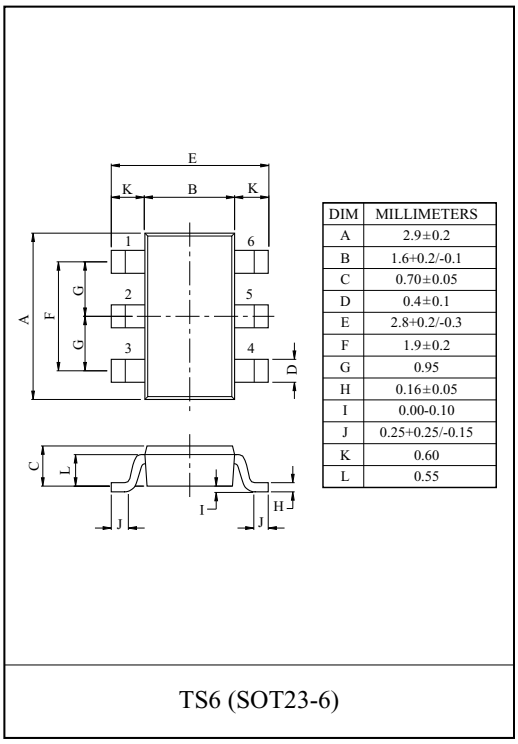
Adjustable 1 - Channel Current Limited Power Switch



DIM	MILLIMETERS
A	2.9±0.2
B	1.6+0.2/-0.1
C	0.70±0.05
D	0.4±0.1
E	2.8+0.2/-0.3
F	1.9±0.2
G	0.95
H	0.16±0.05
I	0.00-0.10
J	0.25+0.25/-0.15
K	0.60
L	0.55

TS6 (SOT23-6)

Description

The KIC6961T is integrated power switches optimized for USB and other hot-swap applications with a programmable current limit feature. Current limit accuracy ± 10 % can be achieved at high current-limit settings.

The family of devices complies with USB 2.0 and is available with high polarity of Enable input. They offer current and thermal limiting and short circuit protection as well as controlled rise time and under-voltage lockout functionality.

Features

☐Single USB Port Power Switches with discharge
☐Operating input voltage range 2.7V to 5.5V
☐Up to 2.1A Maximum Load Current
☐Adjustable Current Limit : 0.5A to 2.6A
☐Reverse Current Blocking
☐Fault report with blanking time(7ms)
☐100mΩ Power MOSFET
☐Qualified to AEC-Q100.

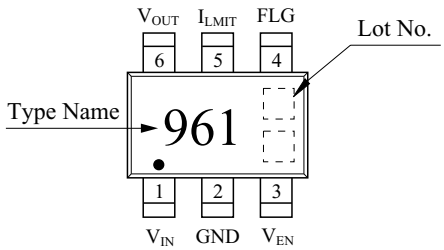
Maximum Ratings (Ta=25℃)

Characteristic	Symbol	Rating	Unit
Input Voltage	V_{IN}	6.5	V
Output Voltage	V_{OUT}	6.5	V
Power Dissipation (No Heatsink)	P_D *	900	mW
Operating Junction Temperature	Tj	-40 ~ 125	℃
Storage Temperature	T_{stg}	-55 ~ 150	

* Note) Package Mounted on a Ceramic Board (600mm² × 0.8mm)

