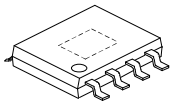
4.5V~100V, 3.8A PEAK CURRENT LIMIT STEP-DOWN CONVERTER



HSOP-8

■ DESCRIPTION

The UTC **UD100201** is a 100V/3.8A peak switching current limit, non-sync buck converter.

The **UD100201** integrated with high-side power MOSFET with advanced COT control method, the size of the total solution will be small, load transient will be excellent, and also with good robustness.

Integrated BST charge circuit minimize the cost and solution size. High duty on-time extension make the part ideal for the application that need low drop-out feature. 190μA quiescent current saves the power, and 3μA low off current is good for those battery powered applications.

With 4.5V to 100V wide input voltage range, the **UD100201** accommodates a variety of step-down applications.

■ FEATURES

* 4.5V to 100V Wide Input Range
* 3.8A Typical Peak Current Limit
* Integrated 500mΩ low resistance high side power MOS
* Constant On Time Control with Constant Switching Frequency
* 190μA Low Quiescent Current
* 150kHz, 240kHz, 460kHz Switching Frequency Selectable
* Special Valley Current Limit for non-sync Buck Short Protection
* 3μA Low Current at Off-state
* Built-in Pull-up Current at EN Pin
* Full Protection: Over Current Protection, Output Over Voltage Protection, FB Open/Short Protection, Over Temperature Protection

■ TYPICAL APPLICATION

* Battery powered tools
* E-bike powers, E-motors
* Industry applications
* GPS tracker

■ ORDERING INFORMATION

Ordering Number		Package	Packing
Lead Free	Halogen Free		
UD100201L-SH2-R	UD100201G-SH2-R	HSOP-8	Tape Reel

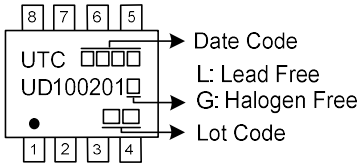
UD100201G-SH2-R

(1)Packing Type
(2)Package Type
(3)Green Package

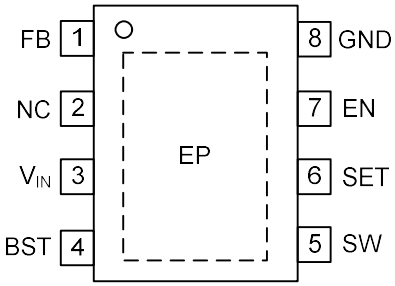
(1) R: Tape Reel
(2) SH2: HSOP-8
(3) G: Halogen Free and Lead Free, L: Lead Free

