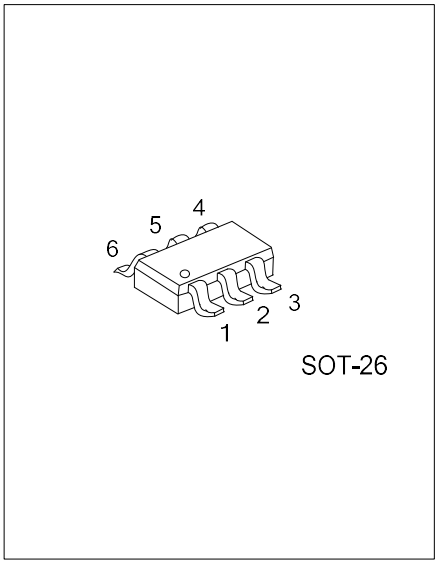
18V, 2A, 580kHz SYNCHRONOUS STEP DOWN CONVERTER



■ DESCRIPTION

The UTC **UD182013** is an 2A synchronous step- down DC-DC converter with an input voltage range of 4.5V to 18V. The UTC **UD182013** adopts the COT architecture to achieve fast transient responses for high voltage step down applications. The UTC **UD182013** operates in pulse skip mode that maintains high efficiency during light load operation. The UTC **UD182013** features cycle-by-cycle current limit protection and prevent the UTC **UD182013** from the catastrophic damage in output short circuit, over current or inductor saturation. A build-in soft-start block prevents inrush current during start up. The UTC **UD182013** also includes input under-voltage lockout, output under-voltage protection, and over-temperature protection to provide safe and smooth operation in all working conditions.

■ FEATURES

* 4.5V to 18V Input Voltage Range
* 2A Available Load Current
* 580kHz Constant Switching Frequency
* Low R_{DSON} for Internal Switches:
  High-side:130mΩ
  Low-side:70mΩ
* Soft Start Time: 1.5ms
* Advanced Constant On-Time Control
* Fast Transient Responses
* Input Under-Voltage Lockout
* Input Over-Voltage Protection
* Output Under-Voltage Protection
* Cycle-by-cycle Over Current Limit
* Short Circuit with Hiccup Mode
* Over-Temperature Protection
* Optimized for Low-ESR Ceramic Output Capacitors

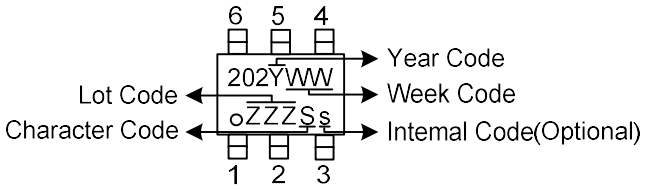
■ ORDERING INFORMATION

Ordering Number		Package	Packing
Lead Free	Halogen Free		
UD182013L-AG6-R	UD182013G-AG6-R	SOT-26	Tape Reel

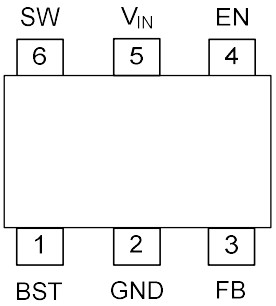
UD182013G-AG6-R (1)Packing Type (2)Package Type (3)Green Package	(1) R: Tape Reel (2) AG6: SOT-26 (3) G: Halogen Free and Lead Free, L: Lead Free

