



## HIGH-SIDE POWER SWITCHES WITH FLAG

### DESCRIPTION

The UTC **US211/A/B/C** series are 80mΩ high-side power switches. There's internal single low voltage N-Channel MOSFET which makes it an ideal for all USB applications. This MOSFET should be driven by a charge pump circuitry inside. Its switch on resistance is as low as 80mΩ which we know specially meets the drop voltage for USB applications.

The flag pin can output an open-drain fault flag to next controller.

There're lots internal special ways for protecting the chip's operation.

When in hot-plug events, there's large current which can create the upstream voltage droop to match the USB's voltage droop requirements and soft-start for isolating the power source.

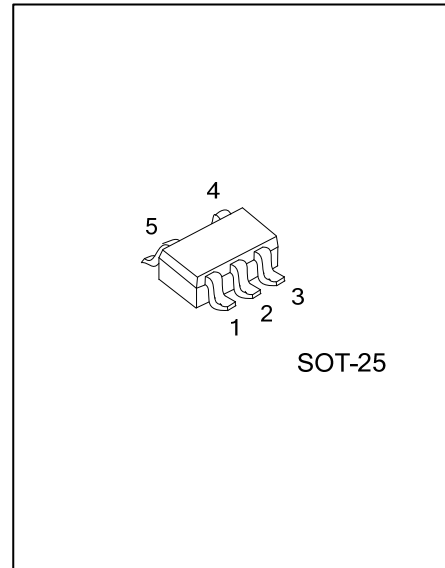
As soon as the die temperature is higher than 130°C, the internal shutdown circuit will work.

Only when there's a normal input voltage in the  $V_{IN}$  pin, the UVLO (under-voltage lockout, 1.3V/2.5V typ.) can make sure the chip is till in the off state.

Because of the requirement of USB power the fault current should be ensured less than 0.6A/1.1A (UTC **US211/A**, single port) and 1.3A /1.5A (UTC **US211B/C**, dual ports).

### FEATURES

- \* 80mΩ(Typ) N-Channel MOSFET
- \* Supply Current:
  - Switch On : 25μA(Typ)
  - Switch Off : 1μA (Typ)
- \* Load Current 500mA for US211 and 1.0A for US211A/B/C
- \* Input Voltage from 2V ~ 5.5V
- \* In Off-State: Output Voltage can be Higher than Input

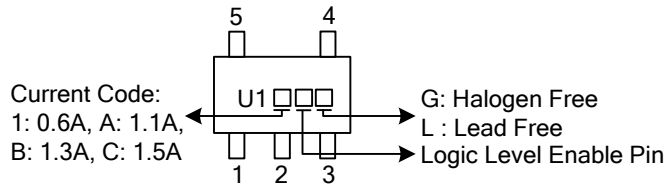


### ORDERING INFORMATION

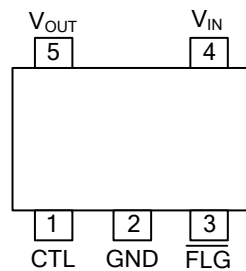
Ordering Number		Package	Packing
Lead Free	Halogen Free		
US211XXL-AF5-R	US211XXG-AF5-R	SOT-25	Tape Reel

<p>US211XXL-AF5-R</p> <ul style="list-style-type: none"> <li>(1)Packing Type</li> <li>(2)Package Type</li> <li>(3)Lead Free</li> <li>(4) Logic Level Enable Pin</li> <li>(5)Current Code</li> </ul>	<ul style="list-style-type: none"> <li>(1) R: Tape Reel</li> <li>(2) AF5: SOT-25</li> <li>(3) G: Halogen Free, L: Lead Free</li> <li>(4) H: Active High, L: Active Low</li> <li>(5) Blank: 0.6A, A: 1.1A , B: 1.3A, C: 1.5A</li> </ul>
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MARKING