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■ MARKING



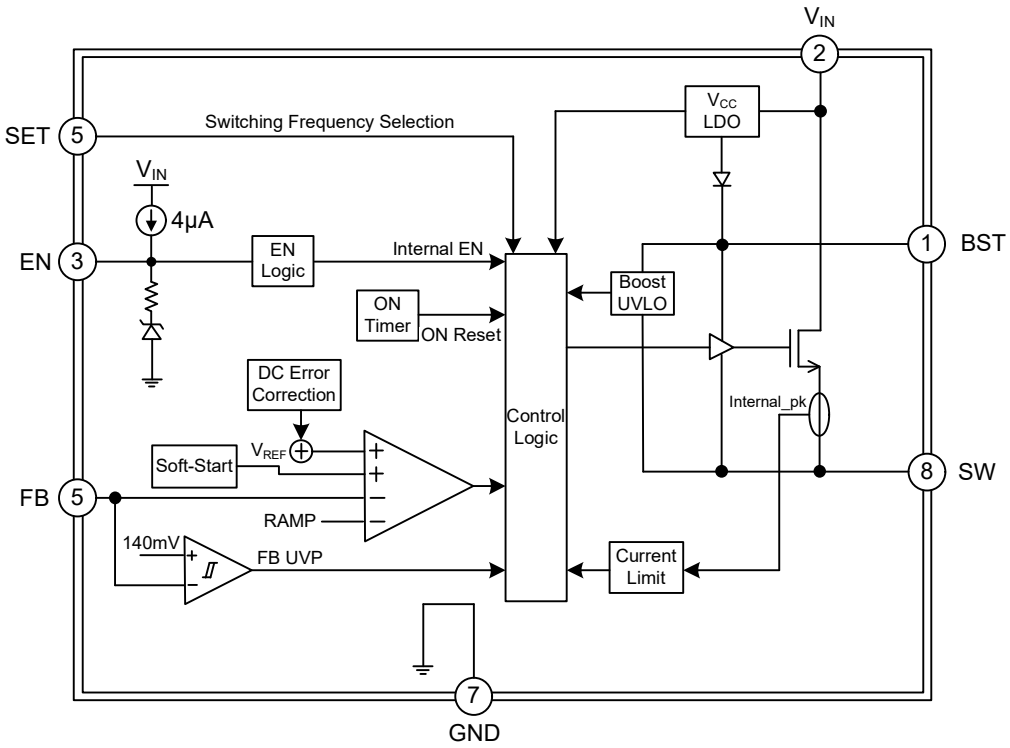
■ PIN CONFIGURATION



■ PIN DESCRIPTION

PIN NO.	PIN NAME	DESCRIPTION
1	FB	Feedback input. Connect a resistor divider to set the output voltage.
2	NC	Do not connect.
3	V_{IN}	Input Supply Pin. Place a capacitor (C_{IN}) as close as to the IC as possible to prevent large voltage spikes from appearing at the input.
4	BST	Bootstrap pin for high side power MOS driving. Connect a high quality 100nF capacitor from this pin to the SW pin.
5	SW	Switching node of power stage. Connect to power inductor.
6	SET	Switching frequency set pin. Place an resistor from this pin to GND to set the IC switching frequency, float this pin or connect it to EN pin directly to set 460kHz switching frequency.
7	EN	Enable pin. Float to enable **UD100201**. Pull down this pin to shut down the part. Internally pulled up by 4μA current.
8	GND	Ground pin. Connect to the power ground of the system.
Exposed Pad	GND	Exposed Pad. Connect exposed pad to the PCB GND plane to achieve good thermal performance.

■ BLOCK DIAGRAM



■ ABSOLUTE MAXIMUM RATING (T_J=25°C, unless otherwise specified)

PARAMETER	SYMBOL	RATINGS	UNIT
V_{IN} to GND	V_{IN}	-0.3 ~ 105	V
V_{SW} to GND	V_{SW}	-0.6 (-5 for 10ns) ~ 105	V
V_{BST} to V_{SW}	V_{BST-SW}	6	V
Max. Input Current to EN Pin	I_{EN}	100 (Note 2)	μA
All Other Pins		-0.3 ~ 6	V
Junction Temperature	T_J	-40 ~ +150	°C
Storage Temperature	T_{STG}	-55 ~ +150	°C

Notes: 1. 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.
2. For details on EN's ABS max rating, please refer to the Enable Control section.

■ RECOMMENDED OPERATING CONDITIONS

PARAMETER		SYMBOL	RATINGS	UNIT
V_{IN} to GND		V_{IN}	4.5 ~ 100	V
Output Voltage		V_{OUT}	0.8 ~ V_{IN} × D_{MAX}(Note) or V_{OUT} < 30V	V
Max Continuous Output Current	V_{OUT}=12V	I_{OUT_DC}	0 ~ 1.5	A
	V_{OUT}=5V		0 ~ 2	A
Transient Output Current		I_{OUT_AC}	0 ~ 3	A

Note: D_{MAX} = t_{ON_MAX} / (t_{ON_MAX} + t_{OFF_MIN}). Typical value is 97%.

■ THERMAL DATA

PARAMETER	SYMBOL	RATING	UNIT
Junction to Ambient	θ_{JA}	34	°C/W
Junction to Case (TOP) Thermal Resistance	$\theta_{JC(TOP)}$	4	°C/W
Junction to Case (Bottom) Thermal Resistance	$\theta_{JC(BOT)}$	2.3	°C/W

Note: Measured on demo board, 2-Layer PCB.

