



## UCC40501

CMOS IC

### 40V, 5A SYNCHRONOUS BUCK CONVERTER WITH 2CH CC/CV

#### DESCRIPTION

The UTC **UCC40501** is a monolithic synchronous buck regulator. The device integrates internal high side and external low side power MOSFETs, and provides 5A of continuous load current over a wide input voltage. Current mode control provides fast transient response and cycle-by-cycle current limit. An internal soft-start prevents inrush current at turn-on.

#### FEATURES

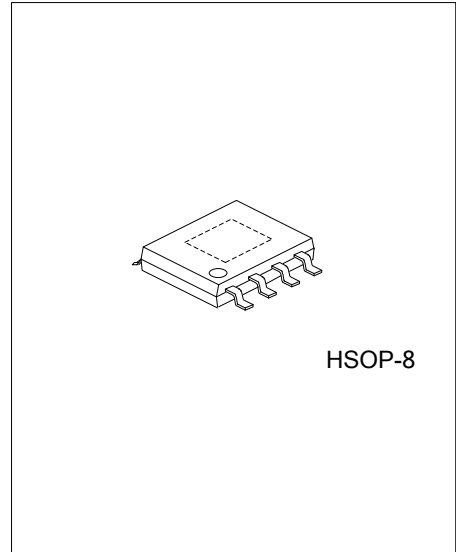
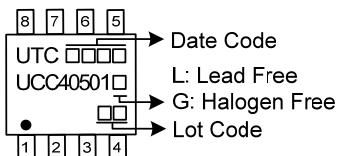
- \* Wide 8V to 40V Operating Input Range
- \* Integrated 45mΩ high side Power MOSFET Switches
- \* Output Adjustable from  $V_{FB}$  (1.00V±2%) to 16V
- \* Up to 95% Efficiency
- \* Internal Soft-Start and Fixed 160KHz Frequency
- \* Stable with Low ESR Ceramic Output Capacitors
- \* Cycle-by-Cycle Over Current Protection
- \* Input Under/Over Voltage Lockout

#### ORDERING INFORMATION

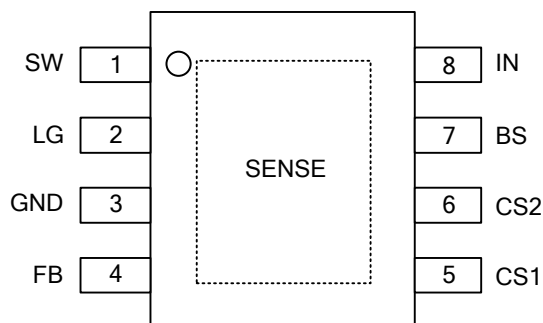
Ordering Number		Package	Packing
Lead Free	Halogen Free		
UCC40501L-SH2-R	UCC40501G-SH2-R	HSOP-8	Tape Reel

<p>UCC40501G-SH2-R</p> <ul style="list-style-type: none"><li>(1) Packing Type</li><li>(2) Package Type</li><li>(3) Green Package</li></ul>	<ul style="list-style-type: none"><li>(1) R: Tape Reel</li><li>(2) SH2: HSOP-8</li><li>(3) G: Halogen Free and Lead Free, L: Lead Free</li></ul>
--	--

