DESCRIPTION

The A4774 is an integrated power switch for self-powered and bus-powered Universal Serial Bus (USB) applications. A4774 is 52mΩ $R_{DS(ON)}$.

Several Protection features include current limiting and thermal shutdown to prevent catastrophic switch failure caused by increasing power dissipation when continuous heavy loads or short circuit occurs. A built-in P-channel MOSFET with true shutdown function to eliminate any reversed current flow across the switch when it is powered off. When the output voltage is higher than input voltage, the power switch is turned off by internal output reverse-voltage comparator.

A4774 offers a programmable current-limit threshold between 300mA and 3.5A via an external resistor. $\overline{FLG}$ is an open-drain output report over-current or over-temperature event and has typical 8ms deglitch timeout period. In addition, $\overline{FLG}$ also has typical 3ms deglitch timeout period and reports output reverse-voltage condition.

The A4774 is available in SOT-26 Package.

FEATURES

- 52mΩ High-Side MOSFET
- Adjustable Current Limit, 300mA and 3.5A (typ)
- Operating Range: 2.5V to 5.5V
- 0.2ms Typical Rise Time
- Fast Over-current Response 8μs (TYPICAL)
- Under voltage Lockout
- 30μA Quiescent Supply Current
- 1μA Maximum Shutdown Supply Current
- Logic Level Enable Pin, Available with Active-High Version
- No Reverse Current when Power Off
- Deglitched Open-Drain Over-Current Flag Output ($\overline{FLG}$)
- Available with or without Output Shutdown Pull-low Resister
- Output Reverse-Voltage Protection
- Available in SOT-26 Package

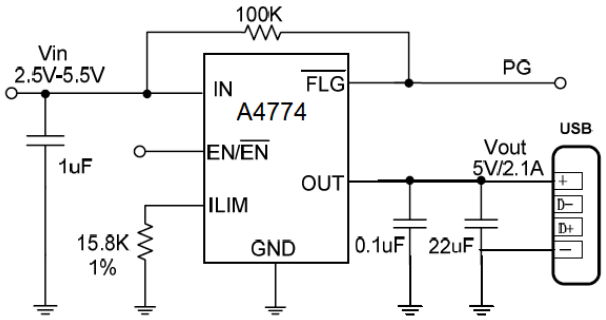
APPLICATION

- High-Side Power Protection Switch
- USB Host and Self-Powered Hubs
- USB Bus-Powered Hubs
- Set Top Box
- Smart TV
- MID and Notebook Computer

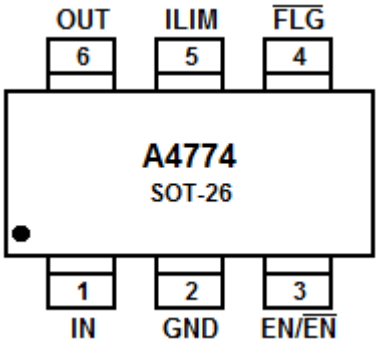
ORDERING INFORMATION

Package Type	Part Number	
SOT-26 SPQ: 3,000pcs/Reel	E6	A4774E6R-T
		A4774E6VR-T
Note	T: Active H: High V: Halogen free Package. R: Tape & Reel	
AiT provides all RoHS products		

TYPICAL APPLICATION



PIN DESCRIPTION



Top View

Pin #	Symbol	Function
1	IN	Input Supply: Connected with internal MOSFET Source, which also supplies IC's internal circuitry. Connect to positive supply.
2	GND	Ground.
3	EN($\overline{EN}$)	Enable: Logic level enable input. Make sure EN pin never floating.
4	$\overline{FLG}$	Over-Current: Open-Drain Fault Flag Output.
5	ILIM	External resistor used to set current-limit ILIM threshold.
6	OUT	Switch Output: Connected with internal MOSFET Drain. Typically connect to switched side of load.