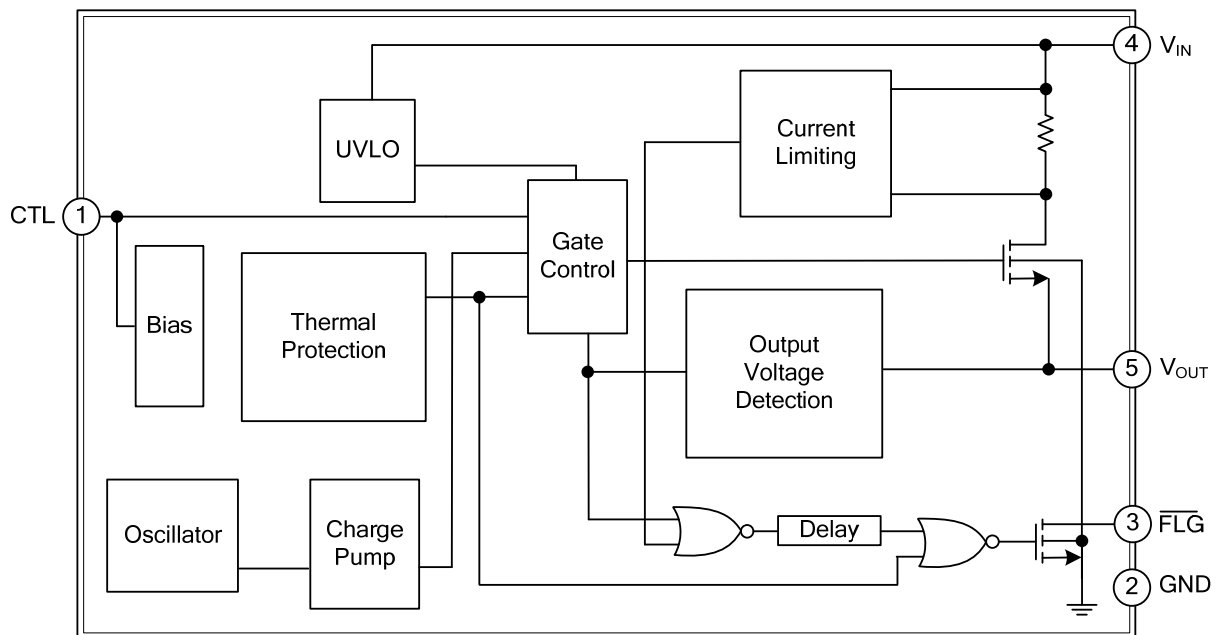
PIN CONFIGURATION



PIN DESCRIPTION

PIN NO	PIN NAME	DESCRIPTION
1	CTL	Enable Input pin, H: High active, L: Low active
2	GND	Ground
3	FLG	Open-drain fault flag output
4	V <sub>IN</sub>	Power input voltage
5	V <sub>OUT</sub>	Output voltage

BLOCK DIAGRAM



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

PARAMETER		SYMBOL	RATINGS	UNIT
Supply Voltage		$V_{CC}$	6.5	V
			+2 ~ +5.5 (Note 2)	V
Input/Output Pins		$V_{CTL}$	-0.3~ +6.5	V
			0 ~ +5.5 (Note 2)	V
		$V_{FLG}$	6.5	V
Junction Temperature		$T_J$	150	$^{\circ}\text{C}$
			-20 ~ +100 (Note 2)	$^{\circ}\text{C}$
Storage Temperature		$T_{STG}$	-65 ~ +150	$^{\circ}\text{C}$

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. The device is not guaranteed to function when it's beyond its operating conditions.

