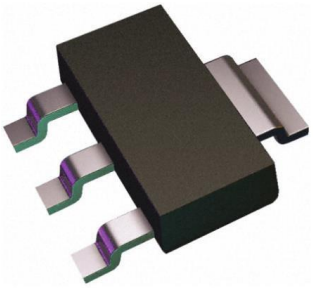
Smart Low-Side Power Switch

I. Overview

The SL8402 is a smart low-side power switch in SOT-223 package with integrated protections. Its working frequency ranges from DC to 10 KHz. The chip has built-in overheat protection circuit, current-limiting circuit and overvoltage protection circuit.



SOT-223

Loads of different resistance, induction, and capacity levels all can be driven by the device, and its capability depends on the maximum driving power.

Besides, the SL8402 features thermal shutdown protection that can keep the device from overheating resulted from overload or poor heat dissipation. Input currents to the IN pin would instantly increase during the shutdown to report the failure back to driver circuits

Also, this function enables the SL8402 to automatically shut itself down as the temperature is excessively high; and the DRAIN would reopen while detecting the temperature fall below the hysteresis threshold.

What's more, overvoltage protection would also work when loads or inductive loads are switched off. with the drain-source voltage of Power MOSFET clamped at a preset value. That means overvoltage protection would still stand whatever the IN pin's state, even if it is at zero volts.

II. Characteristics

- Low Input Current
- Short Circuit Protection and Clamping Function
- Current-limiting Function
- Input Protection (ESD)
- Thermal Shutdown Protection
- Standard-Compliant Power MOSFET
- RoHs

III. Application

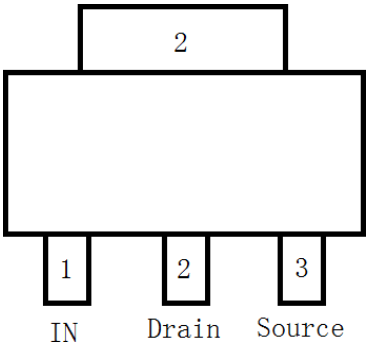
- Driving vehicle-specific relays
- Driving loads of different resistance, induction, and capacity levels
- Driving loads with spikes
- Replacing discrete devices

- **Table 3.1 Product General Description**

Symbols	Parameters	Max	Units
V_D	Drain-Source Voltage	42	V
VIN(max)	Input Voltage	7	V
RDS(ON, amb. typ)	Typical On-State Resistance (Tj=25℃，Vin=5V)	0.28	Ω
RDS(ON, hot. max)	Maximum On-State Resistance (Tj=150℃，Vin=5V)	0.95	Ω
I_D	Maximum Operating Current	1.2	A

- [1)]Active Clamping Voltage

IV.SL8402 Pin Description



Name	Symbol	Function
1	IN	Input/Fault Feedback Port
2	Drain	Power tube drain/load connection
3	Source	Grounding end