ABSOLUTE MAXIMUM RATINGS

V_{OUT}, Output Voltage	7V
I_{OUT}, Output Current	Internally Limited
V_{EN}, Enable Input	-0.3V~7V
θ_{JA} NOTE1, Thermal Resistance Junction to Ambient	
SOT-26	250°C/W
Continuous Power Dissipation (T_A = +25°C)	
SOT-26	0.5W
θ_{JC}, Thermal Resistance Junction to Case	
SOT-26	60°C/W
Junction Temperature NOTE2	150°C
T_S, Storage Temperature	-65°C~+150°C
Reflow Temperature (soldering, 10sec)	260°C
ESD Protection (Human Body Mode) NOTE3	6kV

Stress beyond above listed “Absolute Maximum Ratings” may lead permanent damage to the device. These are stress ratings only and operations of the device at these or any other conditions beyond those indicated in the operational sections of the specifications are not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

OPERATING RATINGS

Parameter	Symbol	Min	Max	Units
Supply Voltage	V_{IN}	2.5	5.5	V
Operating Temperature	T_A	-40	85	°C

ELECTRICAL CHARACTERISTICS[NOTE4]

V_{IN} = 5V, C_{IN}=1μF, C_{OUT}=1μF, T_A = 25°C.

Parameter	Symbol	Conditions	Min	Typ.	Max	Unit
IN section						
Input Voltage	V_{IN}		2.5	-	5.5	V
Supply Current, Enable	I_{in_on}	V_{IN}=5.5V, No load on OUT	-	30	60	μA
Shutdown Current, Disable	I_{in_off}	V_{IN}=5.5V, No load on OUT	-	0.1	1	μA
Reverse Leakage Current	I_{REV}	V_{OUT}=5.5V, V_{IN}=0V	-	2	5	μA
Under Voltage Lockout Exit	V_{UVLO_ON}	V_{IN} rising from 0-5V	-	2	2.3	V
UVLO Hysteresis	V_{UVLO_hys}		-	25	-	mV
EN section						
High-Level Enable Voltage	V_{EN_H}	V_{IN}=5.5V	1.2	-	-	V
High-Level Disable Voltage	V_{EN_L}	V_{IN}=2.5V	-	-	0.7	V
EN Input Current	I_{EN}	V_{EN}=5.5V or 0V	-0.5	5	10	μA
Turn On Time	t_{on}	C_L=1μF, R_L=100ohm	-	0.2	-	ms
Turn Off Time	t_{off}	C_L=1μF, R_L=100ohm	-	0.3	-	ms
OUT section						
Over Current CC Regulation	I_{oc}	R_{ILIM}=15.8kΩ V_{IN}=5V, V_{OUT}=3.5V	2.6	2.75	2.9	A
Reverse Voltage Protection	$V_{Reverse}$	V_{OUT}-V_{IN}	5	20	50	mV
Reverse Current Protection	$I_{Reverse}$		0.1	0.4	1	A
Output Rise Time	t_{Rise}	C_L=1μF, R_L=100ohm	-	0.1	-	ms
Output Fall Time	t_{Fall}	C_L=1μF, R_L=100ohm	-	0.3	-	ms
Response Time To Short Circuit	t_{ios}		-	8	-	μs
FLG(Fault flag) section						
Output Low Voltage	V_{OL}	I_{FLG}=1mA	-	-	180	mV
Continuous FLG Sink Current	I_{FLG}		-	-	10	mA
Off-State Leakage	$I_{FLG\_leakage}$		-	-	1	μA
Fault flag Deglitch Time	t_{FLG}		-	8	-	ms

Parameter	Symbol	Conditions	MIN	TYP.	MAX	Unit
Power switch						
	R_{DS_ON}	I_{OUT}=1A	-	52	-	mohm
Thermal Shutdown						
Thermal Shutdown Threshold	T_{normal}		-	150	-	℃
Thermal Shutdown Threshold Hysteresis	$T_{normal\ hys}$		-	20	-	℃
Thermal Shutdown Threshold In Current Limit	$T_{current\_limit}$		-	130	-	℃
Thermal Shutdown Threshold Hysteresis	$T_{current\_limit\_hys}$		-	20	-	℃

NOTE1: Thermal Resistance is specified with approximately 1 square of 1 oz copper.