■ THERMAL DATA

PARAMETER	SYMBOL	RATINGS	UNIT
Junction to Ambient	$\theta_{JA}$	260	$^{\circ}\text{C}/\text{W}$
Junction to Case	$\theta_{JC}$	81	$^{\circ}\text{C}/\text{W}$

■ ELECTRICAL CHARACTERISTICS

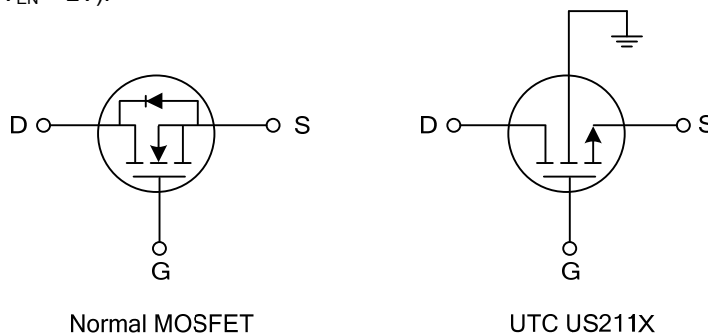
PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT	
<b>ENABLE INPUT</b>							
CTL Threshold	Low	$V_{IL}$	$V_{IN}=2\text{V}\sim 5.5\text{V}$ , Switch OFF		0.8	V	
	High	$V_{IH}$	$V_{IN}=2\text{V}\sim 5.5\text{V}$ , Switch ON		2.0	V	
CTL Input Current	$I_{I(CTL)}$	$V_{CTL}=0\text{V}\sim 5.5\text{V}$		0.01		$\mu\text{A}$	
<b>UNDER VOLTAGE LOCK</b>							
Under-Voltage Lockout	$V_{UVLO}$	$V_{IN}$ increasing	US211/ US211A	1.0	2.1	2.9	V
			US211B/ US211C		2.5		
Under-Voltage Hysteresis	$\Delta V_{UVLO}$	$V_{IN}$ decreasing		0.1		V	
<b>SUPPLY CURRENT</b>							
Supply Current	$I_{SW(ON)}$	Switch on, $V_{OUT}=\text{OPEN}$		25	45	$\mu\text{A}$	
	$I_{SW(OFF)}$	Switch off, $V_{OUT}=\text{OPEN}$		0.1	1	$\mu\text{A}$	
Output Leakage Current	$I_{O(LEAK)}$	$V_{CTL}=0\text{V}$ , $R_{LOAD}=0\Omega$		0.5	10	$\mu\text{A}$	
<b>CURRENT LIMIT</b>							
Current Limit	$I_{LIMIT}$		US211	0.6	0.8	1.1	A
			US211A	1.1	1.5	1.9	A
			US211B	1.3	1.7	2.1	A
			US211C	1.5	2.0	2.4	A
Short Circuit Fold-Back Current	$I_{SC(FB)}$	$V_{OUT}=0\text{V}$ , measured prior to thermal shutdown	US211		0.8		A
			US211A		1.0		A
			US211B		1.0		A
			US211C		1.3		A
<b>POWER SWITCH</b>							
Switch ON Resistance	$R_{DS(ON)}$	$I_{OUT}=500\text{mA}$	US211		80	110	$\text{m}\Omega$
		$I_{OUT}=1.0\text{A}$	US211A/B/C		80	110	$\text{m}\Omega$
Output Turn-ON Rise Time	$t_{ON(RISE)}$	10% ~ 90% of $V_{OUT}$ rising		400		$\mu\text{s}$	
<b>OVER CURRENT FLAG</b>							
FLAG OFF Current	$I_{FLG(OFF)}$	$V_{FLG}=5\text{V}$		0.01	1	$\mu\text{A}$	
FLAG Output Resistance	$R_{FLG}$	$I_{SINK}=1\text{mA}$		20	400	$\Omega$	
FLAG Delay Time	$t_D$	From fault condition to $\overline{\text{FLG}}$ assertion	2	10	15	ms	
<b>THERMAL SHUTDOWN</b>							
Thermal Shutdown Protection	$T_{SD}$			130		$^{\circ}\text{C}$	
Thermal Shutdown Hysteresis	$\Delta T_{SD}$			20		$^{\circ}\text{C}$	

## ■ APPLICATION INFORMATION

### Input and Output

$V_{IN}$  (input) is the power source connection to the internal circuitry and the drain of the MOSFET.  $V_{OUT}$  (output) is the source of the MOSFET. In a typical application, current flows through the switch from  $V_{IN}$  to  $V_{OUT}$  toward the load. Because the MOSFET is bidirectional when on, if  $V_{OUT}$  is greater than  $V_{IN}$ , current will flow from  $V_{OUT}$  to  $V_{IN}$ .

