Method of Providing Hiccup Operation for UCC2897AEVM

John Bottrill

ABSTRACT

This application note is to provide users of the UCC2897AEVM with a method of generating a cyclic restart or restart attempt of the EVM should the converter encounter an overcurrent condition including an output short.

1 Introduction

Most EVMs that utilize the output voltage generation system to power the primary side automatically have a method of turning off the converter and initiating a soft-start restart. This is accomplished by depriving the primary side of sufficient voltage to keep the control device above the UVLO turn-off trip point.

2 Description

The UCC2897AEVM is designed to implement maximum efficiency so the use of the output inductors voltage to provide the voltage to the primary was a desirable feature. There was a design decision made to use a series regulator to implement start up verses providing the necessary capacitance and delay time needed to implement the start up through the on-chip series regulator.

The series regulator also powers the primary side in the event of an output overcurrent condition preventing a shutdown/restart cycle from occurring, even if the output is shorted. To prevent this it is necessary to limit the time the series regulator operates and to delay the retry once the converter shuts down.

The current limit on this EVM was tested and found to be about 35 amps before the output voltage would start to drop. The circuit that is described in this application note provides a delay in turn on and forces a shutdown if there is a low voltage on the output. Figure 1 shows the circuit and the components needed to do this.

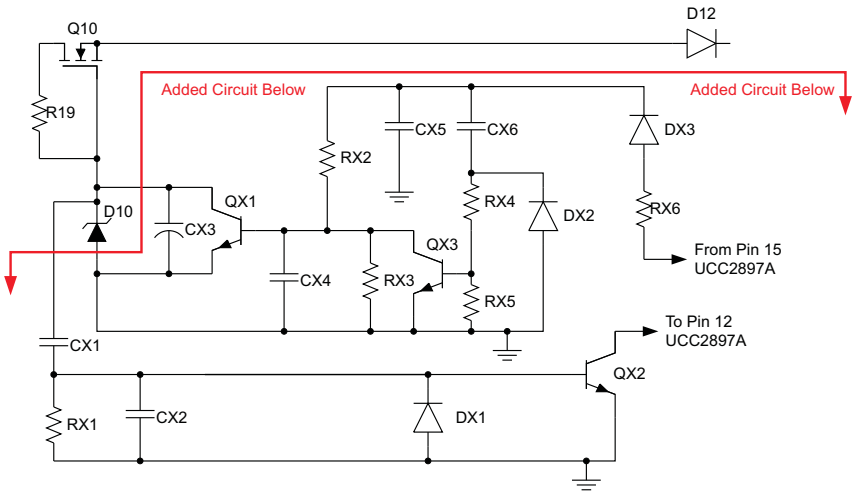

Figure 1. Hiccup Mode Implementation

Table 1. Hiccup Mode Implementation Parts List

COMPONENT	VALUE
CX1	1.0 µF
CX2	1.2 nF
CX3	10 µF
CX4	0.1 µF
CX5	1.0 nF
CX6	0.22 nF
RX1	20 kΩ
RX2	301 kΩ
RX3	100 kΩ
RX4	100 kΩ
RX5	100 kΩ
RX6	100 kΩ
DX1	1N4148
DX2	1N4148
DX3	1N4148
QX1	2N2222A
QX2	2N2222A
QX3	2N2222A

There are several things that this circuit has to do. The first is to remove the source of primary-side power shortly after the device starts to operate. This is accomplished by QX1, CX4, RX2, RX3, CX5, DX3, and RX6.

When power is applied to the input, current through R19 charges CX3 and turns Q10 on as a linear regulator, providing power through D12, to the control device and the converter starts. D10 limits the voltage on the gate of Q10. Once the voltage on D10 stabilizes, the converter starts and voltage is pulsed on pin 15 which is connected to RX6. Current flow through RX6 and DX3 resulting in a voltage on CX5. This in turn charges CX4 through RX2 causing QX1 to turn on, shorting the gate of Q10 to ground and turning off Q10.