■ ELECTRICAL CHARACTERISTICS (V_{IN}=60V, T_A=25°C, unless otherwise specified)

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
INPUT UVLO AND QUIESCENT CURRENT						
V_{IN} UVLO Rising Threshold	V_{IN_UVR}		4.15	4.3	4.45	V
V_{IN} UVLO Falling Threshold	V_{IN_UVF}		3.9	4.05	4.2	V
V_{IN} UVLO Hysteresis	$V_{IN_UV_HYS}$			0.25		V
V_{IN} Current at Shut Down	I_S	EN=0		3	6	μA
Quiescent Current at No Switch State	I_Q	V_{FB} =0.85V		190		μA
FEEDBACK VOLTAGE						
Feedback Voltage	V_{FB}		0.768	0.78	0.792	V
Feedback Voltage Under Voltage Threshold	V_{FB_UV}			0.14		V
POWER STAGE						
High-Side Power MOS ON Resistance	R_{HSON}	V_{BST} - V_{SW} = 5V		500		mΩ
CURRENT LIMIT						
High-Side Current Limit Threshold	I_{LIM_HS}		3	3.8	4.5	A
SOFT START						
Soft-Start time	T_{SS}	V_{OUT} from 10% to 90%		1.8		ms
SWITCHING FREQUENCY						
Switching Frequency	F_{SW}	SET Pin Float or Connected to EN Pin	400	460	520	kHz
		R_{SET} = 150K	200	240	300	kHz
		R_{SET} = 75K	120	150	190	kHz
Min. On Pulse (Note)	T_{ON_MIN}			150		ns
Max. On Pulse	T_{ON_MAX}			10		μs
Min. OFF Time (Note)	T_{OFF_MIN}			320		ns
ENABLE						
Enable Rising Threshold	V_{EN_RISING}		1.1	1.2	1.2	V
Enable Falling Threshold	$V_{EN_FALLING}$		0.85	0.95	1.05	V
Enable Pulled-up Current	$I_{EN_PULL_UP}$	V_{EN}=High		4		μA
		V_{EN}=Low		1		μA
EN Clamp Voltage	V_{EN_CLAMP}	EN Voltage at 100μA Current		5.7		V
THERMAL PROTECTION						
Thermal Shutdown Entry Threshold (Note)	T_{OTP_R}			160		°C
Thermal Shutdown Recovery Threshold (Note)	T_{OTP_F}			140		°C

Note: Guaranteed by design and engineering sample characterization.

■ FUNCTION DESCRIPTIONS

Pulse-Width Modulation (PWM) Control

The **UD100201** is a fully integrated, non-synchronous, rectified, step-down, switch-mode converter. Constant-on-time (COT) control is employed to provide fast transient response and ease loop stabilization. At the beginning of each cycle, the high-side MOSFET (HS-FET) is turned on when the feedback voltage (V_{FB}) is below the reference voltage (V_{REF}), which indicates an insufficient output voltage. The on period is determined by both the output voltage and input voltage to make the switching frequency fairly constant over the input voltage range.

After the on period elapses, the HS-FET is turned off. The HS-FET is turned on again when V_{FB} drops below V_{REF}. By repeating operation this way, the converter regulates the output voltage.

Internal compensation is applied for COT control to provide a more stable operation, even when ceramic capacitors are used as output capacitors. This internal compensation improves jitter performance without affecting the line or load regulation.

Heavy-Load Operation

Continuous conduction mode (CCM) is when the output current is high and the inductor current is always above zero amps (see Figure 1). When V_{FB} is below V_{REF}, the HS-FET is turned on for a fixed interval determined by the one-shot on-timer. When the HS-FET is turned off, the external free-wheeling diode will handle the current.

In CCM operation, the switching frequency is fairly constant. This is called pulse-width modulation (PWM) mode.