V. Internal Logic Flowchart and Typical Application Circuit of the SL8402

5.1 .Internal Logic Flowchart

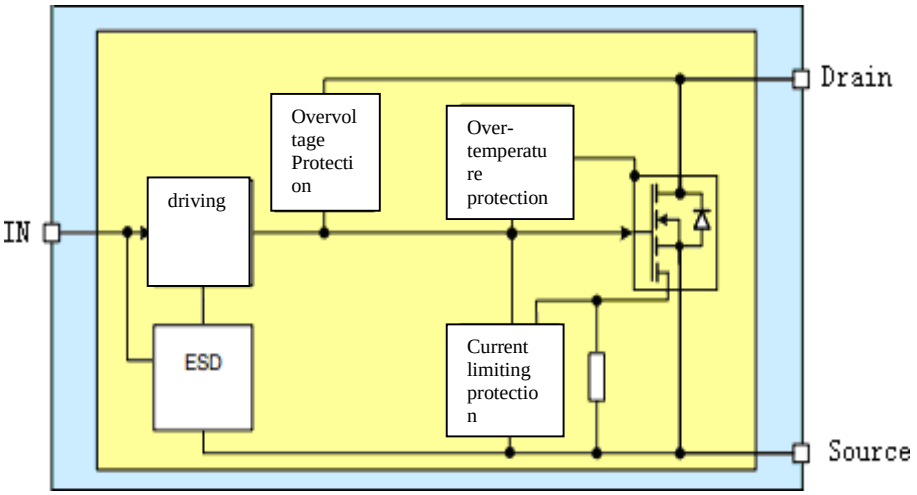


Figure 5-1 Internal Logic Flowchart

5.2 .Typical Application Circuit

Figure**5-2** illustrates the typical application circuit of the SL8402, where the number of **C1** can be tailored to specific needs, which plays a role in minimizing spikes on the **Drain**.

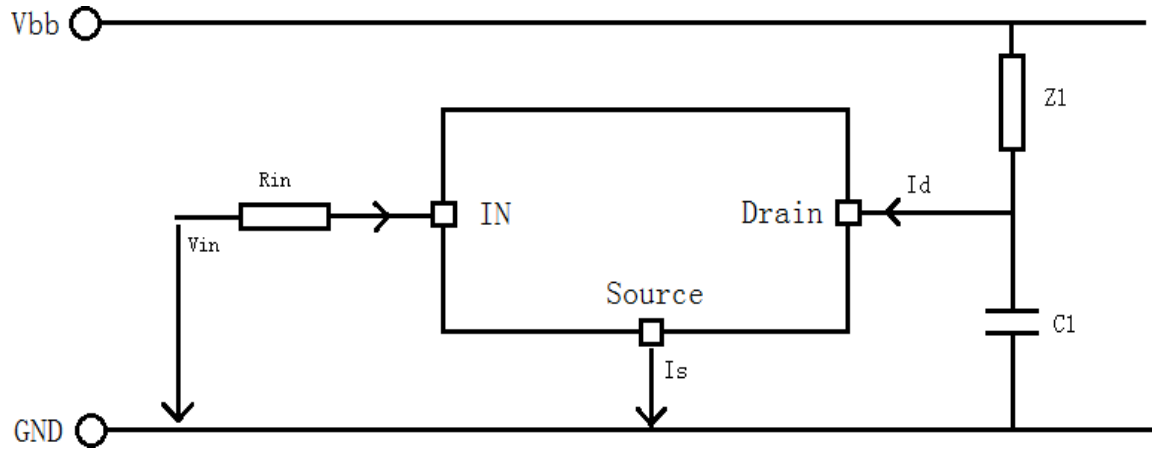


Figure 5-2 Typical Application Circuit of the SL8402

VI. Absolute Maximum Ratings

Table 6.1 Electrical Parameter Characteristics

Tj = -40°C to +150°C, all voltages are ground voltages, and the current flowing into pins is positive, unless otherwise specified.

Parameters	Symbols	Limiting value		Units	Testing conditions
		Min value	Max		
Voltage					
Drain Voltage	VD	-	42	V	V_{IN}=0V, I_D=10mA
Input Voltage	V_{IN}	-0.2	7	V	-
Input Current	I_{IN}	-20	20	mA	V_{IN}<-0.2V or V_{IN}>7V
Drain Current	I_D	-	2	A	Tj=25℃
Power Consumption					
Total Consumption	Ptot	-	7	W	Ta = 25℃

temperature					
Junction temperature	Tj	-40	+150	℃	-
Storage temperature	Tstg	-40	+150	℃	-
ESD Sensitivity					
ESD Voltage	V_{ESD}	-4	4	kV	R = 1.5k C = 100pF Tj = 25℃

Table 6.2 Thermal Resistance

Parameters	Symbols	Limiting value			Units
		Min		Max	
PN junction to solder joint thermal resistance	R_{thJC}	-		18	℃/W
PN junction to ambient thermal resistance (All channels are on-state)	R_{thJA}	-		70	℃/W

Note: Excess of threshold values listed above may cause permanent damage to the device.