Since the converter needs a finite time (softstart time) to establish a voltage on the output and power the converter it was necessary to delay the turn off of Q10. This was accomplished by adding CX6, RX4, Rx5 DX2 and QX3.

When the voltage on CX5 increases a voltage is developed across RX4 and RX5 by the charging of CX6. This turns on QX3 which will short the base /emitter junction of QX1 preventing it from turning on and shorting the gate of Q10 to ground. As the voltage across CX6 increases QX3 will be turned off and QX1 can then turn on. DX2 provides a path for the discharge of CX6 when needed.

Restart time can be adjusted by changing the value of CX3.

To prevent premature pulsing of pin 15, additional circuitry, CX1, RX1, CX2, DX1 and QX2, was added.

While CX3 is charging, a current is generated through CX1 and the base emitter junction of QX2, turning on QX2 and shorting Pin 12 (SOFTSTART) to ground. RX1 is used to discharge the base of QX2 once the voltage on Q10 gate stabilizes. CX2 is added for noise immunity. DX1 provides a current path to discharge CX1 when QX1 turns on. Having the soft start shorted to ground prevents the control device from pulsing and charging CX5 until after CX3 is fully charged.

Initial testing showed excellent response during testing into a short and heavy load, however, it was observed that momentary shorts could result in an output overshoot. The solution to this (see Figure 2) was to change R21 to a 1.0-kΩ resistor and to add a diode (1N4148) across R38 (anode to ground). This allowed for the rapid discharge of C23 and controlled restarts.