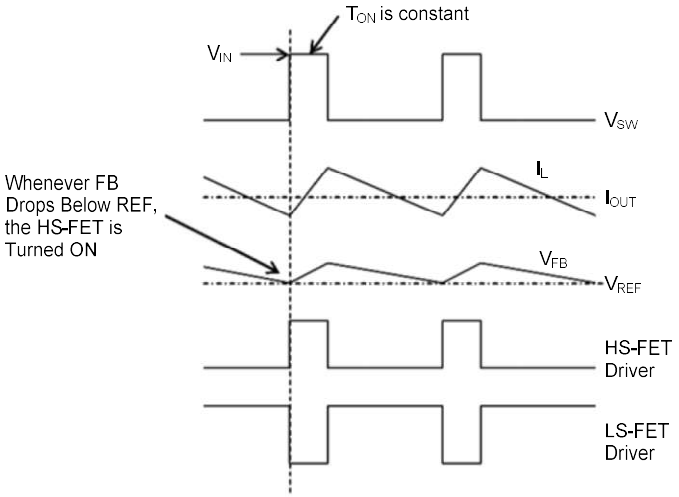


Figure 1. Heavy-Load Operation

Light-Load Operation

When the load decreases, the inductor current decreases as well. Once the inductor current reaches zero, the operation transitions from CCM to discontinuous conduction mode (DCM).

Light-load operation is shown in Figure 2. When V_{FB} is below V_{REF}, the HS-FET is turned on for a fixed interval determined by the one-shot on-timer. When the HS-FET is turned off, the LS-FET is turned on until the inductor current reaches zero. In DCM operation, V_{FB} cannot reach V_{REF} while the inductor current is approaching zero. The free-wheeling diode will shutdown the negative current and IC goes into tri-state. The output capacitors discharge to GND through the feedback resistor slowly. As a result, the efficiency in light-load condition is improved greatly. In light-load condition, the HS-FET is not turned on as frequently as it is in heavy-load condition. This is called skip mode.

At light-load or no-load condition, the output drops very slowly, and the UTC **UD100201** reduces the switching frequency naturally. High efficiency is achieved at light load.

■ FUNCTION DESCRIPTIONS (Cont.)

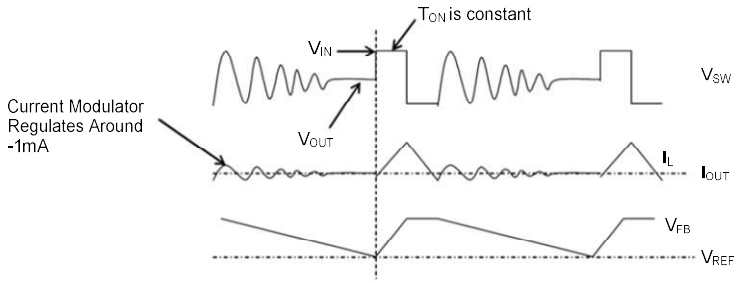


Figure 2. Light-Load Operation

As the output current increases from the light-load condition, the current modulator regulation time period becomes shorter. The HS-FET is turned on more frequently, and the switching frequency increases accordingly. The output current reaches the critical level when the current modulator time is zero. The critical level of the output current can be determined with Equation (1):

$$I_{OUT_Critical}=\frac{(V_{IN}-V_{OUT})\times V_{OUT}}{2\times L\times f_{SW}\times V_{IN}} \quad (1)$$

The device enters PWM mode once the output current exceeds the critical level. Afterward, the switching frequency remains fairly constant over the output current range.

Enable (EN) Control

UTC **UD100201** has a dedicated enable control pin with positive logic. Drive EN pin voltage higher than 1.2V(typical) to turn on the regulator, and drive EN pin voltage lower than 0.95V(typical) to turn it off. By using the two external resistor dividers, it is easy to optimize the start and stop voltage of the system via EN pin:

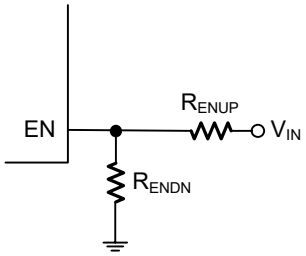


Figure 3. Feedback Network

Start voltage setting:

$$V_{START}=1.2\times\frac{R_{ENUP}+R_{ENDN}}{R_{ENDN}}-4\mu A\times R_{ENUP} \quad (2)$$

Stop voltage setting:

$$V_{STOP}=0.95\times\frac{R_{ENUP}+R_{ENDN}}{R_{ENDN}}-4\mu A\times R_{ENUP} \quad (3)$$

Under-Voltage Lockout (UVLO)

Under-voltage lockout (UVLO) protects the chip from operating at an insufficient supply voltage. The UTC **UD100201** UVLO comparator monitors the input voltage. The UVLO rising threshold is about 4.3V, while its falling threshold is consistently 4.05V.