NOTE2: T_J is calculated from the ambient temperature T_A and power dissipation P_D.

NOTE3: Human body model (HBM), per ESDA/JEDEC JDS-001-2014.

NOTE4:100% production test at +25°C. Specifications over the temperature range are guaranteed by design and characterization. The device is not guaranteed to function outside its operating conditions.

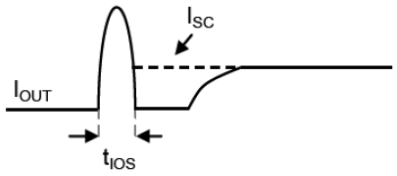


Figure 1.

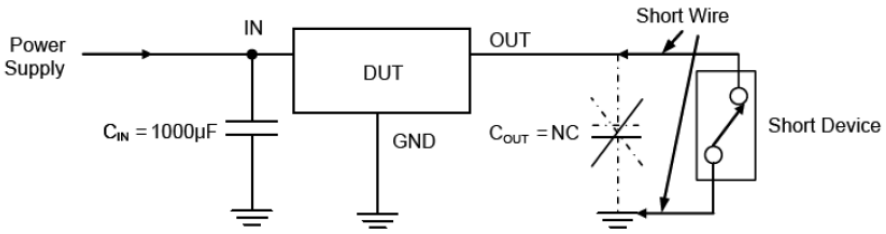


Figure 2.

Note:

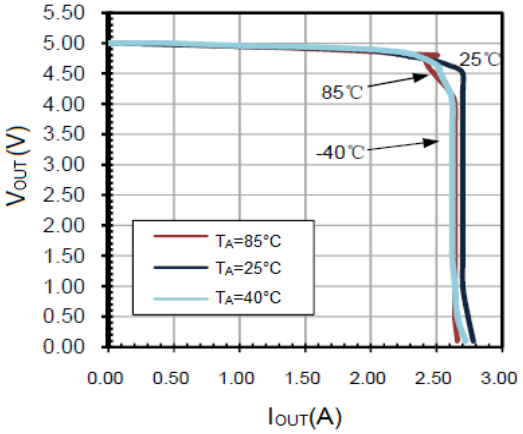
To exactly identify the short circuit characteristic of IC, avoid the test result interfered by parasitic inductor, output capacitor, and contact resistor. It is necessary to follow the recommendation as follows.

Please,

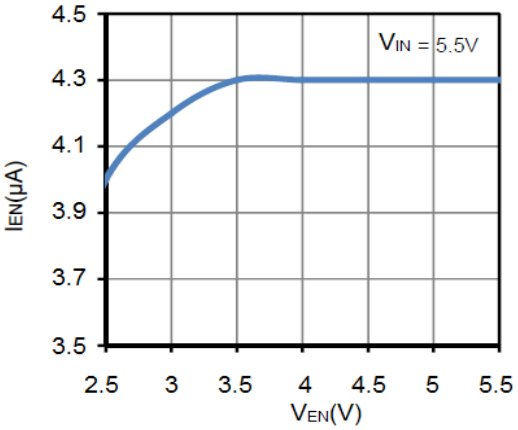
1. Add 1000μF of capacitor between V_{IN} and GND, and close to IC.
2. Remove output capacitor.
3. Shorter the short circuit device wire.
4. Measure output current (I_{OUT}).