#### MARKING



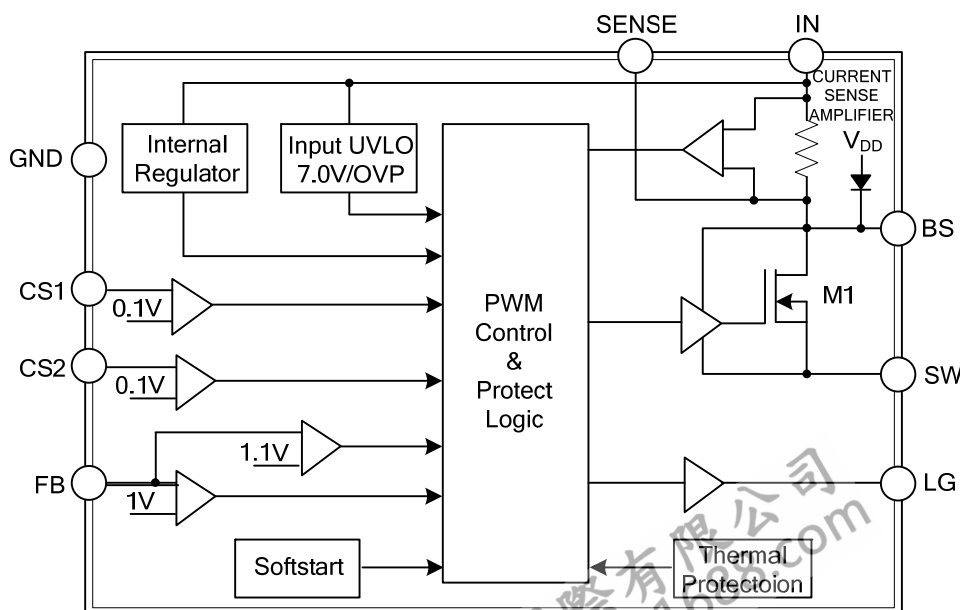
HSOP-8



■

PIN NO.	PIN NAME	DESCRIPTION
1	SW	Power Switching Output. SW is the switching node that supplies power to the output. Connect the output LC filter from SW to the output load.
2	LG	Gate drive for external low side N-MOSFET.
3	GND	Ground
4	FB	Feedback Input. FB senses the output voltage to regulate that voltage. Drive FB with a resistive voltage divider from the output voltage.
5	CS1	The Current Sense 1 pin.
6	CS2	The Current Sense 2 pin.
7	BS	Boot-Strap Pin. Supply high side gate driver.
8	IN	Power Input pin. Bypass IN to GND with a suitably large capacitor to eliminate noise on the input to the IC.

■



■ ABSOLUTE MAXIMUM RATING ( $T_A=25^{\circ}\text{C}$ , unless otherwise specified)

PARAMETER	SYMBOL	RATINGS	UNIT
Supply Voltage	$V_{IN}$	42	V
Switch Node Voltage	$V_{SW}$	$V_{IN}+0.3$	V
Boost Voltage	$V_{BS}$	$V_{SW}+6$	V
All Other Pins		6	V
Output Voltage	$V_{OUT}$	$V_{FB} \sim 20$	V
Junction Temperature	$T_J$	+150	$^{\circ}\text{C}$
Storage Temperature	$T_{STG}$	-65 ~ +150	$^{\circ}\text{C}$

Note: Absolute maximum ratings are those values beyond which the device could be permanently damaged. Absolute maximum ratings are stress ratings only and functional device operation is not implied.

■ THERMAL CHARACTERISTICS

PARAMETER	SYMBOL	RATINGS	UNIT
Junction to Ambient	$\theta_{JA}$	40	$^{\circ}\text{C/W}$
Junction to Case	$\theta_{JC}$	15	$^{\circ}\text{C/W}$

Note:  $\theta_{JA}$  is measured with the PCB copper area of approximately  $1 \text{ in}^2$  (Multi-layer). That need connect to exposed pad.

■ ELECTRICAL CHARACTERISTICS ( $V_{IN}=12\text{V}$ ,  $T_A=25^{\circ}\text{C}$ , unless otherwise specified)

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Input Voltage Range			8		40	V
Quiescent Current	$I_{CCQ}$	$V_{FB}=1.05\text{V}$		1	1.5	mA
Feedback Voltage	$V_{FB}$	$8\text{V} \leq V_{IN} \leq 38\text{V}$	0.98	1.00	1.02	V
Feedback Overvoltage Threshold	$\text{OVP}_{(FB)}$			1.1X		$V_{FB}$
Line Compensation Current (Note 1)	$I_{CFB}$	$V_{CS}=100\text{mV}$		4		$\mu\text{A}$
High-Side Switch On Resistance (Note 1)	$R_{DS(ON)1}$			45		$\text{m}\Omega$
High-Side Switch Leakage Current		$V_{FB}=1.15\text{V}$ , $V_{SW}=0\text{V}$			10	$\mu\text{A}$
High-Side Switch Current Limit (Note 1)		Minimum Duty Cycle	5.1	6.0		A
LG Rise Time	$T_{LGR}$	$C_{LX}=1200\text{pF}$		40		ns
LG Fall Time	$T_{LGF}$	$C_{LX}=1200\text{pF}$		40		ns
LG Driver Bias Supply Voltage				5		V
Oscillation Frequency	$F_{OSC1}$			160		KHz
Short Circuit Oscillation Frequency	$F_{OSC2}$	$V_{FB} < 0.4\text{V}$		80		KHz
Short Circuit Retry Time (Note 1)	$RT_{SCP}$	$V_{FB} < 0.5\text{V}$		1		mS
Maximum Duty Cycle	$D_{MAX}$			90		%
Minimum On Time (Note 1)	$T_{ON(min)}$			220		ns
Current Sense Voltage	$V_{CS1/2}$		90	100	115	mV
Input Under Voltage Lockout Threshold	UVLO	$V_{IN}$ Rising	6.5	7.2	7.8	V
Input Under Voltage Lockout Threshold Hysteresis	UVLO-Hys			800		mV
Input Over Voltage Lockout Threshold	OVLO	$V_{IN}$ Rising		40		V
Input Over Voltage Lockout Threshold Hysteresis	OVLO-Hys			3		V
Soft-Start Period				2		ms
Thermal Shutdown	$T_{SD}$			150		$^{\circ}\text{C}$
Thermal Shutdown Hysteresis	$T_{SH}$			30		$^{\circ}\text{C}$

Note: Guaranteed by design.

## ■ FUNCTION DESCRIPTIONS

The **UCC40501** is a synchronous rectified, current-mode, step-down regulator. It regulates input voltages from 8V to 40V down to an output voltage as low as V<sub>FB</sub>, and supplies up to 5A of load current.

The **UCC40501** uses current-mode control to regulate the output voltage. The output voltage is measured at FB through a resistive voltage divider and amplified through the internal Transconductance error amplifier. The voltage at the COMP pin is compared to the switch current measured internally to control the output voltage.