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■ MARKING



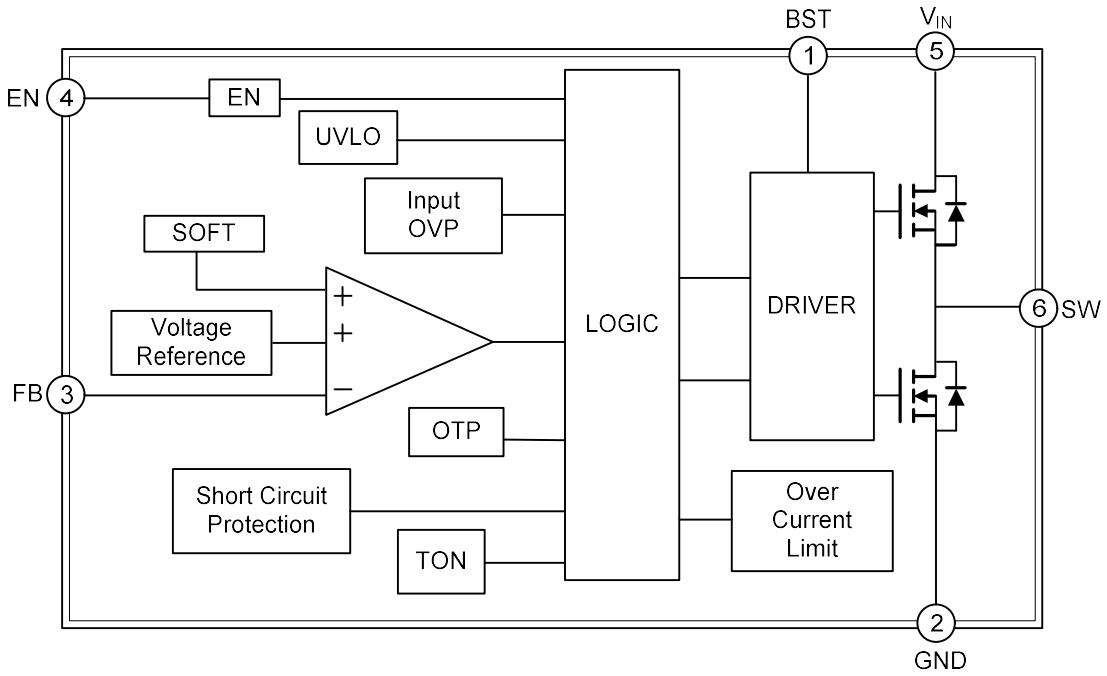
■ PIN CONFIGURATION



■ PIN DESCRIPTION

PIN NO.	PIN NAME	I/O	DESCRIPTION
1	BST	I	Bootstrap capacitor connection node to supply the high-side gate driver. Connect a 0.1uF ceramic capacitor between this pin and SW pin
2	GND	P	Ground Pin.
3	FB	I	Feedback Pin, The device regulates the FB voltage at Feedback Reference Voltage.
4	EN	I	Enable control pin. Pull high to turn on.
5	V_{IN}	P	Supply voltage pin. Decouple this pin to the GND pin with at least a 22μF ceramic capacitor.
6	SW	O	Switch node connection to inductor.

■ BLOCK DIAGRAM


BST
V_{IN}
1
5
EN
4
EN
UVLO
Input
OVP
SOFT
Voltage
Reference
FB
3
LOGIC
DRIVER
6
SW
OTP
Short Circuit
Protection
TON
Over
Current
Limit
2
GND

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

PARAMETER	SYMBOL	RATINGS	UNIT
V_{IN} Voltages	V_{IN}	-0.3 ~ 19	V
SW Voltage	V_{SW}	-0.3 ~ 19	V
EN Voltages	V_{EN}	-0.3 ~ 17	V
SW Voltage (Less than 40ns)	V_{SW}	-5 ~ 24	V
BST Voltage	V_{BST}	-0.3 ~ 24	V
BST to SW Voltage	V_{BST}	-0.3 ~ 6	V
FB Voltage	V_{FB}	-0.3 ~ 6	V
Operating Junction Temperature	T_J	-40 ~ +150	°C
Storage Temperature	T_{OPR}	-65 ~ +150	°C

Note: Stresses beyond those listed under “absolute maximum ratings” may cause permanent damage to the device. These are stress ratings only, functional operation of the device at these or any other conditions beyond those indicated under “recommended operating conditions” is not implied. Exposure to absolute maximum-rated conditions for extended periods may affect device reliability.