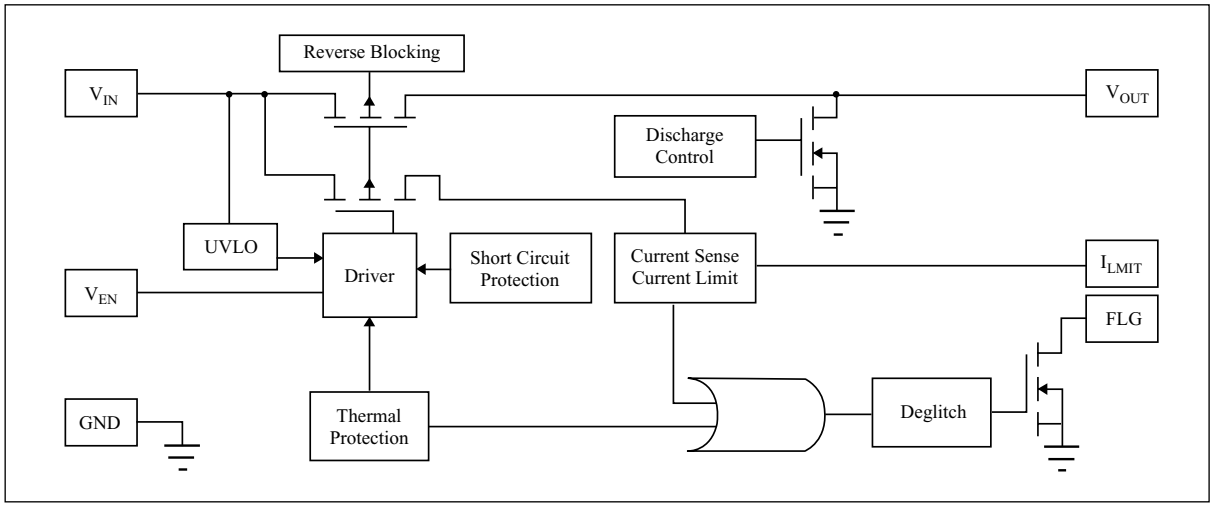
Pin Configurations

(Top view)



TS6(SOT23-6)

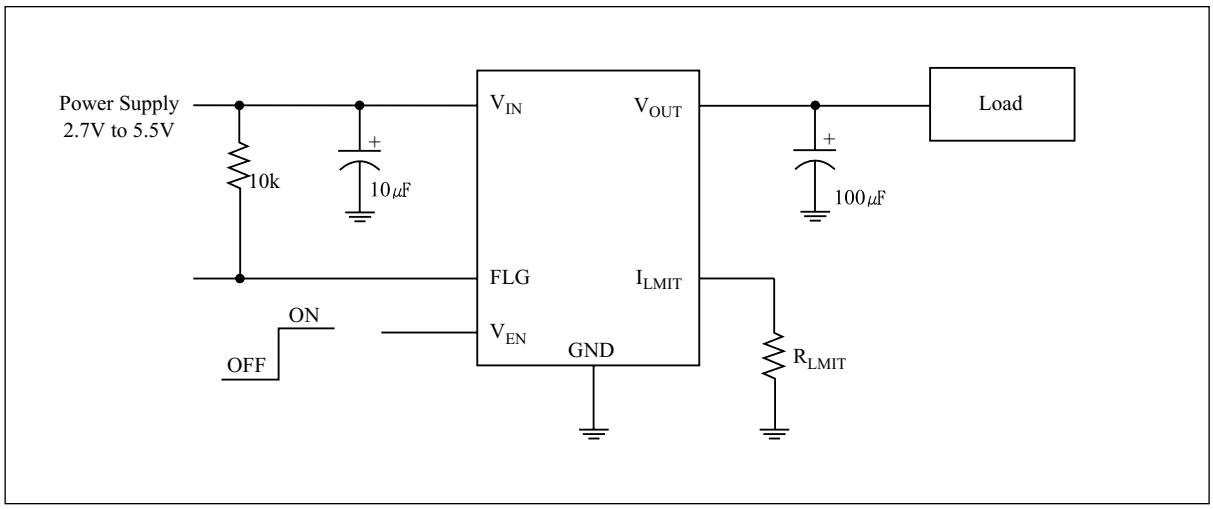
Block Diagram



Pin Descriptions

Pin Number	Pin Name	Descriptions
1	V_{IN}	Voltage input pin
2	GND	Ground
3	V_{EN}	Enable input (Active high)
4	FLG	Over-current and over-temperature fault report pin (Open drain)
5	I_{LMIT}	Current limit set pin ※ External resistor used to set current limit threshold
6	V_{OUT}	Voltage output pin

Typical Application Circuit



Recommended Operating Conditions (Ta=25℃, Unless otherwise stated)

Symbol	Parameter	Min.	Max.	Units
V_{IN}	Input Voltage	2.7	5.5	V
V_{EN}	Enable Voltage	0	5.5	V
V_{IH}	High-Level Input Voltage on EN	2.0	V_{IN}	V
V_{IL}	Low-Level Input Voltage on EN	0	0.8	V
R_{LMIT}	Current-Limit Threshold Resistor Range (1% initial tolerance)	10	49.9	kΩ