The converter uses internal N-Channel MOSFET switches to step-down the input voltage to the regulated output voltage. Since the high side MOSFET requires a gate voltage greater than the input voltage, a boost capacitor connected between SW and BS is needed to drive the high side gate. The boost capacitor is charged from the internal 5V rail when SW is low.

When the **UCC40501** FB pin exceeds 10% of the nominal regulation voltage of V<sub>FB</sub>, the over voltage comparator is tripped and the COMP pin is discharged to GND, forcing the high-side switch off.

## ■ APPLICATION INFORMATION

### Setting the Output Voltage

The output voltage is set using a resistive voltage divider from the output voltage to FB pin. The voltage divider divides the output voltage down to the feedback voltage by the ratio.

Thus the output voltage is:

$$V_{OUT} = V_{FB} \times \frac{R1+R2}{R2}$$

For example, V<sub>FB</sub> = 1.00V for a 5.0V output voltage, R2 is 10kΩ, and R1 is 40kΩ.

DUTY ON	< 55%	55 ~ 90%
CFB	3.3nF	1nF

### Inductor Selection

The inductor is required to supply constant current to the output load while being driven by the switched input voltage. A larger value inductor will result in less ripple current that will result in lower output ripple voltage. However, the larger value inductor will have a larger physical size, higher series resistance, and/or lower saturation current. A good rule for determining the inductance to use is to allow the peak-to-peak ripple current in the inductor to be approximately 30% of the maximum switch current limit.

V <sub>IN</sub>	< 28V	< 35V
Inductor	33μH	33μH

The choice of which style inductor to use mainly depends on the price vs. size requirements and any EMI requirements.

### Output Short-Circuit protection

The UTC **UCC40501** provides output short-circuit protection retry function. When V<sub>OUT</sub> is short (V<sub>FB</sub> < 0.5V), the auto restart function can be started that restart the regulator cycle by cycle. (Retry time 1mS, Shutdown regulator time 20mS) .

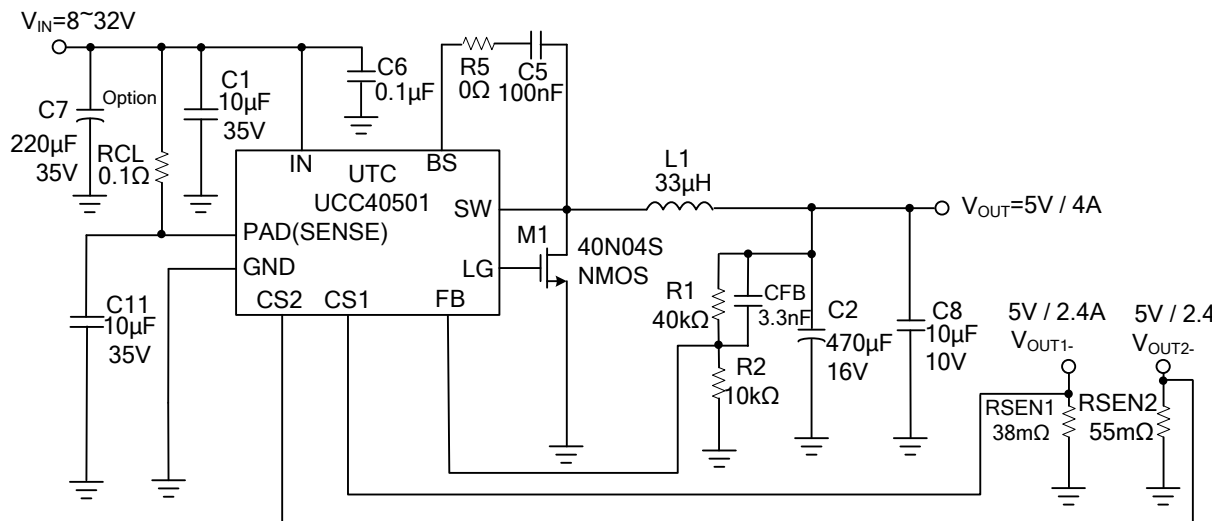
### Output Cable Resistance Compensation

To compensate for resistive voltage drop across the charger's output cable, the UTC **UCC40501** integrates a simple, user-programmable cable voltage drop compensation using the impedance at the FB pin. Use the curve in Figure 1 to choose the proper feedback resistance values for cable compensation. R1 is the high side resistor of voltage divider.

$$V_{OUT} = V_{FB} \times (1 + R1/R2) + R1 \times I_{CFB} (4\mu A)$$

## ■ APPLICATION INFORMATION (Cont.)

Application circuit : EMI C9 and R7.



$$V_{OUT} = V_{FB} \times (1 + R1/R2), V_{FB} = 1.00V, R2 \text{ suggest } 1k \sim 40k\Omega$$

$$I_{SEN} = 2.63A (I_{SEN} = V_{CS1}(0.1V) / R_{SEN}(38m\Omega))$$

Cable Compensation at Various Resistor Divider Values

