UNISONIC TECHNOLOGIES CO., LTD
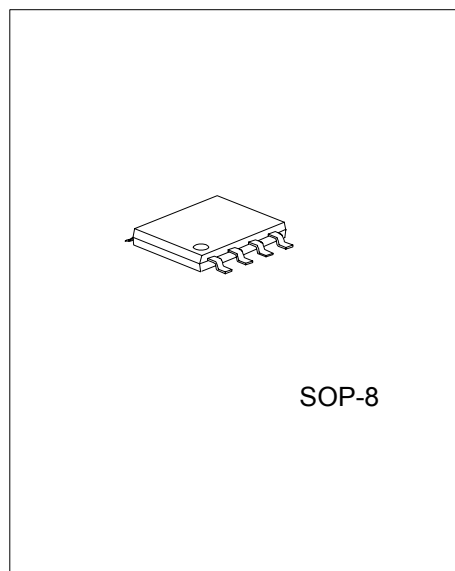
US2026A

CMOS IC

DUAL-CHANNEL USB POWER SWITCH AND OVER-CURRENT PROTECTION

■ **DESCRIPTION**

The UTC **US2026A** is a standard dual channels power switch with independent over-current protection fault flag functions, optimized for bus-powered Universal Serial Bus (USB) and self-powered applications, including Notebook and desktop PC's that supply power to more than one port.

The UTC **US2026A** also offers thermal shutdown protection that reduces current consumption in fault modes for each switch and the entire device. With a 1ms delay on the fault FLAG output prevents erroneous over current reporting caused by in-rush currents during hot-plug events.

In addition, the UTC **US2026A** employs soft-start circuitry that minimizes in-rush current in applications where highly capacitive loads are employed.

SOP-8

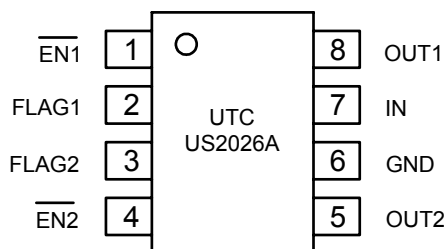*Pb-free plating product number: US2026AL

■ **FEATURES**

* Two P-channel power MOSFET control switch
* 110μA Max operating current
* 5μA Max standby current
* 145 mΩ Max switch resistance
* 2.7V ~ 5.5V input voltage range
* 500mA minimum continuous load current
* Smooth turn-on eliminates in-rush induced voltage drop
* 1 ms fault flag delay filters Hot-Plug events
* Over-current protection
* Under-voltage lockout circuit
* Thermal shutdown protection
* Flag indicates fault conditions

■ **ORDERING INFORMATION**

Ordering Number		Package	Packing
Normal	Lead Free Plating		
US2026A-S08-R	US2026AL-S08-R	SOP-8	Tape Reel
US2026A-S08-T	US2026AL-S08-T	SOP-8	Tube

US2026AL-S08-R
(1)Packing Type
(2)Package Type
(3)Lead Plating

(1) R: Tape Reel, T: Tube
(2) S08: SOP-8
(3) L: Lead Free Plating, Blank: Pb/Sn

■ PIN CONFIGURATIONS

```
         ┌──────────────┐
 EN1  1  │  ○           │  8  OUT1
         │              │
FLAG1 2  │     UTC      │  7  IN
         │   US2026A    │
FLAG2 3  │              │  6  GND
         │              │
 EN2  4  │              │  5  OUT2
         └──────────────┘
```

■ PIN DESCRIPTION

PIN NO	PIN NAME	DESCRIPTION
1	$\overline{EN1}$	Switch1 Enable input: Logic-compatible enables inputs
2	FLAG1	Fault Detection Flag 1 (OUTPUT): Active-low. N-ch open-drain. Indicates over-current, thermal shutdown, or UVLO conditions
3	FLAG2	Fault Detection Flag 2 (OUTPUT): Active-low. N-ch open-drain. Indicates over-current, thermal shutdown, or UVLO conditions
4	$\overline{EN2}$	Switch2 Enable input: Logic-compatible enables inputs
5	OUT2	Switch2 OUTPUT: Drain of MOSFET for Output. Usually, connected to Load
6	GND	Ground
7	IN	Power input: Source of MOSFET for Output. Power Supply to Internal Circuitry of IC
8	OUT1	Switch1 OUTPUT: Drain of MOSFET for Output. Usually, connected to Load