VII. Module Description and Features

7.1 .Input Circuit

Figure7-1 illustrates the input circuit of the SL8402. Built-in Zener diode is used to protect the input circuit from abrupt ESD pulses. Internal circuits are powered by the IN pin. Under normal operating conditions, input circuits shall be connected to the Gate of Power MOSFET. While if not, the device would increase input currents I_{INlim} to inform driving circuits of the failure.

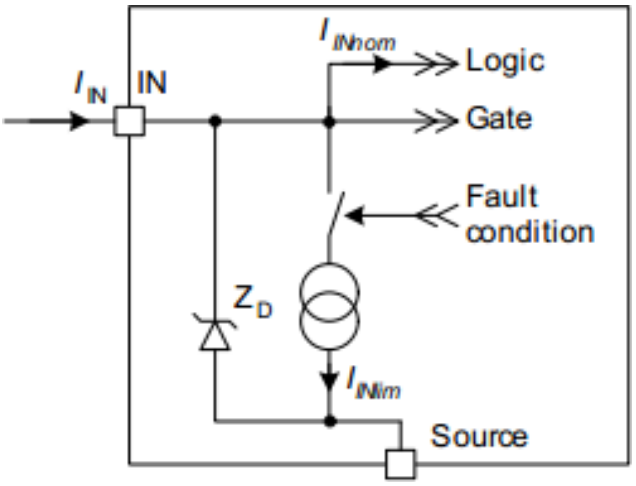


Figure 7-1 Input Circuit

7.2 .Transmission Property

Figure7-2 illustrates the transmission Property

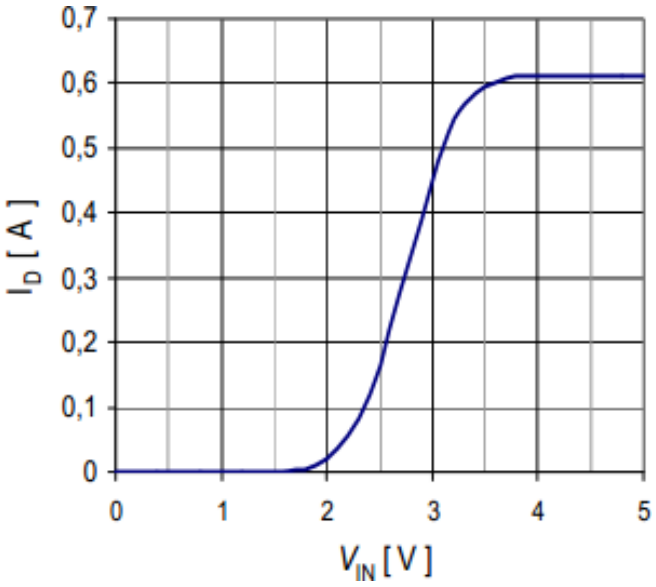


Figure7-2 Typical Transmission Features I_D f(VIN); V_D=12V,

T_{Jstart} =25°C Transmission Features I_{don}

7.3 . ON-State Resistance

On-state resistance depends on junction temperature T_J Figure7-3 shows the typical relationship between on-state resistance $R_{DS(on)}$ and junction temperature.