■ RECOMMENDED OPERATING CONDITIONS

PARAMETER	SYMBOL	RATINGS	UNIT
Supply Voltage	V_{IN}	4.5 ~ 18	V
Ambient Temperature Range	T_A	-40 ~ +85	°C
Operation junction Temperature Range	T_J	-40 ~ +125	°C

■ THERMAL DATA

PARAMETER	SYMBOL	RATINGS	UNIT
Junction to Ambient	θ_{JA}	100	°C/W

■ ELECTRICAL CHARACTERISTICS (V_{IN}=12V, V_{OUT}=3.3V, T_A=25°C, unless otherwise specified)

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
GENERAL SECTION						
Input Voltage Range	V_{IN}		4.5		18	V
Quiescent Current	I_Q	V_{FB} = 0.65V, SW open		280		μA
Shutdown Current	I_{SD}	V_{EN} = 0V		8	16	μA
THRESHOLD VOLTAGE						
Input over-voltage protection threshold	V_{IN_OVP}			19.4		V
Input over-voltage protection hysteresis	$V_{IN_OVP_Hy}$			1.2		V
EN High-Level Input Voltage	V_{ENH}		1.1	1.3	1.5	V
EN Low-Level Input Voltage	V_{ENL}		0.7	0.9	1.1	V
EN Pin Pull-Down Resistance	R_{EN_DN}			450		kΩ
Wake up VIN Voltage	V_{UVLOH}	V_{EN} = 2V	4.1	4.3	4.5	V
Input UVLO Hysteresis	V_{HYS}			320		mV
SOFT START						
Turn on Delay	T_{ON_MIN}			0.5		ms
Soft-Start Time	T_{SS}	V_{OUT} from 0 to 100%	1.0	1.5		ms
ON-TIME TIMER CONTROL						
Minimum on-Time	T_{ON_MIN}			50		ns
Minimum off-Time	T_{OFF_MIN}			200		ns
MODULATOR CONTROL SECTION						
Regulated Feedback Voltage	V_{FB}		0.588	0.6	0.612	V
Switching Frequency	F_{SW}	CCM Mode	493	580	667	kHz
INTERNAL MOSFET						
High-Side Switch Resistance	R_{DSON_H}	I_{SW} = 100mA		130		mΩ
Low-Side Switch Resistance	R_{DSON_L}	I_{SW} = -100mA		70		mΩ
CURRENT LIMIT						
High-Side Switch Current Limit	I_{LIM_H}			5		A
Low-Side Switch Valley Current Limit	I_{LIM_L}			3.2		A
PROTECTION SECTION						
Output Under-Voltage	V_{UVP}			65%		V_{FB}
Hiccup ON-Time	T_{HICCUP_ON}			1.6		ms
Hiccup OFF-Time	T_{HICCUP_OFF}			16		ms
Over-temperature protection threshold	OTP			150		°C
Over-temperature protection hysteresis	OTP_{Hy}			30		°C

Note: Guaranteed by design.

■ OPERATION DESCRIPTION

Overview

The **UD182013** is a synchronous Step-Down converter with input voltage range of 4.5V to 18V and output voltage as low as 0.6V. The **UD182013** adopts the COT architecture to achieve fast transient responses for high voltage step down applications. This device operates at 580kHz operating frequency to ensure a compact, high efficiency design with excellent AC and DC performance.

Input Under-Voltage Lockout

Input under-voltage lockout (UVLO) monitors the input voltage. When the input voltage is higher than the UVLO threshold voltage (Typ. 4.3V), the device turns on. Once the input voltage drops below the threshold with hysteresis (Typ. 0.32V), the device will shut down.

Input Over-Voltage Protection

Input over-voltage protection (OVP) monitors the input voltage. When the input voltage is above the OVP threshold voltage (Typ. 19.4V), the device shuts down. Once the input voltage drops below the threshold with hysteresis (Typ. 1.2V), the **UD182013** will return to normal operation automatically.

Soft Start

The **UD182013** has a built-in soft start circuit that can control the rate of output voltage rise, avoiding excessive surge currents during IC startup. The typical soft start time from 0% V_{OUT} to 100% V_{OUT} is usually 1.5ms

EN Enable

The EN pin is provided to control the device turn-on and turn-off. When the EN pin voltage is above the V_{ENH} threshold (Typ. 1.3V), the device is enabled. When the EN pin voltage falls below the V_{ENL} threshold (Typ. 0.9V), the **UD182013** is disabled and enters shutdown mode.