Electrical Characteristics (V_{IN}=5V, Ta=25℃, Unless otherwise stated)

Characteristics	Symbol	Test Conditions	Min.	Typ.	Max.	Units
Supply						
Input UVLO	V_{UVLO}	V_{IN} rising	1.6	2.2	2.5	V
Input UVLO Hysteresis		V_{IN} decreasing	50	100	150	mV
Input Shutdown Current	I_{SHDN}	Disabled, I_{OUT} = 0A	0.2	0.5	1.0	μA
Input Quiescent Current	I_Q	Enabled, I_{OUT} = 0A	20	45	70	μA
Input Leakage Current	I_{LEAK}	Disabled, V_{OUT} grounded	-	0.1	1	μA
Power Switch						
Switch On-Resistance	$R_{DS(ON)}$	I_{OUT} = 1.0A, Ta=25℃	-	100	-	mΩ
		I_{OUT} = 1.0A, -40℃ ≤ Ta ≤ 85℃	-	-	150	mΩ
Output Turn-On Rise Time	T_R	C_L=1μF, R_{LOAD}=10Ω	-	0.6	1.5	ms
Output Turn-Off Fall Time	T_F	C_L=1μF, R_{LOAD}=10Ω	-	0.2	0.4	ms
Current Limit						
Current Limit	I_{LMIT}	R_{LMIT}=10kΩ	2.335	2.594	2.853	A
		R_{LMIT}=20kΩ	1.121	1.246	1.370	A
		R_{LMIT}=49.9kΩ	0.419	0.477	0.534	A
Enable Pin						
EN Input Logic Low Voltage	V_{IL}	V_{IN}= 2.7V to 5.5V	-	-	0.8	V
EN Input Logic High Voltage	V_{IH}	V_{IN}= 2.7V to 5.5V	2	-	-	V
EN Input Leakage	I_{SINK}	V_{EN}=5V	-	-	1	μA
Output Discharge						
Discharge time	T_{DIS}	C_L=100μF, R_{LOAD}=10Ω	1	3	6	ms
Reverse Voltage Protection						
Reverse Leakage Current	I_{REV}	Disabled, V_{IN}=0V, V_{OUT}=5V, I_{REV}@V_{IN}	-	0.1	1	μA
Fault Flag						
FLG Blanking time	T_{BLANK}	C_{IN}=10μF, C_L=22μF	4	7	15	ms
Thermal Shutdown						
Thermal Shutdown Threshold	T_{SHDN}	Enabled, R_{LOAD}=1kΩ	130	150	170	℃
Thermal Shutdown Hysteresis	T_{HYS}	-	-	25	-	℃

Current- Limit Threshold Programming (Cont.)

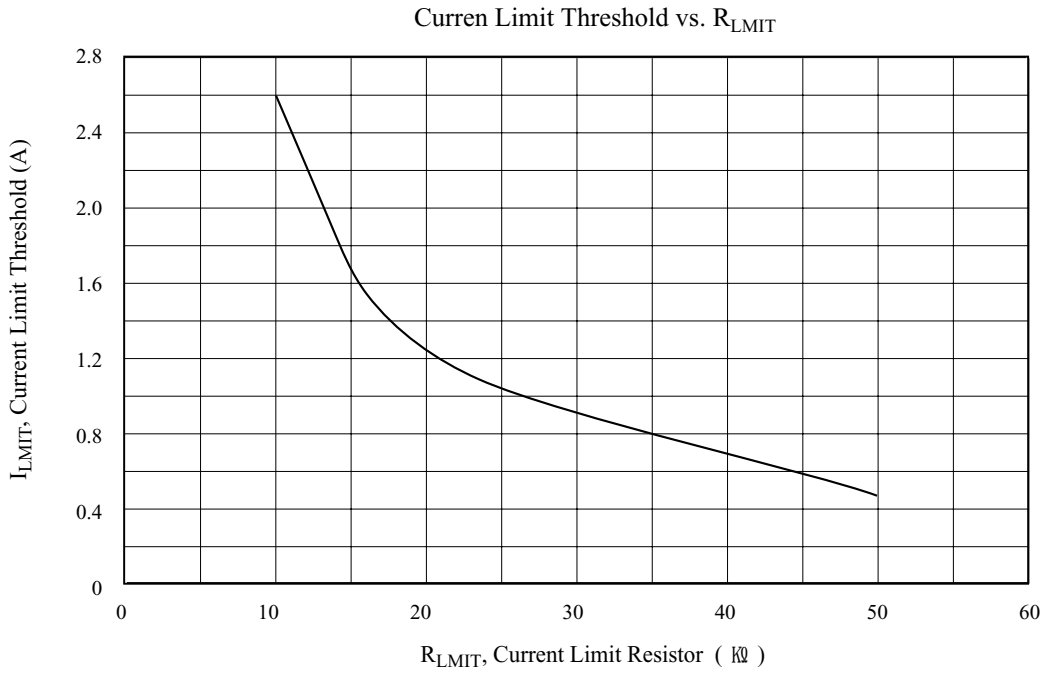
When a heavy load or short circuit situation occurs while the switch is enabled, large transient current may flow through the device. KIC6961T includes a current-limit circuitry to prevent these large currents from damaging the MOSFET switch and the hub downstream ports.