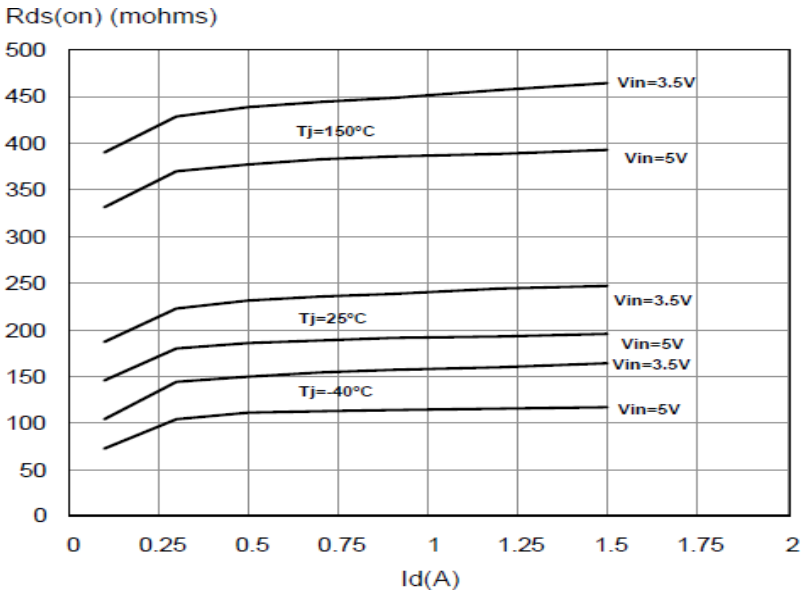


Figure7-3Typical on-resistance $R_{DS(ON)}$

7.4 .Output Timing

The Power MOSFET would turn on at a specific slope when the voltage on the IN pin surpasses the threshold value, and that can help reduce EMC emissions. Figure 7-4 offers the timing definition.

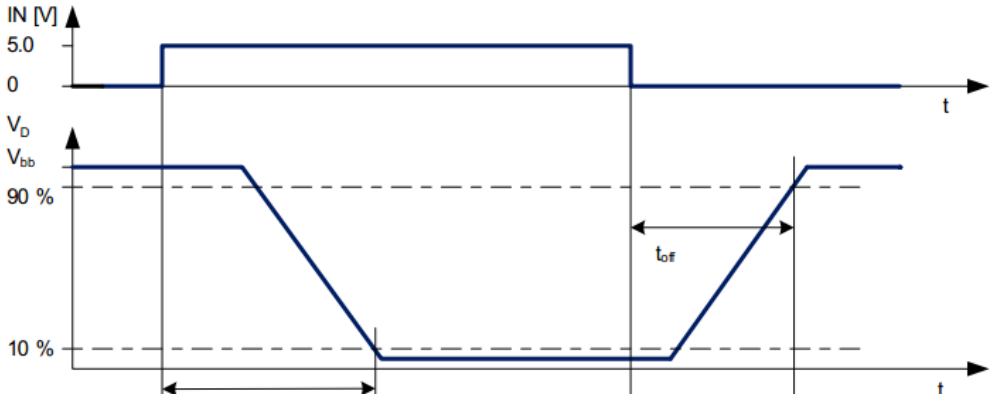


Figure 7-4 Timing Definition of Resistive Load Power Output

7.5 .Electrical Property

Electrical properties of input and Power MOSFET are listed in Table 7.1.

Note: Parameter shifts can also be found in Table 7.1 at a given input voltage and junction temperature. Type refers to typical properties that are consistent with expectations.

Electrical Property : Input and Power MOSFET

Tj= -40°C to +150°C, all voltages are ground voltages, the current flowing to pins is positive (unless otherwise specified)

Table 7.1 Electrical Properties of input and Power MOSFET

Parameters	Symbols	Limiting value			Unit	Testing conditions
		Min value	Typical value	Max value		
input						
Rated Input Current	I_{INnom}	-	50	90	uA	V_D=0V; V_{IN}=5V
Input Current Failure Mode	I_{INmin}	-	330	600	uA	V_{IN}=7V; TJ=150℃
Input Threshold Voltage	V_{INTH}	1.3	1.7	2.2	V	V_D=V_{IN}; I_D=50uA; TJ=25℃
		0.8	-	-	V	V_D=V_{IN}; I_D=50uA; TJ=150℃