There is no a parasitic body diode of N-MOSFET between the drain and source compared to a normal MOSFET,. The **US211** can protect damage from reverse current flow if  $V_{OUT}$  being externally forced to a higher voltage than  $V_{IN}$  when the output disabled ( $V_{EN} > 2V$ ).



### Enable Input

The switch will be disabled when the EN pin is in a logic low/high condition. During this condition, the internal circuitry and MOSFET are turned off, reducing the supply current to 0.1 $\mu$ A typical. Floating the EN may cause unpredictable operation. EN should not be allowed to go negative with respect to GND. The EN pin may be directly tied to  $V_{IN}$  (GND) to keep the part on.

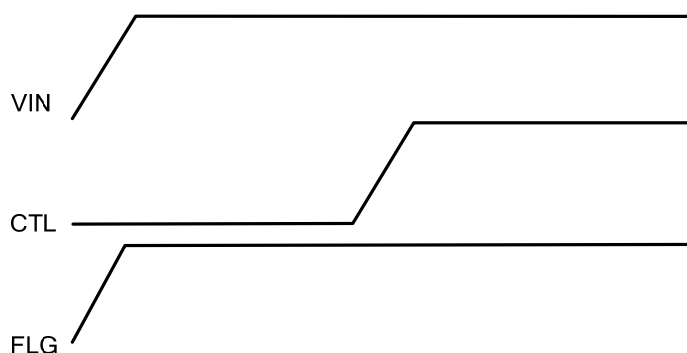
### Soft Start for Hot Plug-In Applications

When hot-plug events occur, the soft start is used to eliminate the upstream voltage droop due to the inrush current. The soft-start protects power supplies from damage caused by highly capacitive loads.

### Fault Flag

The fault flag is an open-drained output of an N-channel MOSFET. The flag drops low to indicate fault conditions: current limit, thermal shutdown or  $V_{OUT} < V_{IN} - 1V$ . In order to reduce energy drain, a large pull-up resistor is required. 100k $\Omega$  pull-up resistor is recommended for most applications.

In the case of over current condition, the fault flag is active only if the flag response delay time ( $t_D$ ) has elapsed. This ensures that  $\overline{FLG}$  is asserted only upon valid over-current conditions and that erroneous error reporting is eliminated. For example, false over-current conditions may occur during hot-plug events when extremely large capacitive loads are connected and causes a high transient inrush current that exceeds the current limit threshold. The  $\overline{FLG}$  response delay time  $t_D$  is typically 10ms.



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**■ APPLICATION INFORMATION(Cont.)****Current Limiting and Short-Circuit Protection**

The current limit circuit protects the MOSFET switch and the hub downstream port from damage. This circuit can deliver load current up to the current limit threshold of typically 0.8A through the switch of US211, 1.5A for US211A, 1.7A for US211B and 2.0A for US211C. When an enabled switch applies a heavy load or short circuit, a large-desired transient current occurs which can cause the current limit circuit response. If this current becomes higher than the current limit threshold, the devices enter constant current mode until thermal shutdown occurs or the fault is removed.

**Thermal Shutdown**

The thermal shutdown circuit is used to prevent damage occurs when the die temperature becomes higher than approximately 130°C. After 20°C of hysteresis, the switch will automatically restart if it enabled. When these devices are disabled or the fault is removed, the output and  $\overline{\text{FLG}}$  signal will continue to cycle on and off.