Especially, The KIC6961T is proposed to have current limit flexibility for customer. I_{LMIT} pin is available to connect pull down resistor to ground, which participate to the current threshold adjustment.

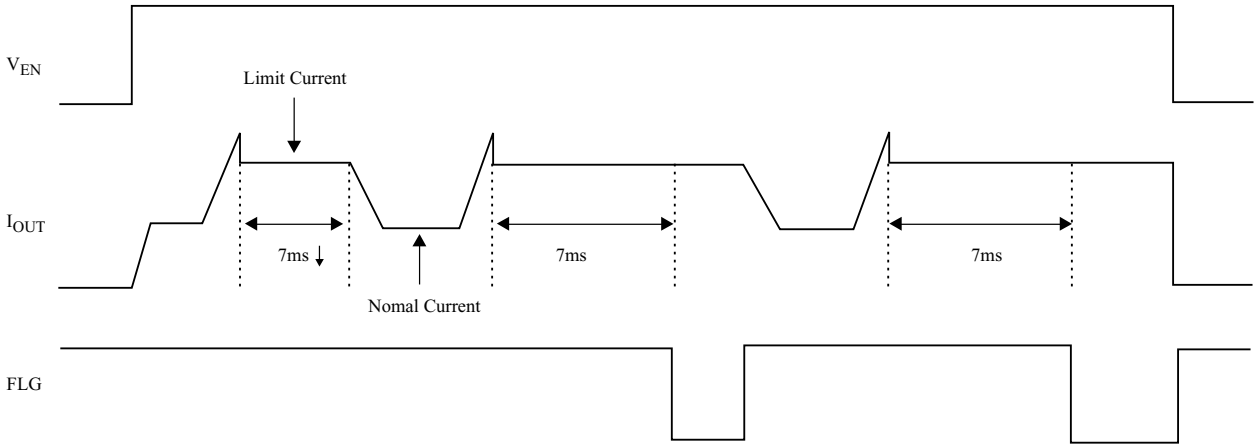
The KIC6961T provides an adjustable current limit threshold between 0.5A and 2.6A (Typ.) via an external resistor, R_{LMIT}, between 10㏀ and 49.9㏀.

It s strongly recommended to use 0.1 or 1% resistor tolerance to keep the over current accuracy.