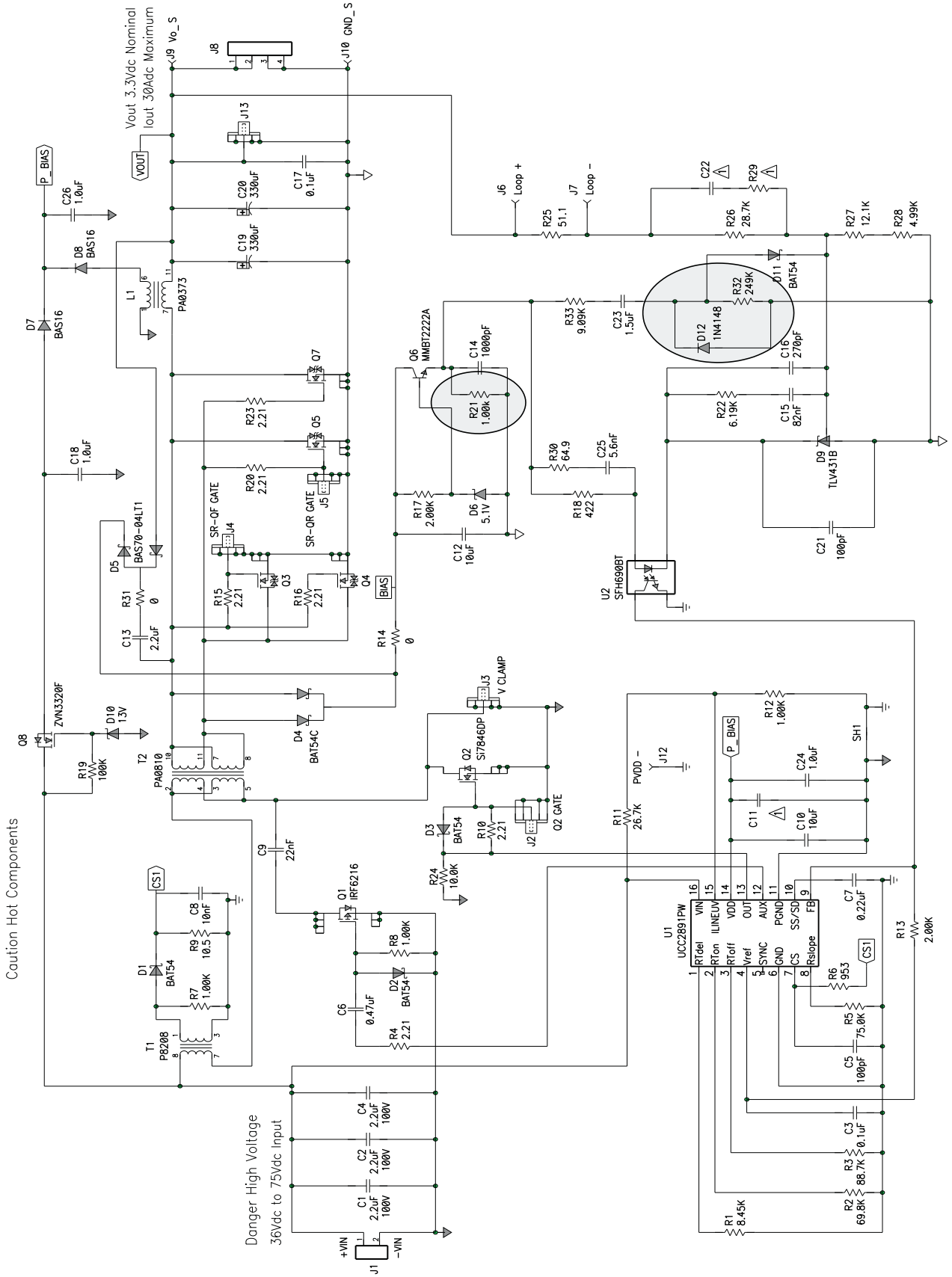

Figure 2. Modification to the Soft-Start Circuit.

The results are shown below. In Figure 3 a short was applied repeatedly across the output of the converter using the shorting button on the electronic load. The results show no overshoot on restart.

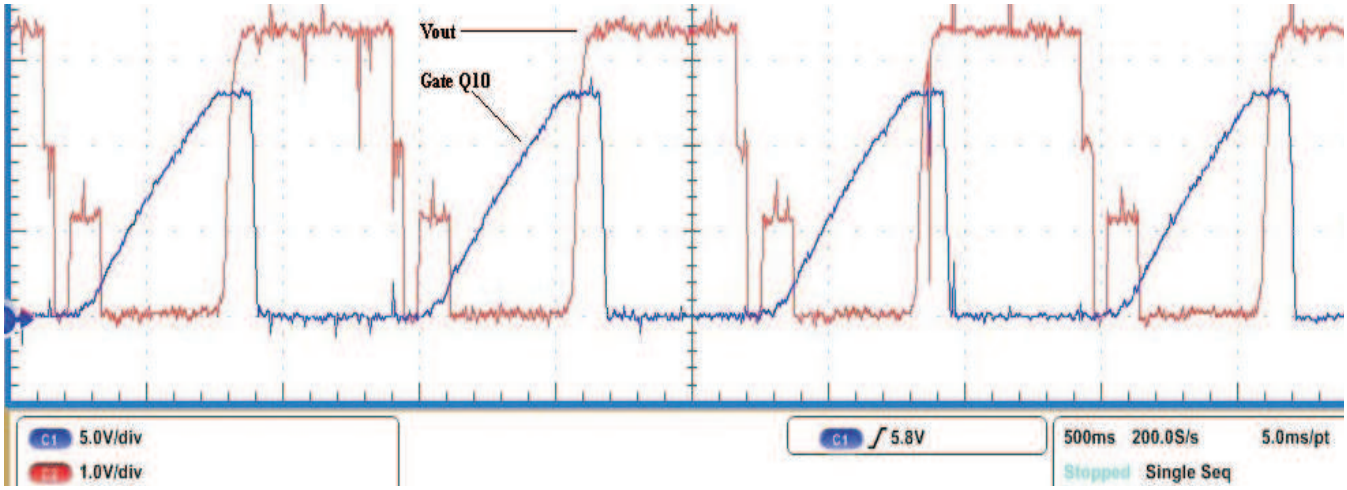

Figure 3. Pulsed Shorts Trace 1 V_{GATE} Q10 5 V/div. Trace 2 V_{OUT} 1 V/div.

