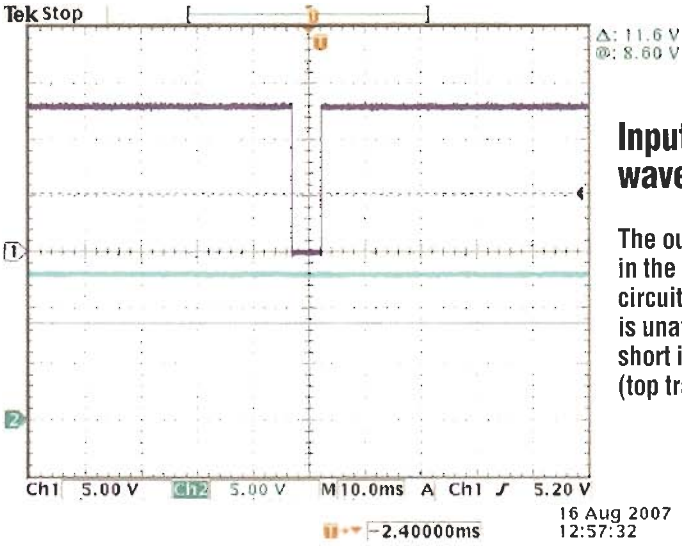
The circuit operates from a nominal 13-V input voltage. During momentary power interruptions, the large capacitance at the input to the dc-dc converter (C1) provides ride-through capability by supplying the converter for periods up to 5 msec or so. During a momentary short circuit of source voltage, the circuit again shields the converter output from interruption by preventing discharge of C1 via the shorted supply.

When the 13-V input drops because of a short to ground, there must be a way to prevent storage capacitor C1 from back discharging through the short. Transistors Q1 and Q2 do this: The short on Q1's gate turns it on, connecting the ~13 V on C1 to the gate of Q2, which turns Q2 on. Q2 shorts to ground the internal charge pump at the Gate pin, which drives the pass transistors Q3 and Q4 to cutoff by quickly discharging their gate capacitance. With Q3 and

Schematic



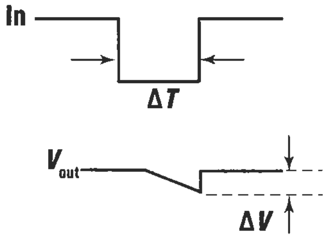
This automotive power supply withstands input-voltage transients up to 72 V and maintains a regulated output despite brief shorts and opens in the input supply voltage.



Input and output waveforms

The output voltage in the accompanying circuit (bottom trace) is unaffected by a brief short in the input voltage (top trace).

Input dip and resulting output



These waveforms define voltage droop (D_V), the decline of capacitor voltage due to discharge during a time interval D_T.

Edited by Leland Teschler

continued

Q4 turned off, C1 cannot discharge through the short, and the output voltage rides through the disturbance unaffected as illustrated in the scope display of the input and output signals.

The total gate charge for transistors Q3 and Q4 should be low, to enable fast turn-on and turn-off times, and V_{DS}(max) should be high enough for the highest voltage transient expected. R_{DS}(on) for Q3 and Q4 should be low to minimize voltage drop and power dissipation.

The value for C1 depends on the load power, the maximum tolerable voltage droop, and the expected duration for loss of input voltage (ride-through time):

Energy stored in the capacitors is

$E = ½CV^2$

i.e., $E = P\Delta T = ½C(\Delta V)^2$

Solving for C,

$C = (2P\Delta T)/\Delta V^2$,

where E = stored energy, C = capacitance, ΔV = maximum tolerable droop, P = power used by load, and ΔT = expected duration of input-voltage loss, sec.

— Ronald Moradkhan, Maxim Integrated Products Inc., Sunnyvale, Calif.

MAKE CONTACT

For further information on the MAX6495, check out www.*maxim-ic.com*