US2026A

■ **BLOCK DIAGRAM**

US2026A
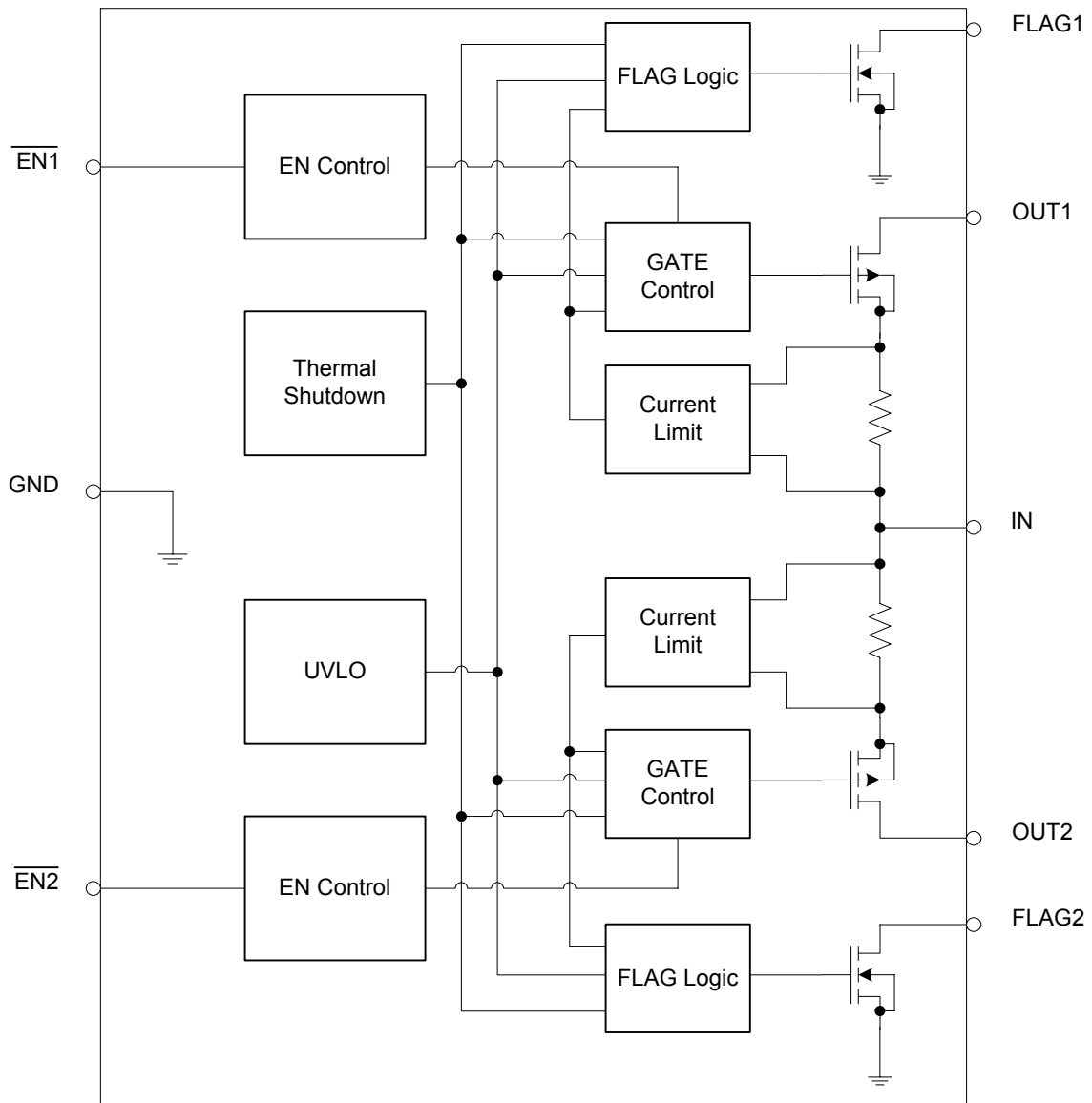
■ **ABSOLUTE MAXIMUM RATINGS**

PARAMETER	SYMBOL	RATINGS	UNIT
Supply Voltage	V_{IN}	-0.3 ~ +6	V
Output Voltage	V_{OUT}	-0.3 ~ +6	V
Voltage at All Other Pins	V_{OTHER}	-0.3 ~ +6	V
Total Power Dissipation	P_D	300	mW
Junction Temperature	T_J	+150	
Operating Temperature	T_{OPR}	-40 ~ +85	
Storage Temperature	T_{STG}	-55 ~ +150	

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.