■ FUNCTION DESCRIPTIONS (Cont.)

Internal Soft Start (SS)

Soft start (SS) prevents the output voltage from overshooting during start-up. When the chip starts, the internal circuitry generates a soft-start voltage (V_{SS}) that ramps up from 0V to 1V. When SS is below REF, SS overrides REF, so the error amplifier uses SS as the reference. When SS exceeds REF, the error amplifier uses REF as the reference. The SS time is set to 1.8ms internally.

Switching Frequency Set

The SET PIN can determine the switching frequency. UTC **UD100201** has three options for switching frequency: 150kHz, 240kHz and 460kHz. Selecting the switching frequency can be done by choosing the resistance value of the resistor connected between SET and GND. See below table:

Table 1. Switching frequency set resistor selection

SET	Switching Frequency
Float or Connected to EN pin	460kHz
150kΩ (±10%) to GND	240kHz
75kΩ (±10%) to GND	150kHz

Current limit and Short protection

The UTC **UD100201** has a peak current limit and a special valley current. During HS-FET on, the inductor current is monitored. If the sensed inductor current reaches the peak current limit after blanking time, the HS-FET would be turn off. Due to the peak current limit's blanking time, the inductor current might runaway when output shorts to ground for a non-sync buck. The special valley current limit in UTC **UD100201** can prevent this. When HS-FET is off and the inductor current is larger than the valley current limit, the HS-FET keeps off until the output current drops below the valley current limit threshold. It's a hiccup type protection. When the output is short to ground, UTC **UD100201** will fold back the switching frequency automatically to prevent the current from runaway. It will make the system more reliable.

Thermal Shutdown

Thermal shutdown prevents the chip from operating at exceedingly high temperatures. When the silicon die temperature exceeds 160°C, the entire chip shuts down. When the temperature falls below its lower threshold (typically 140°C), the chip is enabled again.

■ APPLICATION INFORMATION

Setting the Output Voltage

The **UD100201** output voltage can be set by the external resistor dividers. The reference voltage is fixed at 0.78V. The feedback network is shown in Figure 3.

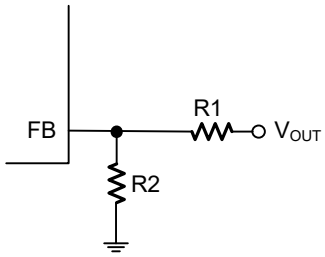


Figure 4. Feedback Network

Choose R1 and R2 using Equation:

$$V_{OUT}=V_{FB}\times\frac{R1+R2}{R2} \quad (4)$$

Selecting the Inductor

An inductor is necessary for supplying constant current to the output load while being driven by the switched input voltage. A larger-value inductor results in less ripple current and a lower output ripple voltage, but also has a larger physical footprint, higher series resistance, and lower saturation current.

For most designs, the inductance value can be derived from Equation:

$$L=\frac{V_{OUT}\times(V_{IN}-V_{OUT})}{V_{IN}\times\Delta I_L\times f_{SW}} \quad (5)$$

Where ΔI_L is the inductor ripple current.

Choose the inductor ripple current to be approximately 30% of the maximum load current. The maximum inductor peak current can be calculated with Equation:

$$I_{L_MAX}=I_{LOAD}+\frac{\Delta I_L}{2} \quad (6)$$

Table 1 lists the recommended feedback resistor values for common output voltages.

Table 2. Resistor Selection for Common Output Voltages (Note)

V_{OUT} (V)	R1 (kΩ)	R2 (kΩ)	C_{ff} (pF)	L (μH)	C_{OUT} (μF)
12	143	10	10	47	2x22
5	53.6	10	47	33	2x22

Note: For a detailed design circuit, please refer to the Typical Application Circuits.

