

## Design Note

### UCC39411 Low Power Synchronous Boost Converter, Evaluation Kit, Schematic and List of Materials

By Dave Olson

The UCC39411/2/3 Evaluation Kit allows the designer to evaluate the performance of the UCC39411/2/3 Low power Synchronous Boost converter in a typical application circuit. The schematic for the evaluation kit is shown in Figure 1. The kit can be configured to evaluate any version of the UCC39411 family.

#### UCC39411/2/3 Features

- 8 pin TSSOP package
- startup guaranteed under full load conditions at  $V_{BAT} \geq 1V$
- Operation down to 0.5V after startup
- Wide input voltage range: 1V to 3.2V
- 200mW output power with  $V_{BAT}$  as low as 0.8V
- Secondary supply voltage from a single inductor
- Output fully disconnected in shutdown
- Adaptive current mode control for optimum efficiency
- Low shutdown supply current
- Built-in Reset function with programmable reset pulse width

#### Programming the Output Voltage

The evaluation board is shipped with the UCC39411 adjustable version programmed for 3.3V. For the UCC39411 adjustable version the output voltage is programmed by the resistor divider R1 and R2 based on the internal reference voltage of 1.25V. For the fixed output voltages (UCC39412/3) R1 and R2 should be removed and Pin 4 is used solely for shutdown purposes.

$$V_{OUT} = 1.25 \cdot \left(1 + \frac{R1}{R2}\right) \quad (1)$$

Note that the Thevenin impedance at the Feedback pin must be  $> 200k\Omega$ .

When designing with the UCC39411 IC (adjustable output), it is important to populate capacitor C5. Capacitor, C5, provides feed forward from the output to the SD/FB pin to compensate for delays caused by the high impedance requirements of the SD/FB pin and the parasitic capacitance on that

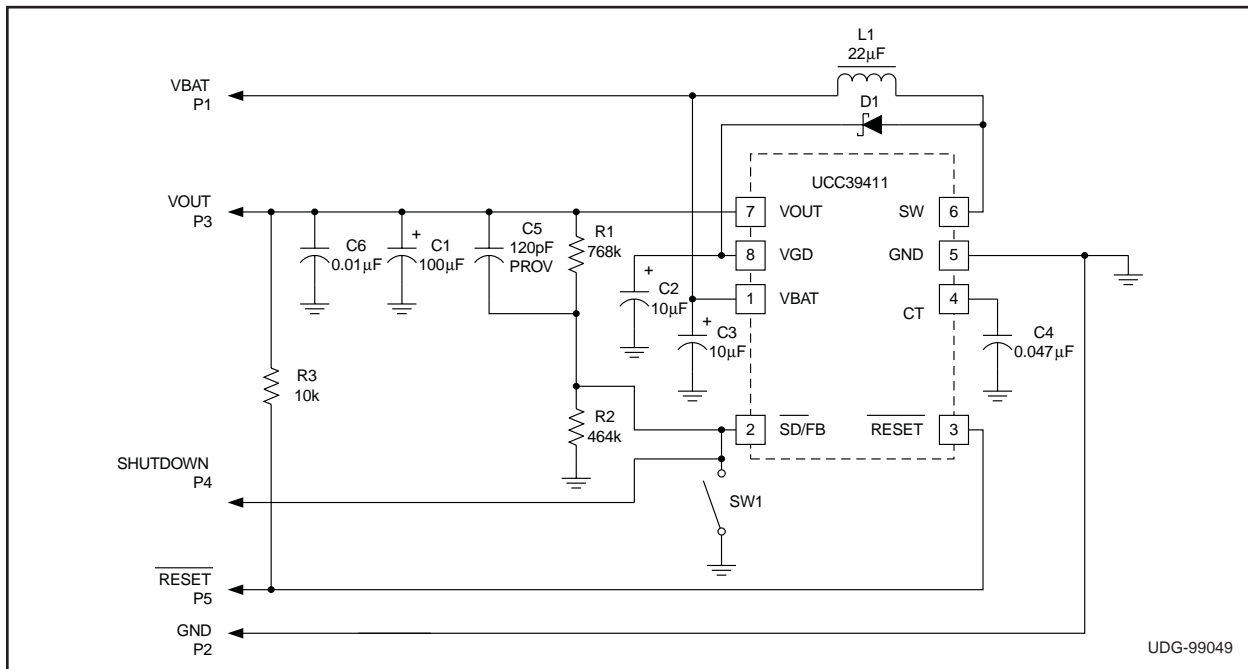


Figure 1. UCC39411/2/3 evaluation kit.

pin. Failure to populate C5 will result in excess output voltage ripple.

### Shutting Down the IC

SW1 can be used to shutdown the IC and disable the output. Switching SW1 to the off position will pull the SD/FB, pin 4 to ground to shutdown the IC. Switching SW1 to the on position will allow the SD/FB pin to float thus enabling the IC.

### Component Selection

Table 1 contains a parts list for the evaluation kit (fixed output version). Reference designations are provided on the circuit board next to the associated components.

**Inductor Selection:** An inductor value of 22 $\mu$ H will work best in most applications, but values between 10 $\mu$ H and 100 $\mu$ H are acceptable. Lower Value inductors typically offer lower ESR and smaller physical size. Due to the nature of hysteretic controllers, larger inductor values will typically result in larger overall voltage ripple, because once the output voltage level is satisfied the converter goes discontinuous, resulting in the residual energy of the inductor causing overshoot. It is recommended that the ESR of the inductor be less than 0.15 $\Omega$  for full load operation.