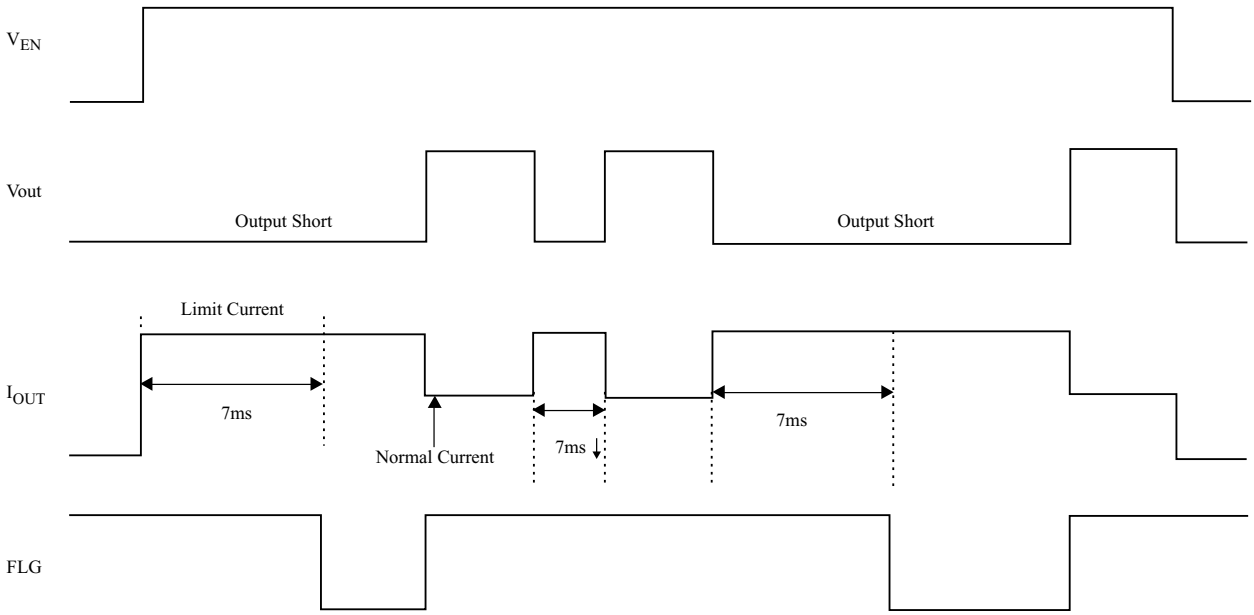
Once the current limit threshold is exceeded, the device enters constant-current mode until either thermal shutdown occurs or the fault is removed.



Over Current & Short Circuit Protection Timing Chart



[Figure 1. Over Current Protection on Power Switch]

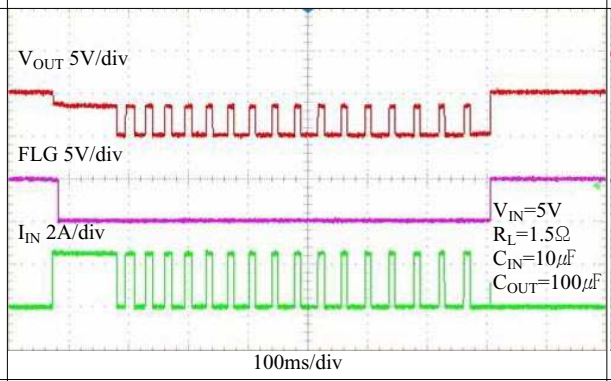
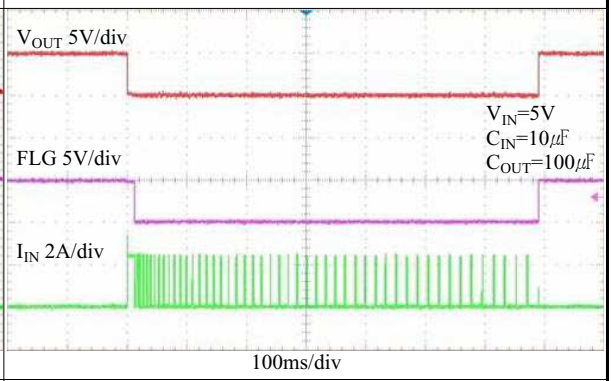
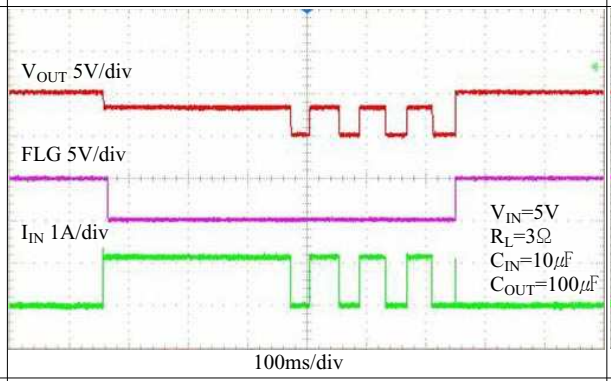
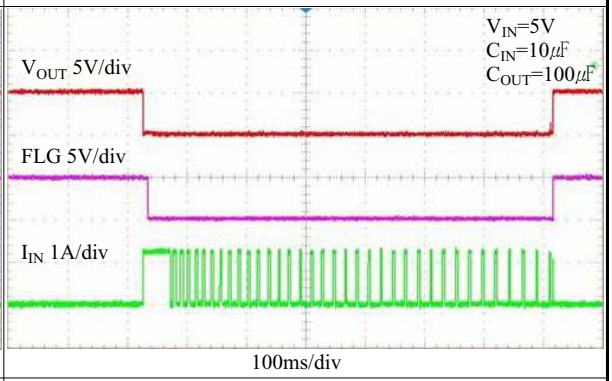
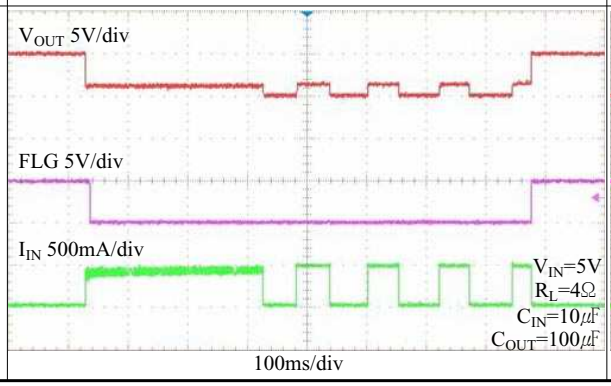
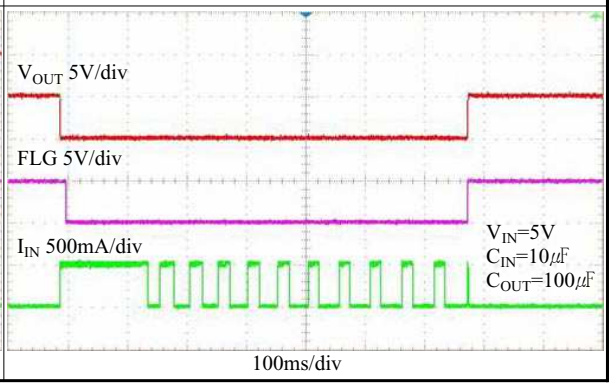