power component						
On-State Resistance	$R_{DS(on)}$	-	0.28	-	Ω	Tj=25℃; V_{IN}=5V; ID=200mA
		-	0.9	1.5	Ω	Tj=150℃; V_{IN}=5V; ID=200mA
Rated load current	I_{Dnom}	-	-	1.2	A	TA=25℃ V_{IN}=5V
Drain Current at Zero Input Voltage	I_{DSS}	-	-	2	uA	VDS=13.5V; VIN =0V; T_J=150℃
		-	2.5	6	uA	VDS=32V; VIN=0V; T_J=-40~85 ℃
		-	4	7	uA	VDS=32V; VIN =0V; T_J=150℃
Switch: Vbb=12V， R_L=82Ω						
Turn-on Time	t_{on}	-	30	60	us	V_{IN} = 7 V to90%I
Shutdown time	t_{off}	-	40	80	us	V_{IN} = 0 V to 10%I_D
Backward Diode						
Backward Diode Forward Voltage	V_D	-	-0.6	-1	V	I_D= -0.2mA V_{IN} = 0V

VIII. Protections

The device provides a variety of integrated protections safeguarding against all unexpected damages caused by electrical failures mentioned in the Spec. Here, the failure refers to the case out of normal operating range.

8.1.Thermal Protection

Thermal protection means the devices would shut itself down in the event of excessively high temperature resulted from overload or poor heat dissipation. And it is all accomplished by a temperature sensor built inside of the Power MOSFET.

What's more, the SL8402 also has an automatic restart in light of temperature. It enables the device to reopen when the temperatures drop. See Figure 8-1

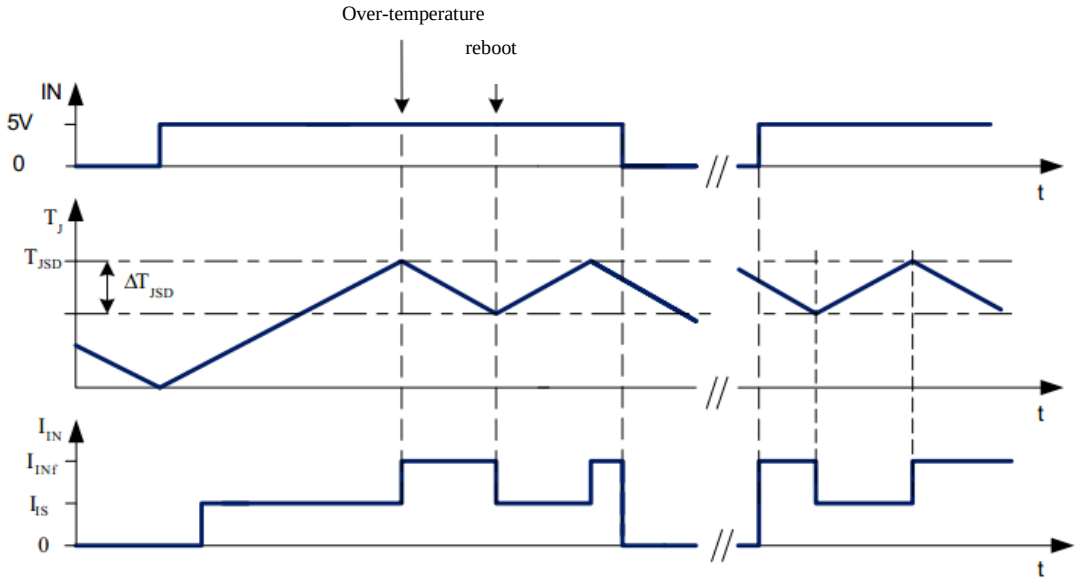


Figure 8-1 Error Signal and Input Current at Thermal Shutdown

8.2 .Overvoltage Protection

Overvoltage protection refers to the case that protection circuits would begin to work, clamping the voltage at a fixed value, once constant currents driven by resulting inductance push the drain-source voltage V_D up beyond the threshold value when inductive loads are shut down by the low-side switch. The demagnetization of inductive load depends on the SL8402's consumption.

