Smart High-Side Power Switch

Basic Features

- Short circuit protection
- Current limitation
- Overload protection
- Over voltage protection
- Over temperature protection
- Undervoltage shutdown with auto- restart and hysteresis
- Clamp of negative voltage at output with inductive loads
- Very low standby current
- Reverse battery protection with external resistor
- Green Product(RoHS compliant)

Application

- µC compatible power switch for 12V and 24V DC applications
- All types of resistive, inductive and capacitive loads
- Replaces electromechanical relays, fuses and discrete circuits

Product Summary

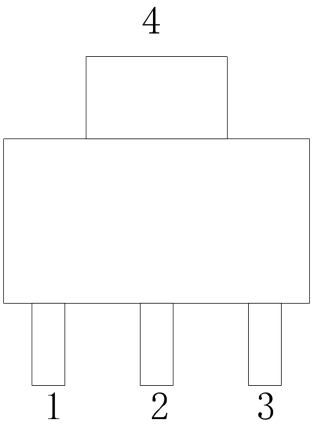
Overvoltage protection	$V_{bb(AZ)}$	53	V
Operating voltage	$V_{bb(ON)}$	6-45	V
On-state resistance	R_{ON}	200	mΩ
Nominal load current	$I_{L(NOM)}$	0.7	A
Short circuit current limit	$I_{L(SCp)}$	1.2	A

Ordering Code

Device	Package Type	Marking	Materials	Package			Package Qty
BTS4140N	SOT-223	BTS4140	Halogen free	Tape&reel	10 reels/box	30k/box	3000/reel
BTS4140E	ESOP8L	BTS4140E	Halogen free	Tape&reel	10 reels/box	40k/box	4000/reel
BTS4140S	ESOP8L	BTS4140S	Halogen free	Tape&reel	10 reels/box	40k/box	4000/reel

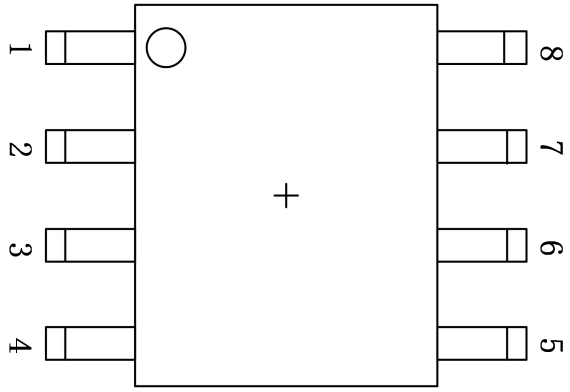
Pin Configuration

SOT-223



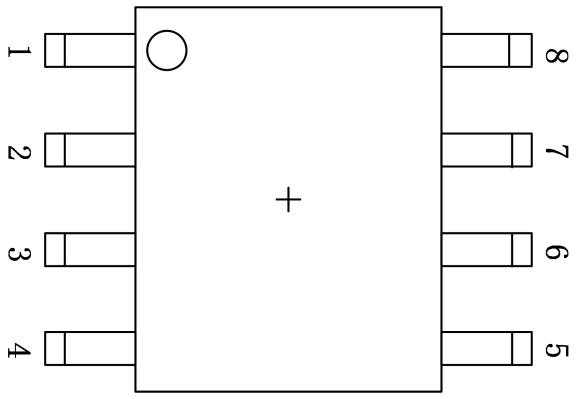
Pin	Symbol	Function
1	OUT	Output to the load
2	GND	Logic ground
3	IN	Input; activates the power switch in case of logic high signal
4	Vbb	Positive power supply voltage

ESOP8L



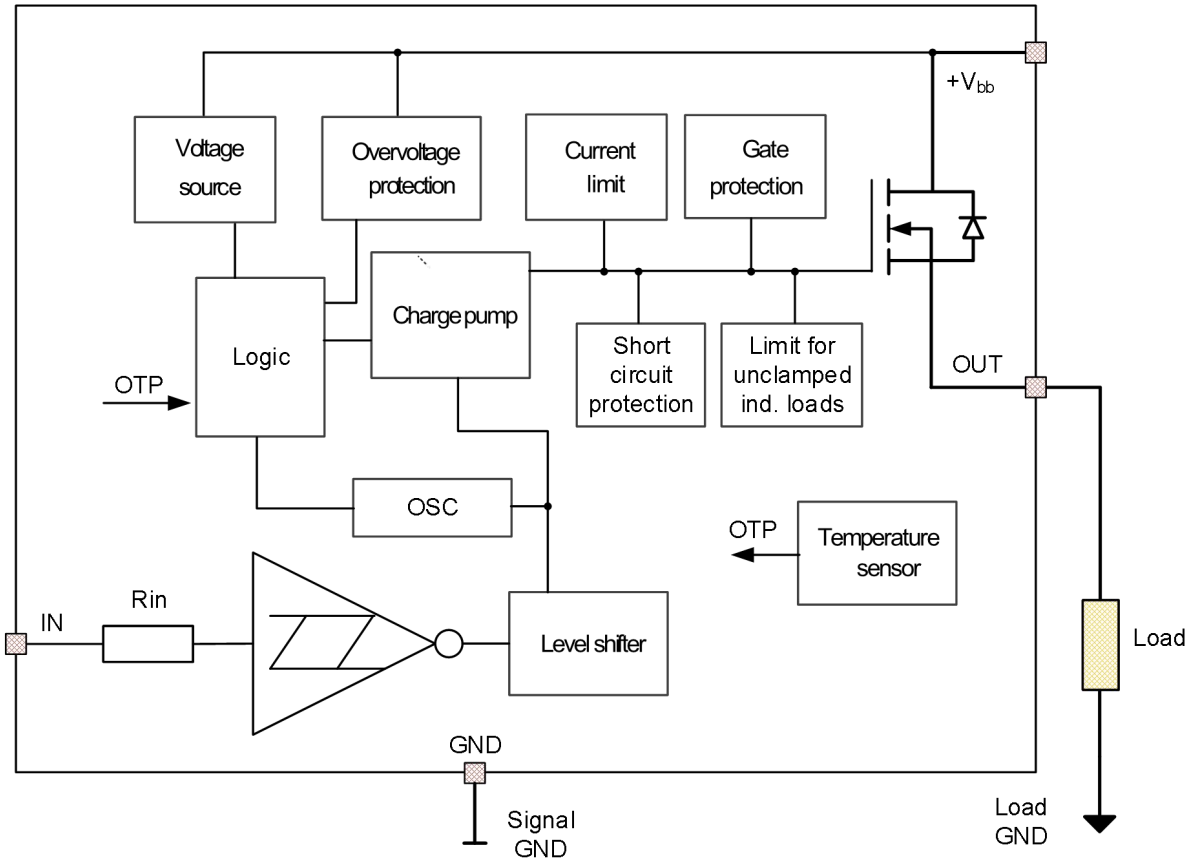
Pin	Symbol	Function
1	GND	Logic ground
2	IN	Input; activates the power switch in case of logic high signal
3/4/5	NC	No internal connection to the chip
6/7/8	OUT	Output to the load
Tab	V_{bb}	Positive power supply voltage