TYPICAL PERFORMANCE CHARACTERISTICS

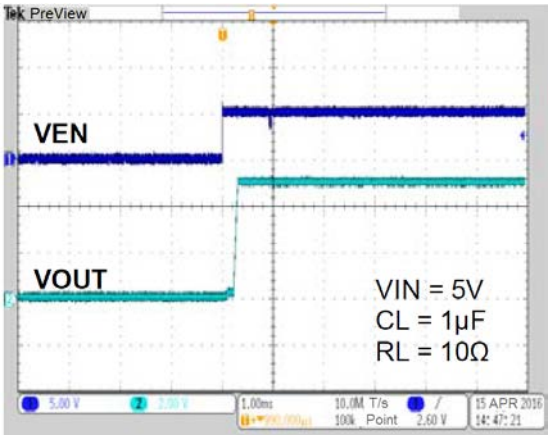
1. Overcurrent Protection Characteristics



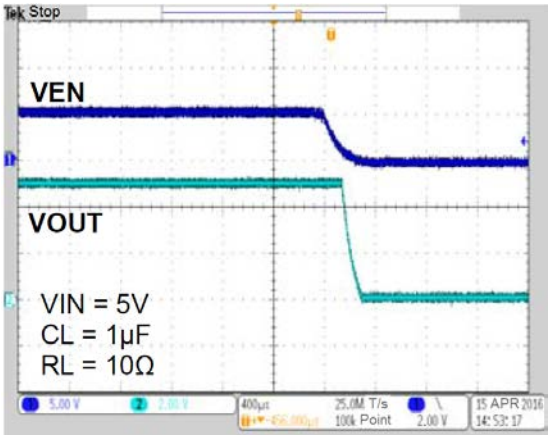
2. IEN vs. VEN Characteristics



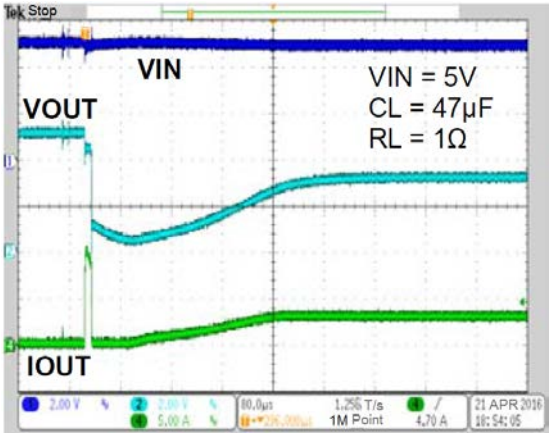
3. Turn on Delay Time and Rise Time



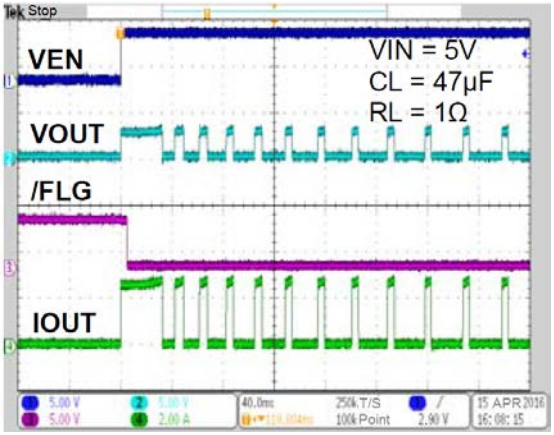
4. Turn off Delay Time and Fall Time



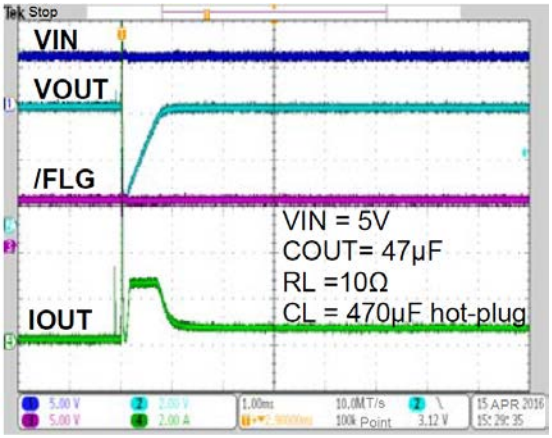
5. Resistance Load Inrush Response



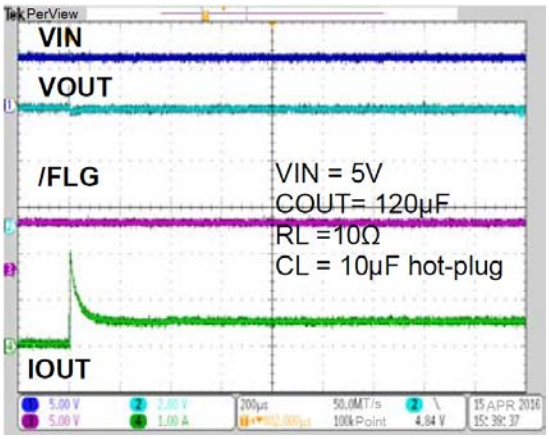
6. Thermal Shutdown Response



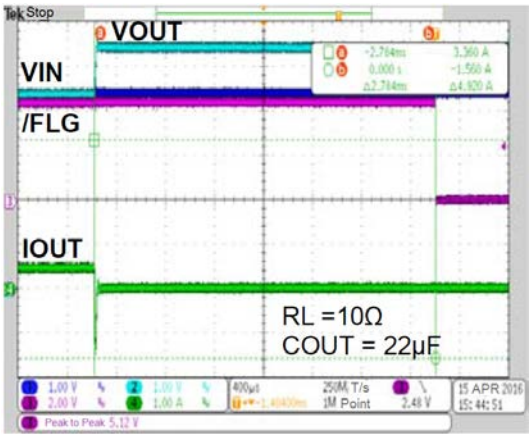
7. Capacitance Load Inrush Response



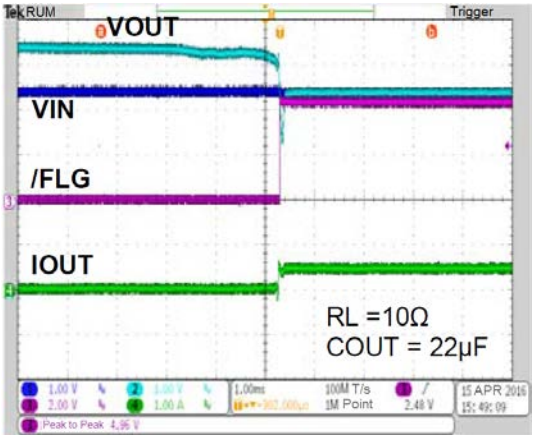
8. Capacitance Load Inrush Response



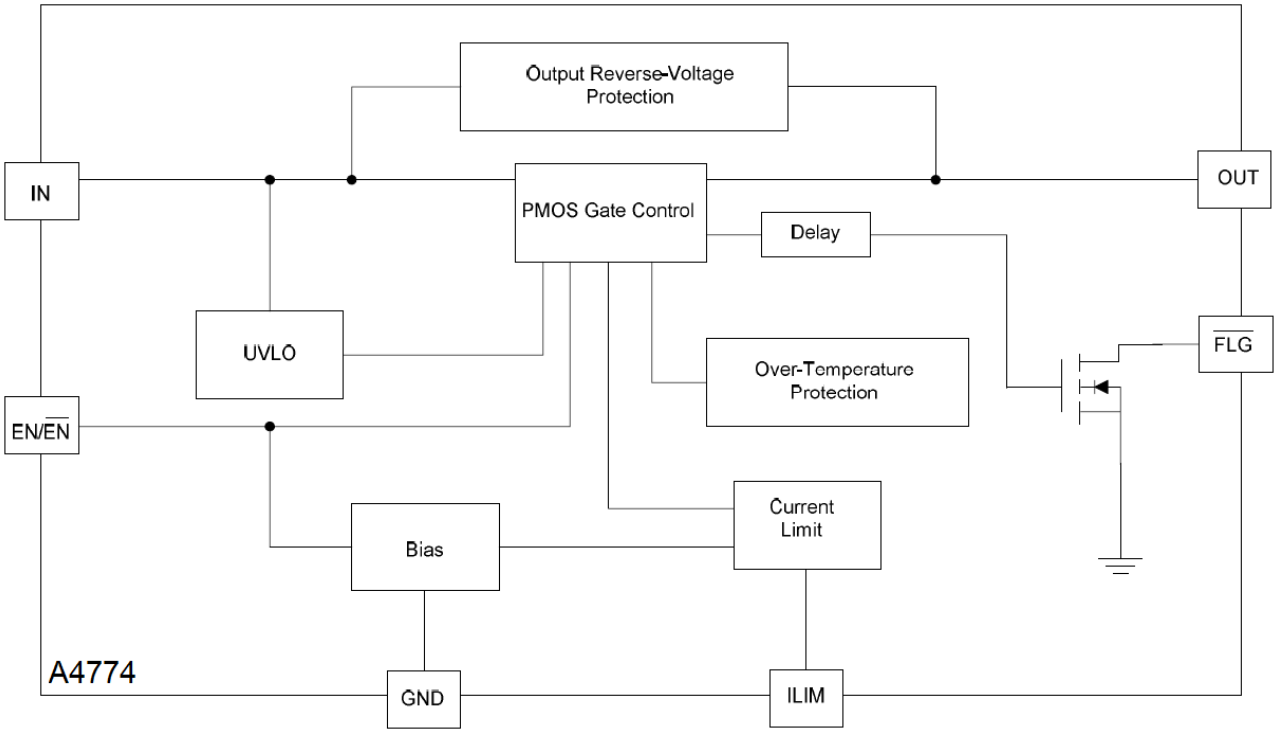
9. Reverse-Voltage Protection Response



10. Reverse-Voltage Protection Recovery



BLOCK DIAGRAM



DETAILED INFORMATION

Applications Information

Overview