[Figure 2. Short Circuit Protection on Power Switch]

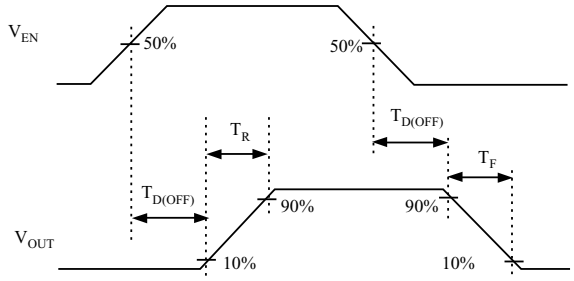
※ FLG Response Condition

	CONDITION	FLG	Remark
Over - Load	V_{IN} - V_{OUT} □0.5V	Active L	
Short Circuit	-	Active L	

※Actual Waveform

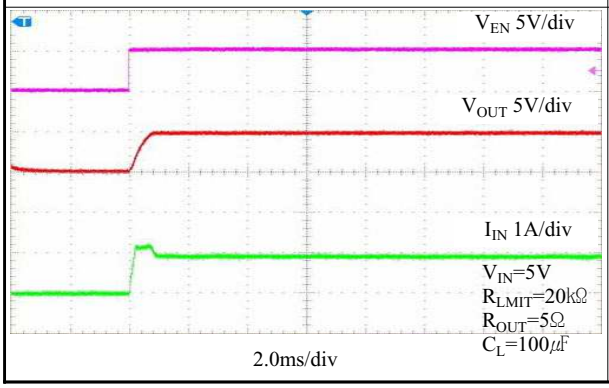
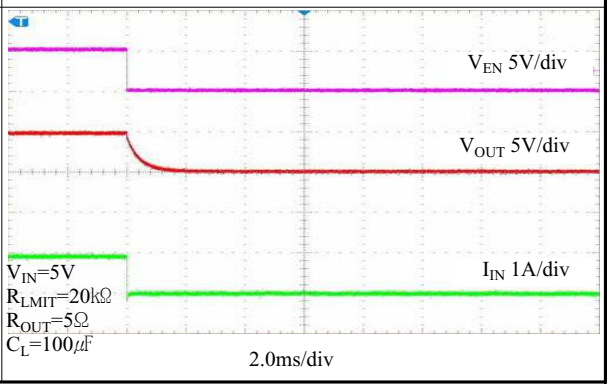
R_{LMIT}	Over Load	Short Circuit
10kΩ		
20kΩ		
49.9kΩ		