**Output Capacitor Selection:** Once the inductor value is selected the output capacitor value will determine the output ripple voltage. The worst case peak to peak ripple voltage is due to two components, the ESR of the output capacitor, and the capacitor value. The worst case ripple occurs when the inductor is operating at maximum current and is expressed as follows:

$$\Delta V = \frac{I_{CL}^2 \cdot L}{2 \cdot C \cdot (V_O - V_{BAT})} + I_{CL} \cdot ESR_{C_{OUT}} \quad (2)$$

where,

L = Input inductance (H)

C = output capacitance (F)

$\Delta V$  = output voltage ripple (VP-P)

$I_{CL}$  = the peak current limit (A)

$V_O$  = output voltage (V)

$V_{BAT}$  = input voltage (V)

The evaluation board is equipped with a 100 $\mu$ F Sprague Tantalum surface mount capacitor with an ESR of 100m $\Omega$ . Output voltage ripple is 20mV<sub>P-P</sub> at 200mW out.

**Input and VGD Capacitor Selections:** The UCC39411 does not require a large decoupling capacitor on VBAT to operate properly, a 10 $\mu$ F capacitor is sufficient for most applications. Optimum efficiency occurs when the capacitor value is large enough to decouple the source impedance.

A 10 $\mu$ F capacitor on VGD should be sufficient to provide proper operation of the UCC39411 under full load conditions.

### Setting the Reset Period

The  $\overline{RESET}$  pin (open drain) provides an indication about the status of VOUT. If VOUT drops below 10% of its nominal value,  $\overline{RESET}$ , (pin 5) will go low. On power up,  $\overline{RESET}$  will stay low until the output has reached 90% of its nominal value and the reset period has elapsed. The reset period is set by the capacitance placed on CT, (pin 6). The reset period is defined by:

$$T_{RESET} = CT \cdot 2.5 \times 10^6 \text{ seconds} \quad (3)$$

where CT is in Farads.

### The Molex Connector

In addition to the AA battery holder to which the board is mounted there is also a 5 pin Molex connector for the user to interface to if desired. The pin-out for the connector is specified in Figure 1. Pin 1 of the connector is at the top left-hand corner of the circuit board.

**Table 1. UCC39411 evaluation board list of materials.**

<b>Designator</b>	<b>Description</b>	<b>Part Value</b>	<b>Manufacturer</b>	<b>Part Number</b>
C1	Tantalum capacitor	100 $\mu$ F, 10V	Sprague	593D107X0010D2W
C2, C3	Tantalum capacitor	10 $\mu$ F, 16V	Sprague	595D106X0016B2T
C4	Ceramic capacitor, 1206, X7R	0.047 $\mu$ F	Panasonic/Digi-key	PCC473BCT-ND
C5	Ceramic capacitor, 0603, NPO	120pF	Digi-key	PCC121ACVCT-ND
C6	Ceramic capacitor, 0603	0.01 $\mu$ F	Digi-key	PCC103BVCT-ND
D1	Schottly Diode SOD-123	MBR0530T1	Newark	MBR0530T1
L1	Inductor	22 $\mu$ H	Coilcraft	DO1608C-223
R1	Resistor, 0603, 0.06W	768k $\Omega$	Digi-key	P768KHCT
R2	Resistor, 0603, 0.06W	464k $\Omega$	Digi-key	P464KHCT-ND
R3	Resistor, 0603, 0.06W	10k $\Omega$	Digi-key	P10KHCT-ND
SW1	Switch		EAO Switch	09 10201 02
TB1	Connector, 5 pin		Molex	22-05-3051
U1	Control IC		Intirode	UCC39411
U2	Battery Holder, AA		Digi-key	BHAA-ND

## IMPORTANT NOTICE

Texas Instruments and its subsidiaries (TI) reserve the right to make changes to their products or to discontinue any product or service without notice, and advise customers to obtain the latest version of relevant information to verify, before placing orders, that information being relied on is current and complete. All products are sold subject to the terms and conditions of sale supplied at the time of order acknowledgement, including those pertaining to warranty, patent infringement, and limitation of liability.

TI warrants performance of its semiconductor products to the specifications applicable at the time of sale in accordance with TI's standard warranty. Testing and other quality control techniques are utilized to the extent TI deems necessary to support this warranty. Specific testing of all parameters of each device is not necessarily performed, except those mandated by government requirements.

CERTAIN APPLICATIONS USING SEMICONDUCTOR PRODUCTS MAY INVOLVE POTENTIAL RISKS OF DEATH, PERSONAL INJURY, OR SEVERE PROPERTY OR ENVIRONMENTAL DAMAGE ("CRITICAL APPLICATIONS"). TI SEMICONDUCTOR PRODUCTS ARE NOT DESIGNED, AUTHORIZED, OR WARRANTED TO BE SUITABLE FOR USE IN LIFE-SUPPORT DEVICES OR SYSTEMS OR OTHER CRITICAL APPLICATIONS. INCLUSION OF TI PRODUCTS IN SUCH APPLICATIONS IS UNDERSTOOD TO BE FULLY AT THE CUSTOMER'S RISK.

In order to minimize risks associated with the customer's applications, adequate design and operating safeguards must be provided by the customer to minimize inherent or procedural hazards.

TI assumes no liability for applications assistance or customer product design. TI does not warrant or represent that any license, either express or implied, is granted under any patent right, copyright, mask work right, or other intellectual property right of TI covering or relating to any combination, machine, or process in which such semiconductor products or services might be or are used. TI's publication of information regarding any third party's products or services does not constitute TI's approval, warranty or endorsement thereof.