The A4774 is current-limited, power-distribution switches using P-channel MOSFETs for applications where short circuits or heavy capacitive loads will be encountered and provide up to 2.4A of continuous load current. These devices allow the user to program the current-limit threshold between 300mA and 3.5A via an external resistor. Additional device shutdown features include over-temperature protection and reverse-voltage protection. The driver controls the gate voltage of the power switch. The driver incorporates circuitry that controls the rise and fall times of the output voltage to limit large current and voltage surges and provides built-in soft-start functionality. The A4774 enters constant-current mode when the load exceeds the current-limit threshold.

Input and Output

IN (input) is the power supply connection to the logic circuitry and the Source of the output MOSFET. OUT (output) is the Drain of the output MOSFET. In a typical application, current flows through the switch from IN to OUT toward the load. OUT pin must be connected together to the load.

Setting Current Limit and $\overline{FLG}$ Function

The over-current threshold is user programmable via an external resistor. The A4774 use an internal regulation loop to provide a regulated voltage on the ILIM pin. The current-limit threshold is proportional to the current sourced out of ILIM. The recommended 1% resistor range for R_{ILIM} is 12kΩ ≤ R_{ILIM} ≤80kΩ to ensure stability of the internal regulation loop. Many applications require that the minimum current limit is above a certain current level or that the maximum current limit is below a certain current level, so it is important to consider the tolerance of the over-current threshold when selecting a value for RILIM. The following Figure 3 can be used to select the resulting type over-current threshold for a given external resistor value (R_{ILIM}). (The curve do not account for tolerance due to external resistor and temperature variation)

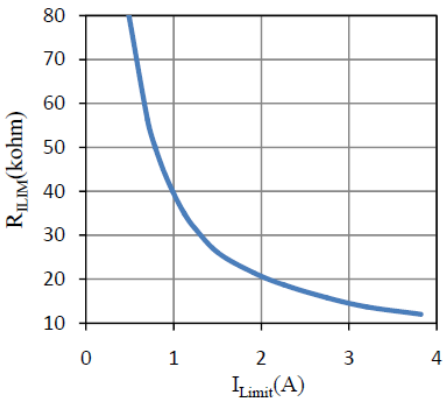


Figure 3 R_{ILIM} vs. I_{limit}

A few standard resistor values are listed in the table "Current Limit R_{ILIM} Values."