■ **RECOMMENDED OPERATION CONDITIONS**

PARAMETER	SYMBOL	RATINGS	UNIT
Supply Voltage Range	V_{IN}	+2.7 ~ +5.5	V
Operating Temperature	T_{OPR}	0 ~ +70	

■ **ELECTRICAL CHARACTERISTICS** (T_J = 25°C, V_{IN} = 5.0V, V_{EN} = 0V, unless otherwise specified.)

PARAMETER		SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
DC CHARACTERISTIC							
$\overline{EN}$ Input Logic	High	V_{IH}	(Note 1)	2.4	1.7		V
	Low	V_{IL}	(Note 1)		1.6	0.8	V
Under-Voltage Lockout Threshold		V_{UVLO}	V_{IN}=increasing		2.3	2.7	V
			Hysteresis voltage		100		mV
OUT Pins Continuous Output Current		I_{OUT}	Each Output	0.5			A
Over-Current Threshold		THD_{OC}			1.5	2.2	A
OUT Pins Output Leakage Current		I_{LEAK}	$V_{\overline{EN}}$ = V_{IN}		0.01	10	µA
$\overline{EN}$ Leakage Current		I_{EN}	$V_{\overline{EN}}$ = 0V or $V_{\overline{EN}}$= V_{IN}	-0.5		0.5	µA
Supply Current	OFF	$I_{O(OFF)}$	Switch-Off		1	5	µA
	ON	$I_{O(ON)}$	Switch-On			110	µA
Error FLAG Leakage Current		I_{FH}	V_{FLAG} = 5V		0.01	1	µA
On Resistance		R_{ON}	V_{IN} = 5V, I_{OUT} = 500mA, each switch		105	145	mΩ
			V_{IN} = 2.7V, I_{OUT} = 500mA, each switch		135	180	
FLAG Output Voltage		R_{FO}	I_{FO} = 10 mA, V_{IN} = 5.0V		10	20	Ω
			I_{FO} = 10 mA, V_{IN} = 3.3V		11	30	
			I_{FO} = 10 mA, V_{IN} = 2.7V		12	40	
Over-Temperature Shutdown Threshold		THD_{OT}	T_J Increasing, with no shorted output		155		°C
			T_J Increasing, with shorted output (s)		145		
			T_J Decreasing (Note 2)		135		
AC CHARACTERISTIC							
Over Current Flag Delay		t_{OC}	R_L = 0		1		ms
OUT Rise Time		t_R	R_L = 10Ω		160		µs
OUT Fall Time		t_F	R_L = 10Ω		5		µs
Turn on Delay, $\overline{EN}$ to OUT		t_{ON}	R_L = 10Ω		240		µs
Turn off Delay, $\overline{EN}$ to OUT		t_{OFF}	R_L = 10Ω		5		µs

Note: 1. OFF is $\overline{EN}$ ≥ 2.4V and ON is $\overline{EN}$ ≤ 0.8V.
     2. Thermal Shutdown will protect the device from permanent damage.