8.3 .Short-circuit Protection

One result of overloading is short circuit. which means the device would begin limiting currents at Ilim, with the temperature rising accordingly. and immediately shut down as soon as the temperatures excess the OTSD threshold. Figure 8-2 illustrates this property. Input currents are greater than IINnom during the current-limiting period. while they are allowed to exceed Ilim at the tdlim .

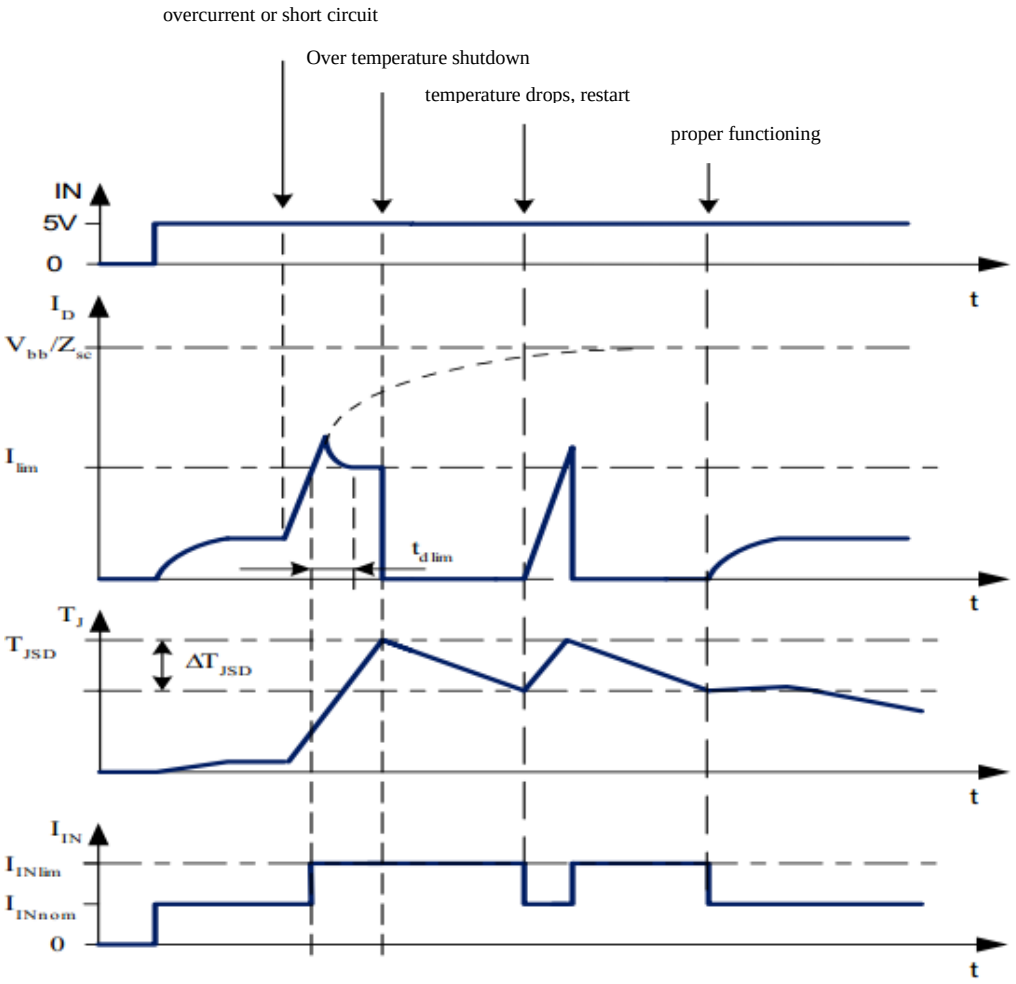


Figure 8-2 Short-Circuit Property of the SL8402

It can be assumed that there is a negligible resistor between the source and ground because the device itself is a low-side switch.