R_{ILIM} (kΩ 1%)	Continuous Current(A)	Current Limit (A)		
		Min	Typ	Max
56.2	0.5	0.63	0.75	0.87
31.6	1	1.23	1.35	1.47
21.5	1.5	1.95	2.1	2.25
15.8	2.1	2.6	2.75	2.9
13.7	2.4	3	3.2	3.4

Table: Current Limit R_{ILIM} Values

(V_{IN} = 5V, V_{OUT} = 3.5V)

For example, the USB port requires 2.1A:

1. Confirm that the expected "Continuous Current" is 2.1A;
2. Find corresponding R_{ILIM} in the table: Select 15.8kΩ 1% for the expected 2.1A continuous current;
3. Find minimum Current Limit: A4774 ensure that minimum Current Limit threshold is above 2.6A and /FLG trigger point of A4774E is above 2.15A, it is important to ensure start up into full load or heavy capacitive loads.
4. Find maximum Current Limit: A4774 ensure that maximum Current Limit threshold is below 2.9A, it is important to avoid current limiting upstream power supplies causing the input voltage bus to droop.

The $\overline{FLG}$ open-drain output is asserted (active low) when an over current condition is encountered after a 8ms deglitch timeout. The $\overline{FLG}$ output remains asserted until the over-current condition is removed. Over temperature condition is also reported by $\overline{FLG}$ open-drain output. In addition, $\overline{FLG}$ is also asserted (active low) in output reverse-voltage condition when the output reverse-voltage condition is removed.

Thermal Shutdown

The A4774 protects itself with two independent thermal sensing circuits that monitor the operating temperature of the power-switch and disables operation if the temperature exceeds recommended operating conditions. The device operates in constant-current mode during over-current conditions, which increases the voltage drop across power-switch. The power dissipation in the package is proportional to the voltage drop across the power-switch, so the junction temperature rises during an over-current condition. The first thermal sensor turns off the power-switch when the die temperature exceeds 130°C and the part is in current limit. The second thermal sensor turns off the power-switch when the die temperature exceeds 150°C regardless of whether the power-switch is in current limit. Hysteresis is built into both thermal sensors, and the switch turns on after the device has cooled approximately 20°C (Thermal shutdown threshold hysteresis in current-limit is 20°C). The switch continues to cycle off and on until the fault is removed. The open-drain $\overline{FLG}$ is asserted (active low) immediately during an over temperature shutdown condition.

Under Voltage Lockout

UVLO (under voltage lockout) prevents the output MOSFET from turning on until IN (input voltage) exceeds 2.45V typically. After the switch turns on, if the voltage drops below 2.425V typically, UVLO shuts off the output MOSFET.

Output Reverse-Voltage Protection

The output reverse-voltage protection turns off the MOSFET switch whenever the output voltage is higher than the input voltage by 20mV (typ) and the MOSFET switch will turn on when output reverse-voltage condition is removed.

Supply Filtering

A 1μF bypass capacitor from IN to GND, located near the A4774, is strongly recommended to control supply transients. Without a bypass capacitor, an output short may cause sufficient ringing on the input (from supply lead inductance) to damage internal control circuitry. Input transients must not exceed the absolute maximum supply voltage ($V_{IN\ max}$ = 7V) even for a short duration.