■ **TEST CIRCUIT**
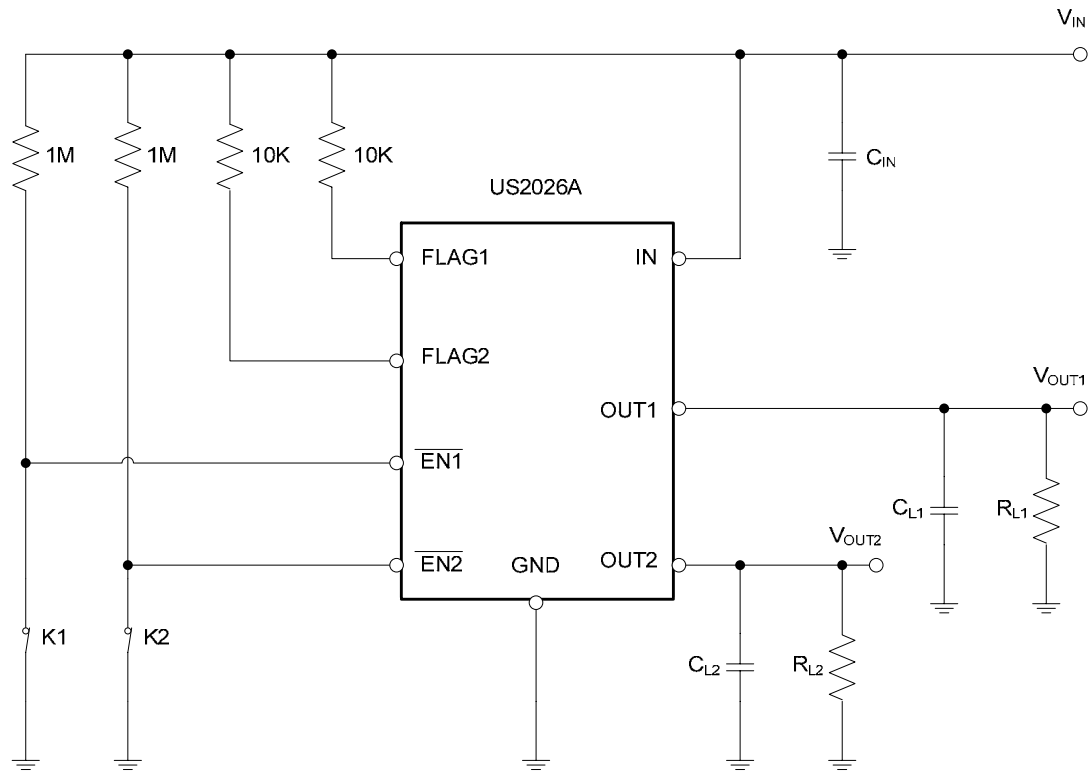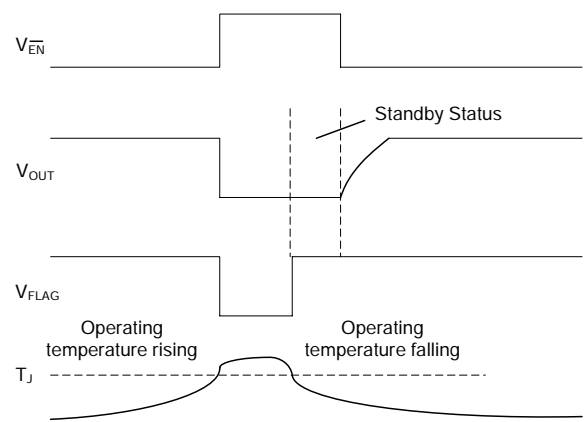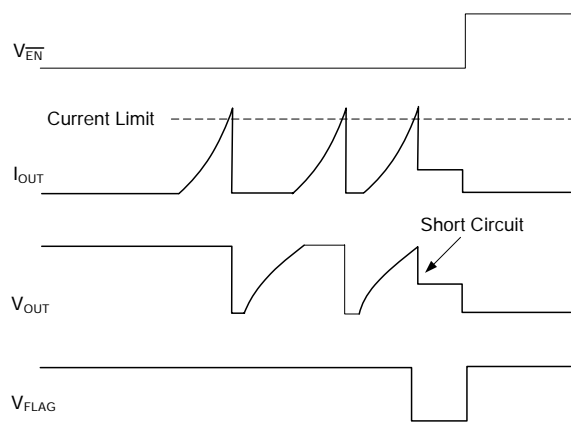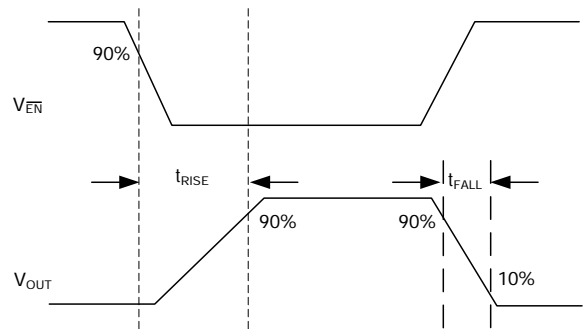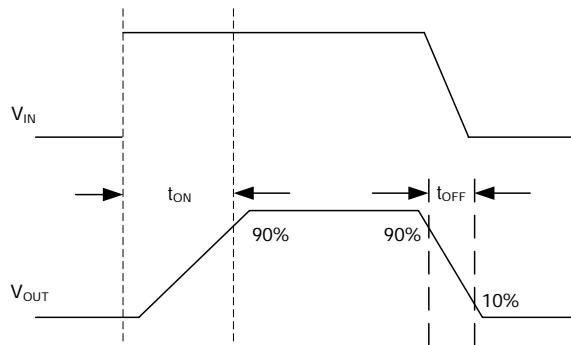
■ **TIMING DIAGRAM**