Over Current Limit Protection and Output Short Protection

The **UD182013** has both high-side and low-side MOSFET cycle-by-cycle current limit function, prevents the device from high load current condition. When the inductor current peak value is larger than the switch peak current limit (Typ. 5A) after the blank time, high side MOSFET is turned off immediately. When inductor current valley value is larger than the valley current limit (Typ. 3.2A) during low side MOSFET on state, the device enters into valley over current protection mode and low side MOSFET keeps on state until inductor current drops down to the value equal or lower than the valley current limit, and then on time pulse could be generated and high side MOSFET could turn on again.

If the output is over current or output short to GND, the output voltage will drop. When the feedback voltage is below the output under-voltage protection threshold (Typ. 65%V_{FB}), the **UD182013** enters into hiccup mode to periodically disable and restart switching operation. The typical hiccup cycle is 17.6ms, the switching operation time in hiccup mode is 1.6ms. The hiccup mode helps to reduce power dissipation and thermal rising during output short condition.

Output Under-Voltage Protection

The **UD182013** detects output under-voltage by monitoring the feedback voltage on the FB pin. When the feedback voltage is below 65%V_{FB}, the IC enters hiccup mode to periodically disable and restart the switch operation.

Over-Temperature Protection

The **UD182013** includes over-temperature protection function. When the junction temperature exceeds about 150°C, the OTP will turn off the switch operation. Once the junction temperature drops to about 120°C, the IC will resume normal operation.

■ APPLICATION INFORMATION

Output Voltage Setting

Figure 1 shows the output voltage setting circuit of **UD182013**. The external resistance voltage divider can set the output voltage according to equation (1).

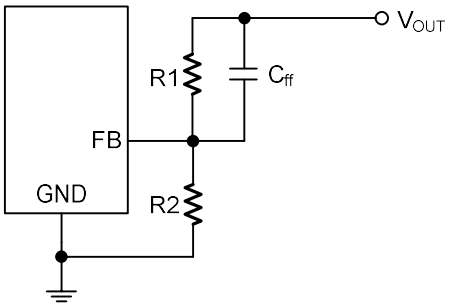


Figure. 1 Output Voltage Setting Circuits

$$V_{OUT}=V_{FB}\times(1+\frac{R1}{R2})=0.6V\times(1+\frac{R1}{R2}) \quad (1)$$

Current consumption and noise sensitivity need to be considered in the selection of resistance R2. A feed forward capacitor Cff improves the loop bandwidth to make a fast transient response, but using a larger Cff brings stability problems.

Inductor Selection

Inductance value, switching frequency, input voltage and output voltage together determine the ripple of inductance current and then affect the output ripple. The ripple of the inductor current can be obtained by Equation (2).

$$\Delta I_L=V_{OUT}\times\frac{1-\frac{V_{OUT}}{V_{IN}}}{L\times F_{SW}} \quad (2)$$

Where ΔI_L is the inductor current ripple, F_{SW} is the switching frequency.

To calculate the maximum inductor current under static load conditions, Equation (3) is given:

$$I_{L_MAX}=I_{OUT}_MAX+\frac{\Delta I_L}{2} \quad (3)$$

Table 1. Recommended Components Selection

V_{OUT} (V)	R1 (kΩ)	R2 (kΩ)	Cff (pF)	L (μH)	C_{OUT} (μF)
5.0	73.3	10	22	4.7	22-88
3.3	45.3	10	22	4.7	22-88
2.5	31.7	10	22	3.3	22-88
1.8	20	10	22	2.2	22-88
1.5	15	10	22	2.2	22-88
1.2	10	10	22	2.2	22-88
1.0	6.68	10	22	2.2	22-88

■ APPLICATION INFORMATION (Cont.)