(7) Enable Function Timing Chart

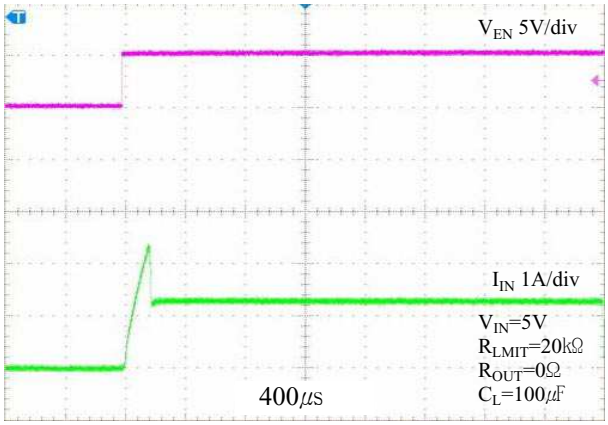


[Figure 3 delay Time]

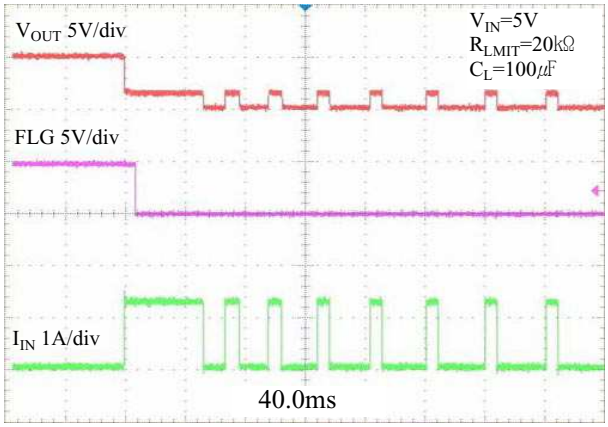
※Actual Waveform

Turn-On Delay and Rise Time	Turn-Off Delay and Fall Time
	

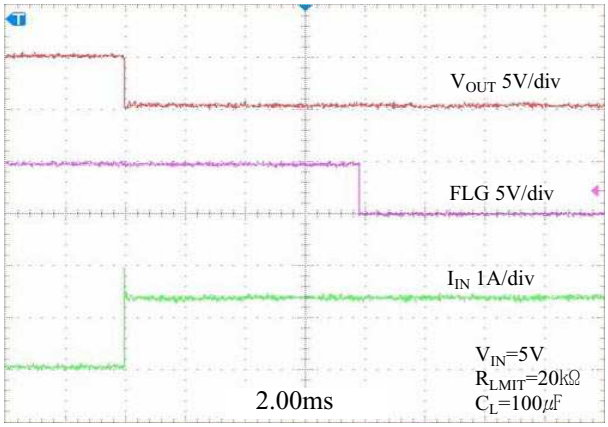
(8) Device Enabled into Short-Circuit



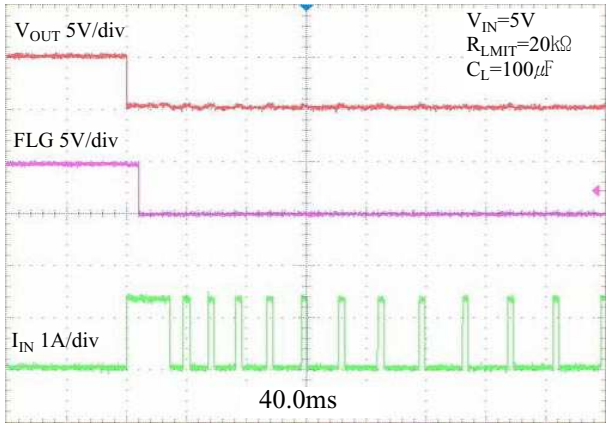
(9) No Load to 1Ω Transient Response



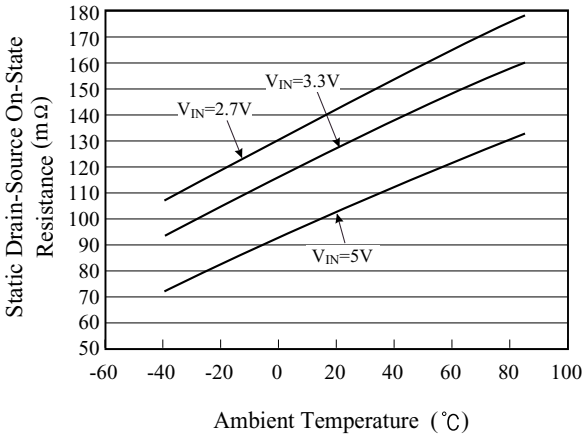
(10) Short-Circuit Limit Response



(11) Extended Short-Circuit into Termal Cycle



(12) Static Drain-Source On-State Resistance vs. Ambient Temerature



Functional Description

1. Over-current and Short Circuit Protection

An internal sensing FET is employed to check for over-current conditions. When an over-current condition is detected, the device maintains a constant output current and reduces the output voltage accordingly. Complete shutdown occurs only if the fault stays long enough to activate thermal limiting.

2. Thermal Protection

Thermal protection prevents the IC from damage when the die temperature exceeds safe margins. This mainly occurs when heavy-overload or short-circuit faults are present for extended periods of time. The KIC6961T implements a thermal sensing to monitor the operating junction temperature of the power distribution switch. Once the die temperature rises to approximately 150°C, the Thermal protection feature gets activated as follows: The internal thermal sense circuitry turns the power switch off and the FLG output is asserted thus preventing the power switch from damage. Hysteresis in the thermal sense circuit allows the device to cool down to approximately 25°C before the output is turned back on. This built-in thermal hysteresis feature is an excellent feature, as it avoids undesirable oscillations of the thermal protection circuit. The switch continues to cycle in this manner until the load fault is removed, resulting in a pulsed output. The FLG open-drain output is asserted when an over-current occurs with 7-ms deglitch.

3. Under-Voltage Lockout (UVLO)