■ FUNCTIONAL DESCRIPTION

The UTC **US2026A** is dual P-Channel switches with active-low and active-high enable inputs, respectively. Fault conditions (such as UVLO, thermal shutdown and over-current) that appear will turn off the power switch, and the FLAG pin will go low. Of course, the two internal FLAG circuits also operate respectively.

Input and Output

IN (Input) is the power supply connection to the control circuitry and the source of the output MOSFET. OUTX (Output) is the connection to the drain of the output MOSFET. In a typical application circuit, current flows through the switch from IN to OUTX towards the load. If V_{OUT} is greater than V_{IN} when the switch is enabled, current will flow from OUTX to IN since the MOSFET is bi-directional.

Power ON and OFF

The UTC **US2026A** performs a soft-start operation on power application, which is to prevent an over-current or inrush-current from flowing through the switch from IN to OUTX towards to the load, while the high-capacity capacitor is connected to the OUTX.

Thermal Shutdown

The UTC **US2026A** is internally protected against excessive power dissipation by thermal shutdown protection circuit. If device junction temperature rise above approximately 145 , both switches are turned off, both fault FLAG outputs are activated, and they goes low. Hysteresis ensures that both switches turned off by thermal shutdown will not be turned on again until the die temperature is reduced to 135 . When the thermal shutdown circuit is activated, the output pins are in the OFF status. However, the UTC **US2026A** enters the standby status when $\overline{EN}$ pins are all inactive.

Current Limit

The current limit circuit is designed to protect the output MOSFET, the load and the IC supply from damage caused by excessive currents. The current limit threshold is preset internally, If an over-current is detected, the IC performs a slow-start operation again, it is assumed that output is short circuit, and FLAG pin will go low, FLAG output is available to indicate fault conditions independently to the USB controller.
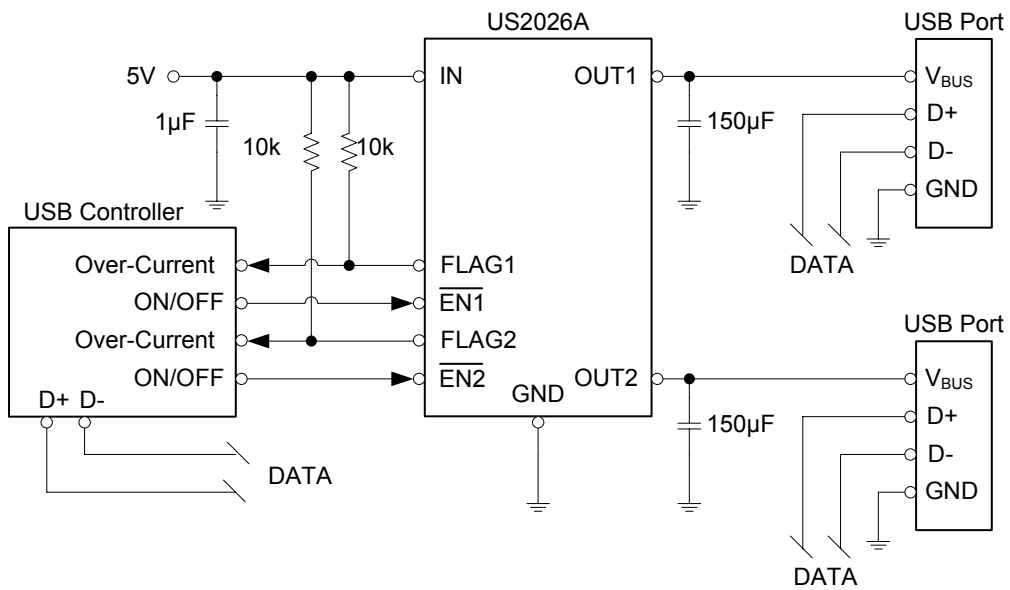
Under-Voltage Lockout