Input Capacitor Selection

The input capacitor C_{IN} is needed to filter the fluctuations caused by the pulsating current at the drain of the high-side power MOSFET. Ceramic capacitors with X5R or a better grade ceramic capacitor dielectrics are highly recommended because of their low ESR and small temperature coefficients. A 22μF ceramic capacitor for most applications is sufficient. A large value may be used for improved input voltage filtering. In applications, place the input capacitor C_{IN} as close as possible to the V_{IN} pin and GND pin of the IC. It is recommended to place the C_{IN} within 1cm of the IC.

Output Capacitor Selection

The output voltage ripple at the switching frequency is a function of the inductor current ripple going through the output capacitor's impedance. The output peak-to-peak ripple voltage ΔV_{OUT}, caused by the inductor current ripple, is composed of ESR ripple ΔVESR and capacitor ripple ΔVCap. The functional relationship of the output ripple is expressed by Equation (4):

$$\Delta V_{OUT}=\Delta V_{ESR}+\Delta V_{Cap}=\Delta I_L \times R_{ESR}+\frac{\Delta I_L}{8\times C_{OUT}\times F_{SW}} \quad (4)$$

Where R_{ESR} is equivalent impedance on capacitor.

A 22μF ceramic can satisfy most applications. When output Capacitor is only Electrolytic capacitors there is no need to add a Cff (feed forward capacitor).

Boost Capacitor Selection

The boost capacitor (CBST) between BST pin and SW pin is used to create a voltage rail above VIN. For most application, it is recommended to use ceramic capacitors with X5R specifications, capacitance of 0.1μF, and 0603 packaging. The rated voltage of the capacitor should be 6.3V or higher.

■ TYPICAL APPLICATION CIRCUIT

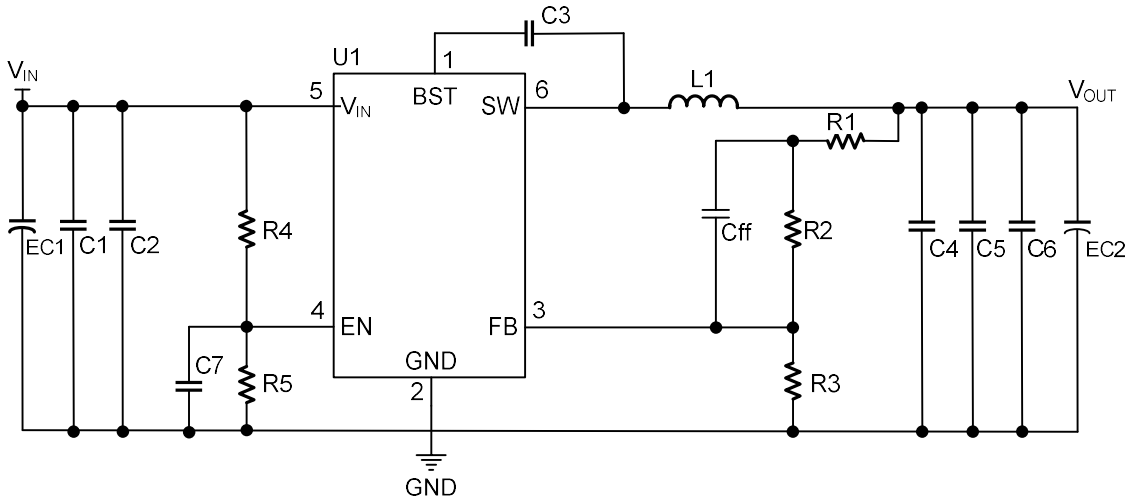


Table 2. Recommended Component Values

Qty.	Designator	Value	
1	C1	22μF	
1	C2, C3	0.1μF	
1	C4	22μF	
1	Cff	22pF	
0	C5,C6,C7	NC	
0	EC1,EC2	NC	
1	R1	0Ω	
1	R2	V_{OUT}=5V	73.3kΩ
		V_{OUT}=3.3V	45.3kΩ
		V_{OUT}=1V	6.68kΩ
1	R3	10kΩ	
1	R4	100kΩ	
0	R5	NC	
1	L1	V_{OUT}=5V, 3.3V	4.7μH
		V_{OUT}=1V	2.2μH
1	U1	**UD182013**	

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