Under-voltage lockout function (UVLO) guarantees that the internal power switch is initially off during start-up. The UVLO functions only when the switch is enabled. Even if the switch is enabled, the switch is not turned ON until the power supply has reached at least 2.2V. Whenever the input voltage falls below approximately 2.2V, the power switch is turned off. This facilitates the design of hot-insertion systems where it is not possible to turn off the power switch before input power is removed.

4. Reverse Current Protection

In a normal MOSFET switch, current can flow in reverse direction (from the output side to the input side) when the output side voltage is higher than the input side, even when the switch is turned off. A reverse-current blocking feature is implemented in the KIC6961T to prevent such back currents. This circuit is activated by the difference between the output voltage and the input voltage. When the switch is disabled, this feature blocks reverse current flow from the output back to the input.

5. Discharge Function

When enable is de-asserted, the discharge function is active. The output capacitor is discharged through an internal NMOS that has a discharge resistance of 100Ω . Hence, the output voltage drops down to zero. The time taken for discharge is dependent on the RC time constant of the resistance and the output capacitor.

6. FLG Response

The FLG open-drain output goes active low for any of the two conditions: Over-Current or Over-Temperature. The time from when a fault condition is encountered to when the FLG output goes low is 7-ms (TYP). The FLG output remains low until both over-current and over-temperature conditions are removed. Connecting a heavy capacitive load to the output of the device can cause a momentary Over-current condition, which does not trigger the FLG due to the 7-ms deglitch timeout. The KIC6961T is designed to eliminate erroneous Over-current reporting without the need for external components, such as an RC delay network.

Applications Information

1. Supply Filtering

Placing a high-value electrolytic capacitor on the input (10uF minimum) and output pin (100uF) is recommended when the output load is heavy.

This precaution also reduces power-supply transients that may cause rining on the input.

2. Enable Input

V_{EN} must be driven logic high for a clearly defined input. Floating the input may cause unpredictable operation. V_{EN} should not be allowed to go negative with respect to GND.