UVLO prevents the output MOSFET switch from turning on until input voltage exceeds 2.3V (typical). If input voltage drops below 2.2V (typical), UVLO shuts off the both output MOSFET switches and signals the FLAG.
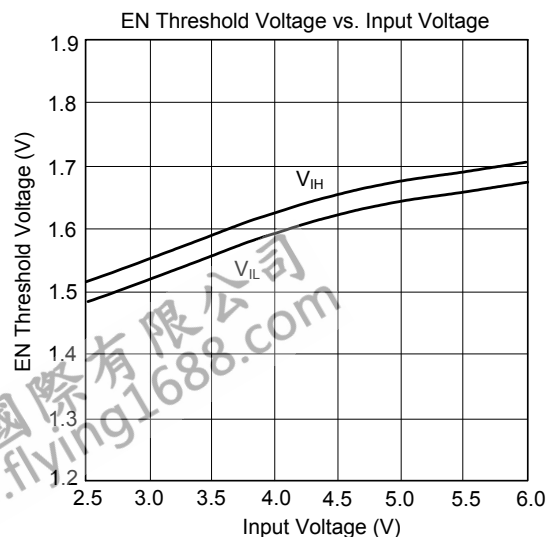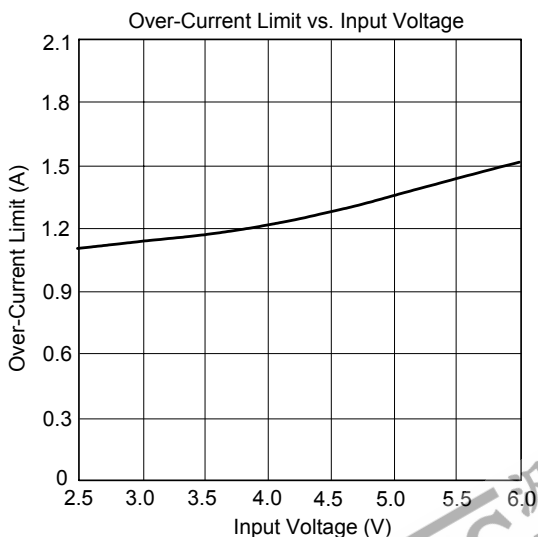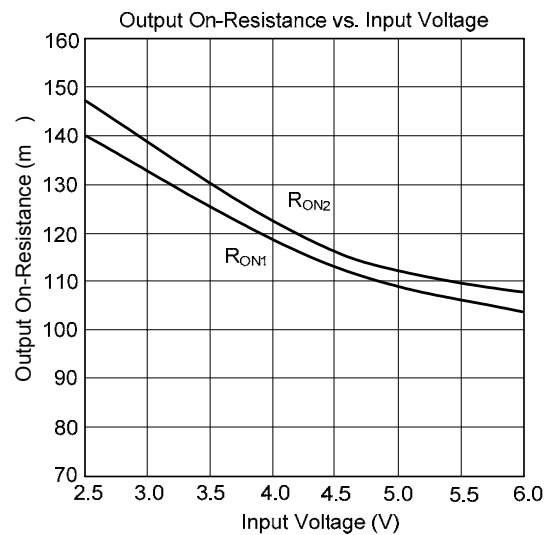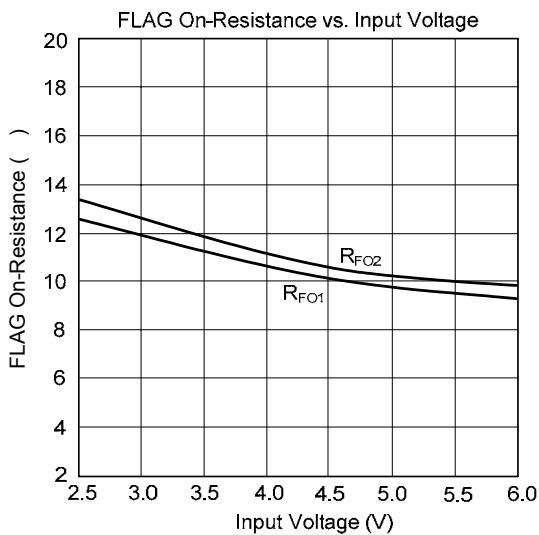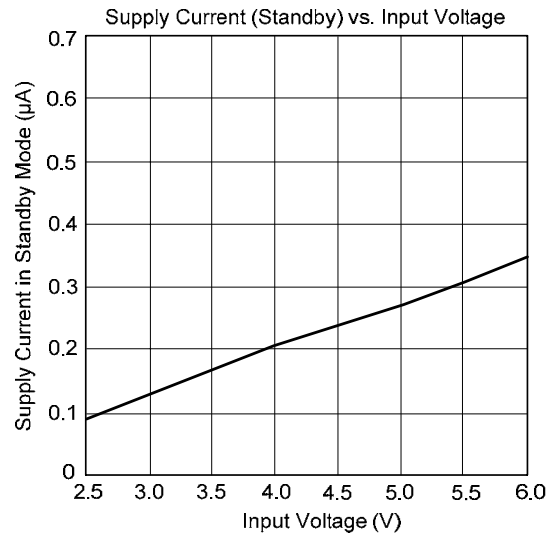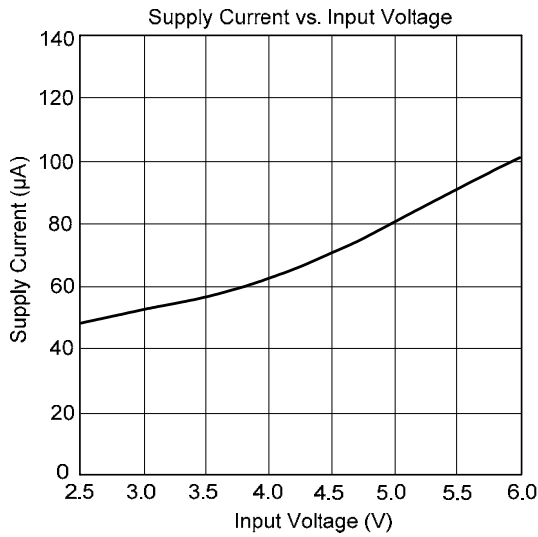
Fault FLAG