8.4 .Electrical Property

Electrical properties of each protection are shown below in Table 8.1.

Description： The characteristic gives the offset of the parameter for a given input voltage and junction temperature Type refers to typical properties that are consistent with expectations.

Electrical Property: Protections

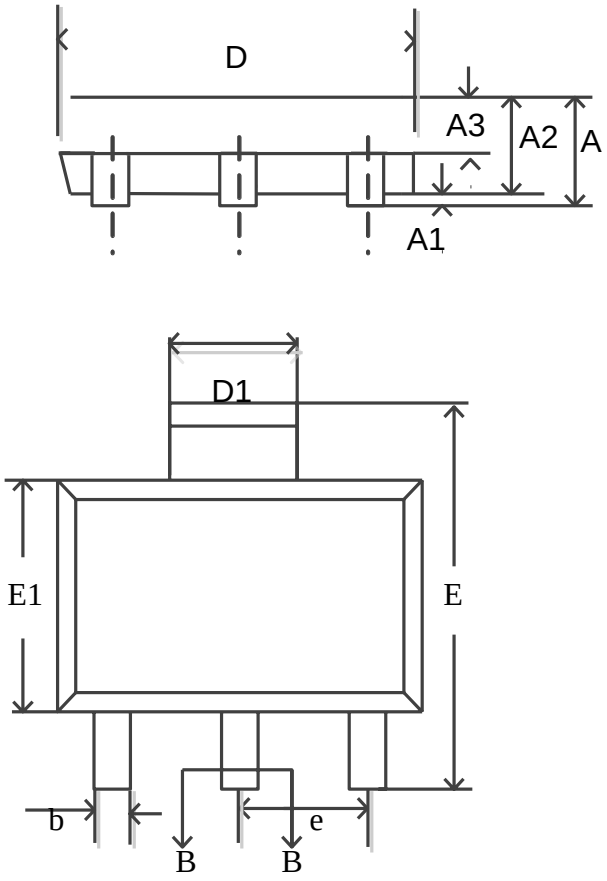
Table 8.1 Electrical Properties of Protections

Tj = -40°C to +150°C, all voltages are ground voltages, and the current flowing into pins is positive (unless otherwise specified).

Parameters	Symbols	Limiting value			Units	Testing conditions
		Min value	Typical value	Max value		
Over-temperature Protection						
Thermal Shutdown Junction Temperature	T_{JSD}	150	165	-	℃	-
Thermal Hysteresis	ΔT_{JSD}	-	20	-	℃	
Overvoltage Protection						
Drain Clamping Voltage	V_{Clamp}	40	-	52	V	V_{IN} =0Vto7V; I_D = 10mA
Current-limiting and Short-circuit Protection						
Limited Current	I_{lim}	1.3	1.8	2.4	A	V_{IN} =0V to7V; VDS = 12V; $t_{measure}$ = 4*t_{dlim} T_J =25℃
		0.6	-	-		T_J=150℃
		-	-	2.8		T_J=-40℃
Current-limiting Delay Time	t_{dlim}	-	-	50	us	

IX. SL8402Package Specification

SOT-223 Package Outlines and Measurement



SYMBOL	MILLIMETER		
	MIN	NOM	MAX
A	1.50	1.65	1.80
A1	0.03	0.06	0.09
A2	1.45	1.60	1.75
A3	0.80	0.90	1.00
b	0.69	-----	0.78
b1	0.68	0.71	0.74
c	0.30	-----	0.35
c1	0.29	0.30	0.31
D	6.30	6.50	6.70
D1	3.00 REF		
E	6.80	7.00	7.20
E1	3.40	3.50	3.60
e	2.30 BSC		
L	0.90	-----	-----
L1	1.75 BSC		
?	0	----	7°
?1	37.5 REF		