The test was repeated with a load that was increased until it exceeded the limit for the supply (Figure 4).

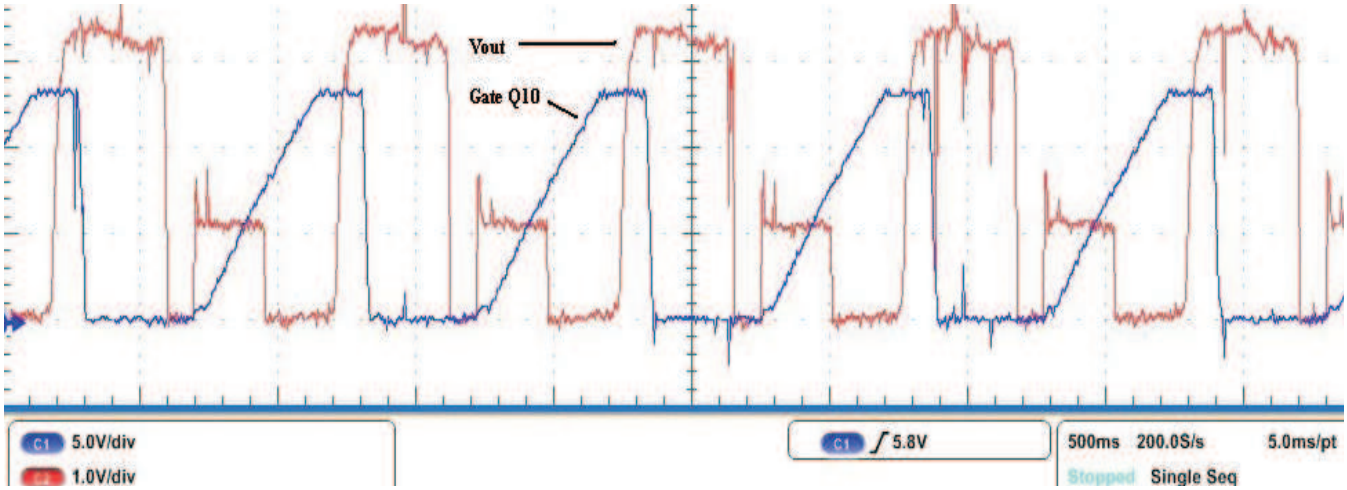

Figure 4. Current Limit Exceeded Trace 1 V_{GATE} Q10 5 V/div. Trace 2 V_{OUT} 1 V/div.

The next test was the application of pulsed shorts at near full load (30 A)