The fault FLAG is an output with open-drain of N-channel. The fault FLAG is pulled down when any of the conditions such as under-voltage, current limit and thermal shutdown. In a typical application circuit, the FALG pin has a pull-up resistor of 10kΩ to input voltage.
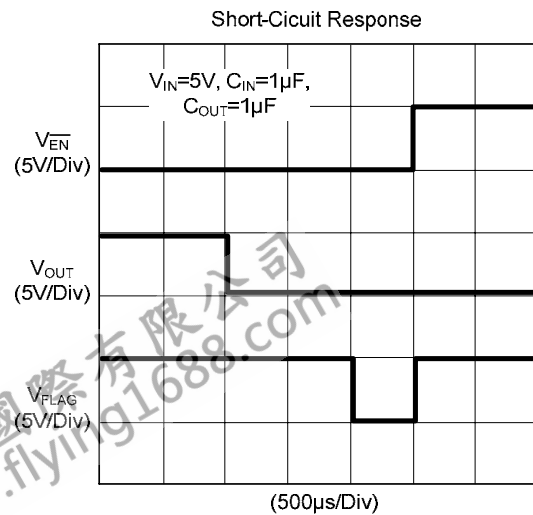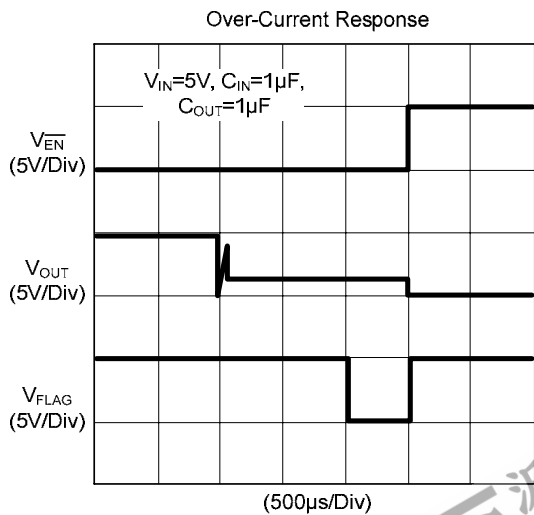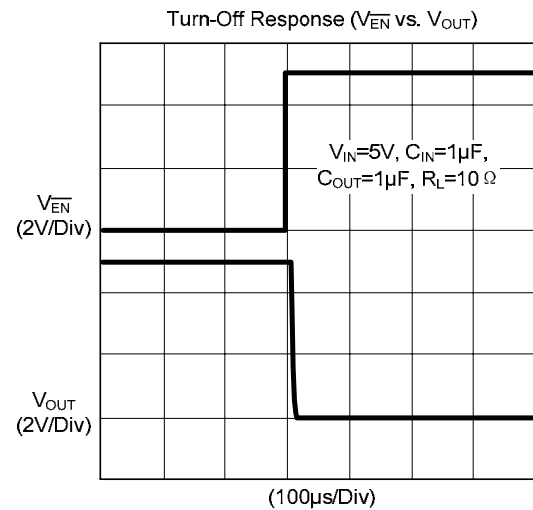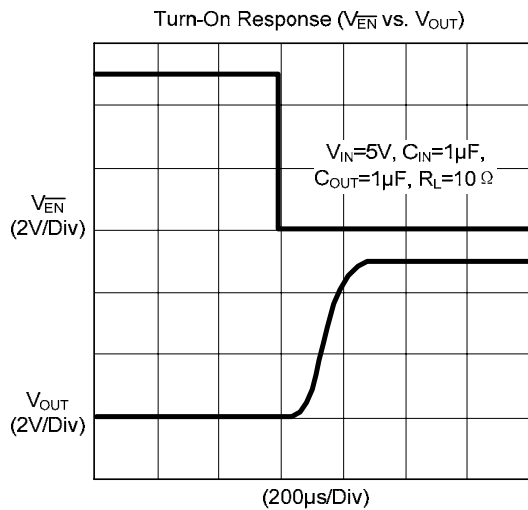
■ TYPICAL APPLICATION CIRCUIT