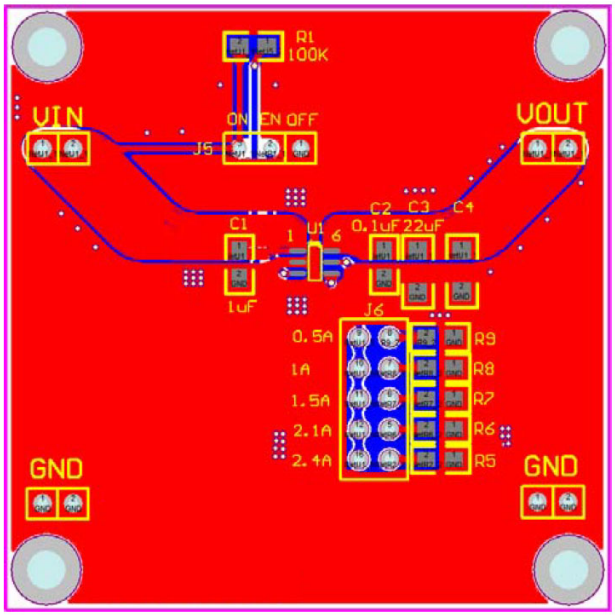
EN, the Enable Input

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

Layout Considerations

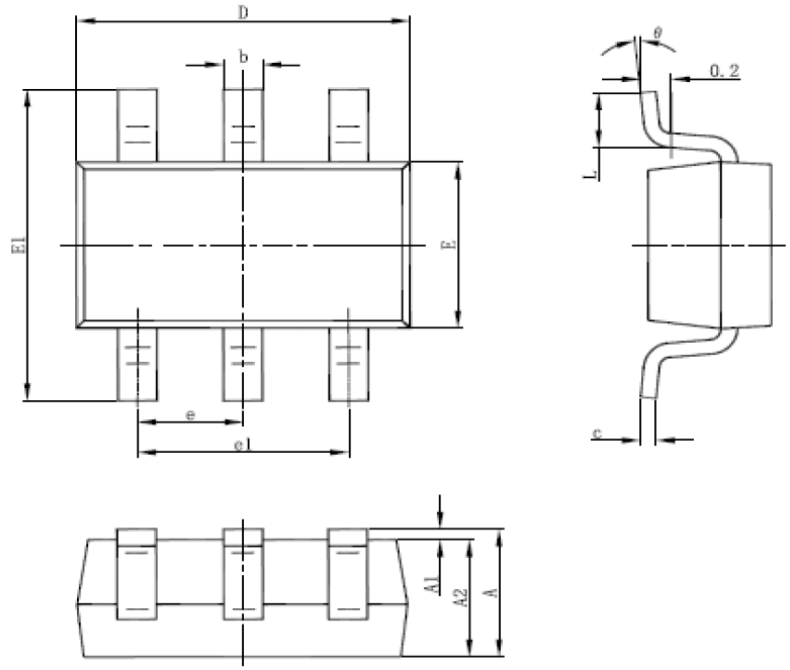
For best performance of the A4774 series, the following guidelines must be strictly followed:

1. Input and output capacitors should be placed close to the IC and connected to ground plane to reduce noise coupling.
2. Keep the R_{ILIM} resistor traces as possible as close to the ILIM Pin and directly connected to ground plane.
3. The GND should be connected to a strong ground plane for heat sink.
4. Keep the main current traces as possible as short and wide.



PACKAGE INFORMATION

Dimension in SOT-26 (Unit: mm)



Symbol	Millimeters		Inches	
	Min	Max	Min	Max
A	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.500	0.012	0.020
c	0.100	0.200	0.004	0.008
D	2.820	3.020	0.111	0.119
E	1.500	1.700	0.059	0.067
E1	2.650	2.950	0.104	0.116
e	0.950(BSC)		0.037(BSC)	
e1	1.800	2.000	0.071	0.079
L	0.300	0.600	0.012	0.024
θ	0°	8°	0°	8°

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