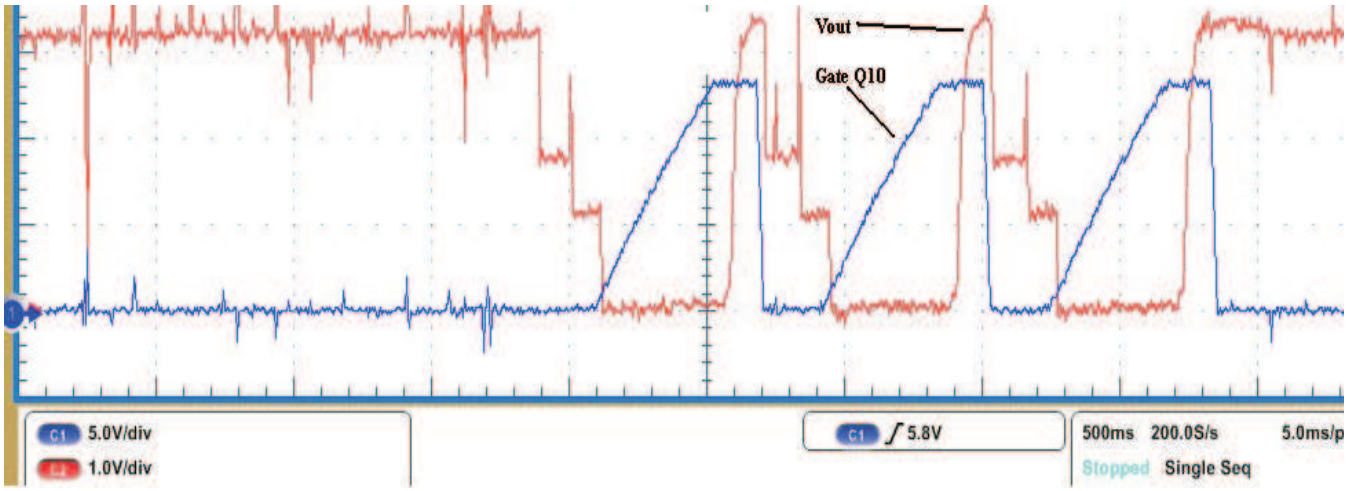

Figure 5. Shorts Applied at 30-A Load. Trace 1 V_{GATE} Q10 5 V/div. Trace 2 V_{OUT} 1 V/div.

The shorts are applied through the electronic load leads so they are not true shorts. They have some residual voltage left.

Figure 6 shows a normal no load startup curve.

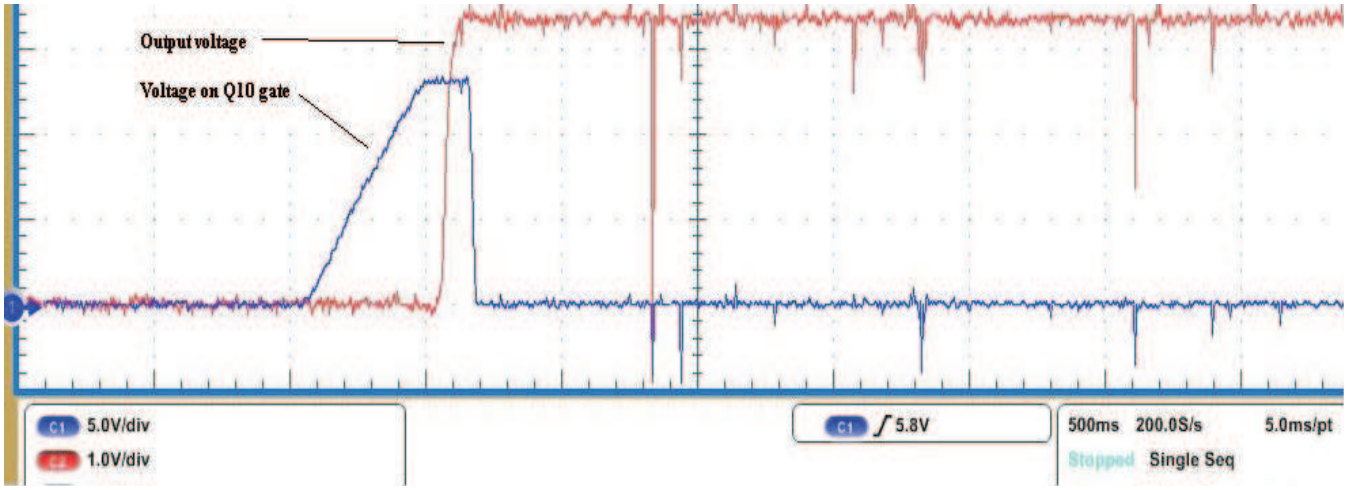

Figure 6. No Load Startup Trace 1 V_{GATE} Q10 5 V/div. Trace 2 V_{OUT}1 V/div.

This circuit unfortunately adds significantly to the component count but it does provide a hiccup restart that does not overshoot and by adjusting Cx3, the time between startup attempts can be increased.

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