∎ **TYPICAL CHARACTERISTICS** (T_J = 25 , V_{IN} = 5.0V, unless otherwise specified)

Supply Current vs. Input Voltage

Supply Current (Standby) vs. Input Voltage

FLAG On-Resistance vs. Input Voltage

Output On-Resistance vs. Input Voltage

Over-Current Limit vs. Input Voltage

EN Threshold Voltage vs. Input Voltage

■ **TYPICAL CHARACTERISTICS(Cont.)**

Turn-On Response (V_{IN} vs. V_{OUT})

V_{IN}=5V, C_{IN}=1μF,
C_{OUT}=1μF, R_L=10Ω

V_{IN}
(2V/Div)

V_{OUT}
(2V/Div)

(200μs/Div)

Turn-Off Response (V_{IN} vs. V_{OUT})

V_{IN}=5V, C_{IN}=1μF,
C_{OUT}=1μF, R_L=10Ω

V_{IN}
(2V/Div)

V_{OUT}
(2V/Div)

(100μs/Div)

Turn-On Response ($V_{\overline{EN}}$ vs. V_{OUT})

V_{IN}=5V, C_{IN}=1μF,
C_{OUT}=1μF, R_L=10 Ω

$V_{\overline{EN}}$
(2V/Div)

V_{OUT}
(2V/Div)

(200μs/Div)

Turn-Off Response ($V_{\overline{EN}}$ vs. V_{OUT})

V_{IN}=5V, C_{IN}=1μF,
C_{OUT}=1μF, R_L=10 Ω

$V_{\overline{EN}}$
(2V/Div)

V_{OUT}
(2V/Div)

(100μs/Div)

Over-Current Response

V_{IN}=5V, C_{IN}=1μF,
C_{OUT}=1μF

$V_{\overline{EN}}$
(5V/Div)

V_{OUT}
(5V/Div)

V_{FLAG}
(5V/Div)

(500μs/Div)

Short-Cicuit Response

V_{IN}=5V, C_{IN}=1μF,
C_{OUT}=1μF

$V_{\overline{EN}}$
(5V/Div)

V_{OUT}
(5V/Div)

V_{FLAG}
(5V/Div)

(500μs/Div)

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