Selecting the Output Capacitor

The output capacitor maintains the DC output voltage ripple. Use ceramic, tantalum, or low-ESR electrolytic capacitors. For best results, use low ESR capacitors to keep the output voltage ripple low. The output voltage ripple can be estimated with Equation (7):

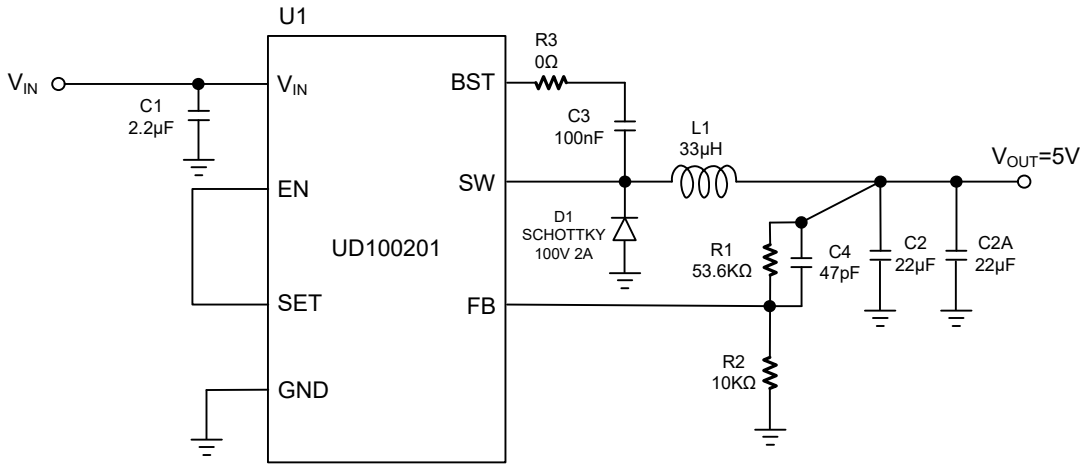
$$\Delta V_{OUT}=\frac{V_{OUT}}{f_{SW}\times L}\times\left(1-\frac{V_{OUT}}{V_{IN}}\right)\times\left(R_{ESR}+\frac{1}{8\times f_{SW}\times C_{OUT}}\right) \quad (7)$$

Where L is the inductor value, and R_{ESR} is the equivalent series resistance (ESR) value of the output capacitor.

The characteristics of the output capacitor also affect the stability of the regulation system. The **UD100201** can be optimized for a wide range of capacitance and ESR values.