■ TEST CIRCUIT

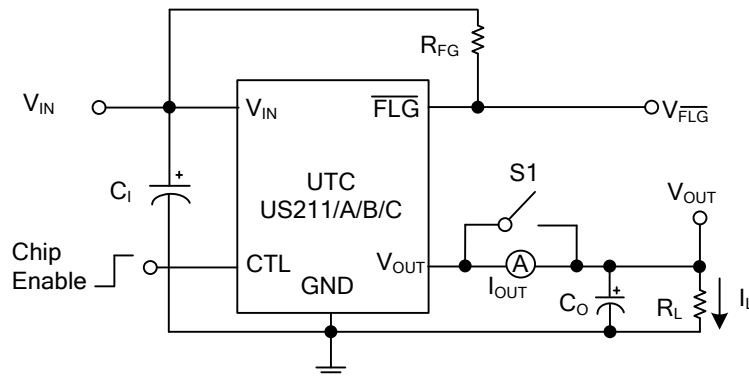


Fig.1 Turn-On & Off Response, Flag Response

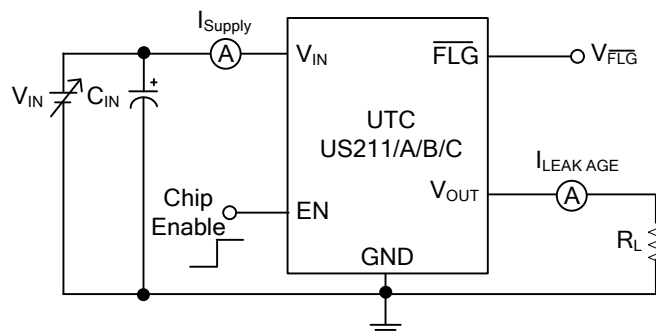


Fig.2 Supply Current

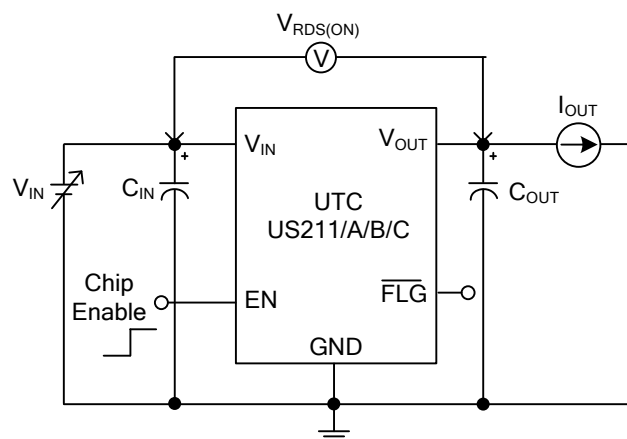


Fig.3 On-Resistance

■ TEST CIRCUIT

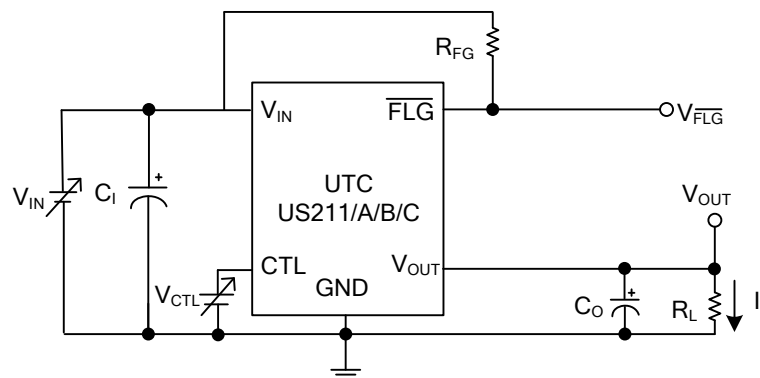


Fig.4 UVLO at Rising & Falling

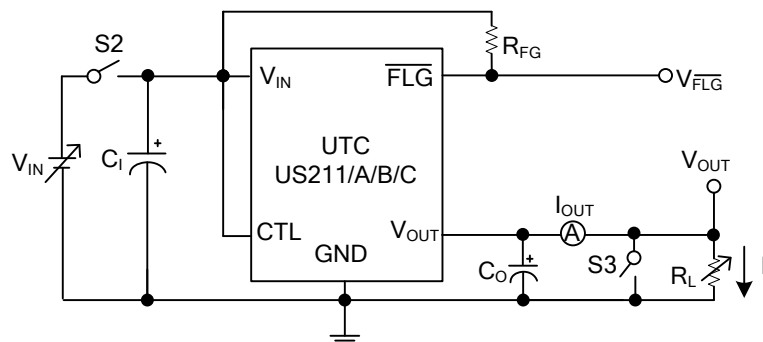
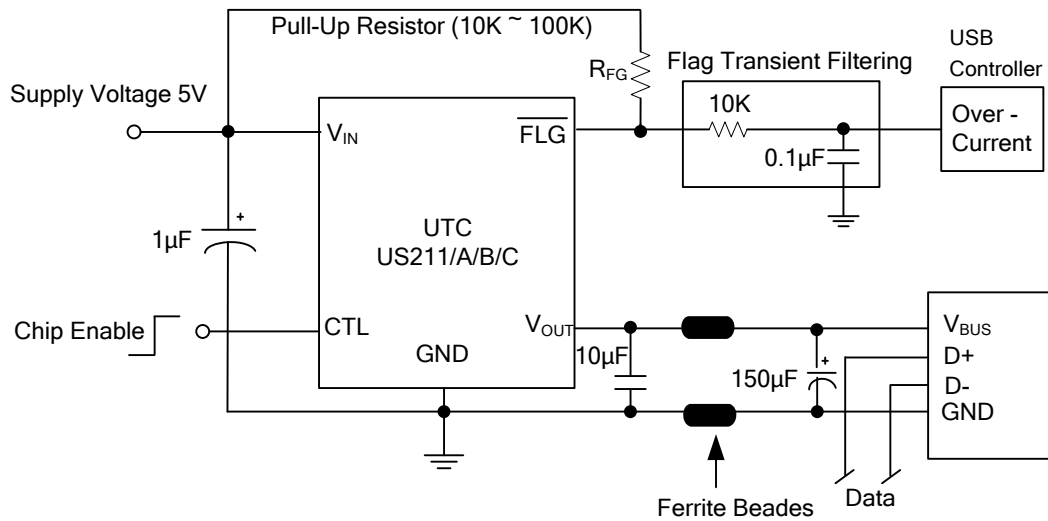


Fig.5 Current Limit vs. Input Voltage, Inrush Current Response, Current Limit Transient Response

Note: Above test circuits reflected the graphs shown on "Typical Operating Characteristics" are as follows:

- Fig.1 Turn-On Rising & Falling Time vs. Temperature, Turn-On & Off Response, Flag Response.
- Fig.2 Supply Current vs. Input Voltage & Temperature, Switch Off Supply Current vs. Temperature, Turn-Off Leakage Current vs. Temperature.
- Fig.3 On-Resistance vs. Input Voltage & Temperature.
- Fig.4 EN Threshold Voltage vs. Input Voltage & Temperature, Flag Delay Time vs. Input Voltage & Temperature, UVLO Threshold vs. Temperature, UVLO at Rising & Falling.
- Fig.5 Current Limit vs. Input Voltage/Temperature, Short Circuit Current Response, Short Circuit Current vs. Temperature, Inrush Current Response, Soft-start Response, Ramped Load Response, Current Limit Transient Response, Thermal Shutdown Response.

■ TYPICAL APPLICATION CIRCUIT



Note. A low-ESR 150µF aluminum electrolytic or tantalum between V<sub>OUT</sub> and GND is strongly recommended to meet the 330mV maximum droop requirement in the hub V<sub>BUS</sub>.

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