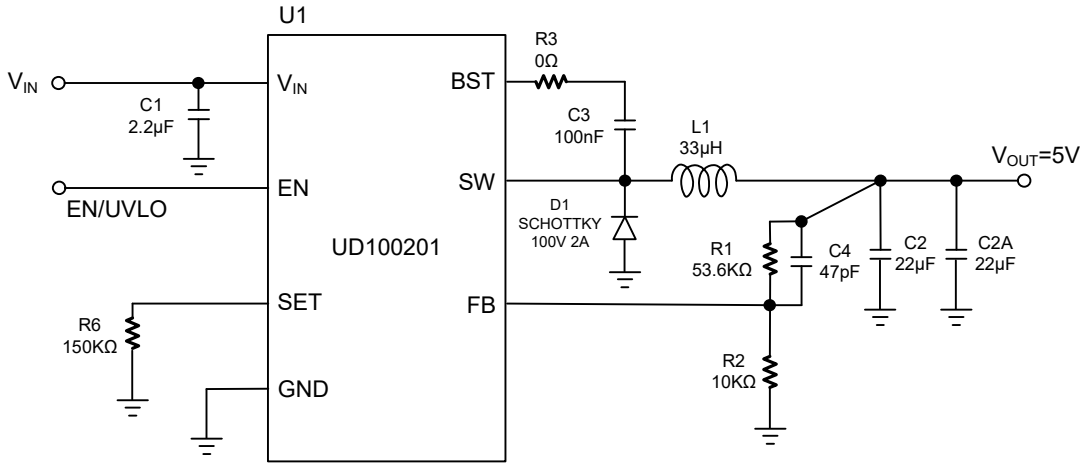
■ TYPICAL APPLICATION CIRCUIT

V_{IN}=48V, V_{OUT}=5V, I_{OUT}=2A, F_{SW}=460kHz



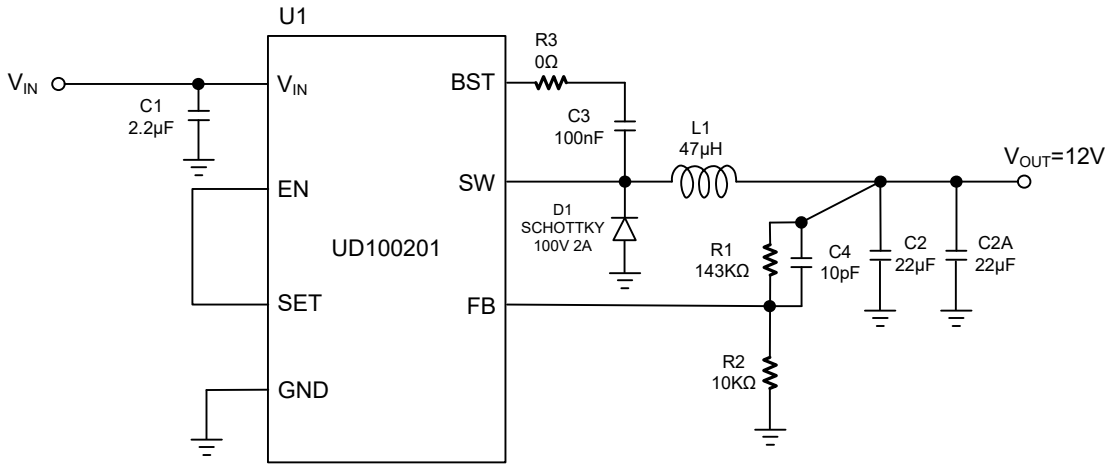
Note: Connect SET pin to EN pin or keep it floating to set 460kHz switching frequency

V_{IN}=48V, V_{OUT}=5V, I_{OUT}=2A, F_{SW}=240kHz



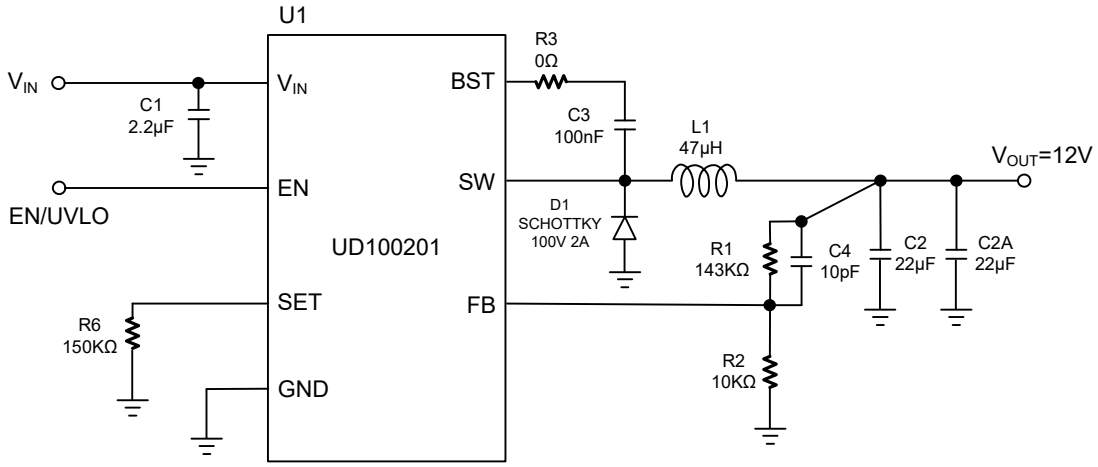
■ TYPICAL APPLICATION CIRCUIT (Cont.)

V_{IN}=48V, V_{OUT}=12V, I_{OUT}=1.5A, F_{SW}=460kHz



Note: Connect SET pin to EN pin or keep it floating to set 460kHz switching frequency.

V_{IN}=48V, V_{OUT}=12V, I_{OUT}=1.5A, F_{SW}=240kHz



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