ESOP8L



Pin	Symbol	Function
1/2	V_{bb}	Positive power supply voltage
3/6	NC	No internal connection to the chip
4	GND	Logic ground
5	IN	Input; activates the power switch in case of logic high signal
7/8	OUT	Output to the load

Block Diagram



Absolute Maximum Ratings[1)]

(Maximum Ratings at T_j=25 °C unless otherwise specified)

Parameter	Symbol	Values	Unit	Note or Test Condition
Supply voltage	V_{bb}	45	V	
Load dump protection	$V_{Load\ dump}$	83	V	$V_{LoadDump}=V_A+Vs$, $R_I=2\Omega$, $t_d=400ms$, V_{IN}=low or high, $V_A=13.5V$, $R_L=47\Omega$
Current through input pin (DC)	I_{IN}	-5 to 5	mA	
Reverse current through GND-pin	$-I_{GND}$	-0.5	A	
Power dissipation (DC)	P_{tot}	1.17	W	SOT223
Continuous input voltage	V_{IN}	-10...V_{bb}	V	
Operating temperature	T_j	-40 to 150	℃	
Ambient temperature	T_a	-40 to 125	℃	
Storage temperature	T_{stg}	-55 to 150	℃	
Thermal resistance @ 6 cm^2 cooling area	$R_{TH(JA)}$	89.4	W	SOT223

Notes:

1. Stresses above the ones listed here may cause permanent damage to the device. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Electrical Characteristics

(T_J=-40°C to +150°C unless otherwise specified)

Symbol	Parameter	Test Condition	Values			Unit
			Min	Typ	Max	
R_{on}	On-state resistance	V_{bb}=24V, V_{IN}=5V, I_{OUT}=0.5A, T_j=25℃	-	150	200	mΩ
		V_{bb}=24V, V_{IN}=5V, I_{OUT}=0.5A, T_j=150℃	-	270	320	
$I_{L(nom)}$	Nominal load current	V_{bb}=24V, V_{IN}=5V	0.7	-	-	A
t_{on}	Turn-ON time	V_{IN} Turn-ON time to V_{OUT} =90%V_{bb}, R_L=47Ω, V_{bb}=15V	-	57	100	us
t_{off}	Turn-OFF time	V_{IN} Turn-OFF time to V_{OUT} =10%V_{bb}, R_L=47Ω, V_{bb}=15V	-	55	150	us
d_V/d_{ton}	Turn-ON Slew rate	V_{OUT} From 10%V_{bb} to 30%V_{bb}, R_L=47Ω, V_{bb}=15V	-	0.9	2	V/us
$-d_V/d_{toff}$	Turn-OFF Slew rate	V_{OUT} From 70%V_{bb} to 40%V_{bb}, R_L=47Ω, V_{bb}=15V	0.7	-	-	V/us
$V_{bb(on)}$	Operating voltage	V_{IN}=5V, R_L=100Ω	6.0	-	45	V
$V_{bb(under)}$	Under voltage shutdown	V_{IN}=5V, R_L=100Ω	4.5	-	5.5	V
$V_{bb(urst)}$	Under voltage restart	V_{IN}=5V, R_L=100Ω	-	-	5.8	V
$\Delta V_{bb(under)}$	Under voltage hysteresis		-	-	0.5	V
$I_{bb(off)}$	Standby current	V_{IN}=0, V_{bb}=30V, T_j≤25℃	-	11	25	uA
I_{GND}	Operating current	V_{bb}=30V, V_{IN}=5V, V_{OUT} floating	-	-	1.6	mA
$I_{L(off)}$	Leakage output current	V_{bb}=15V, V_{IN}=0V	-	-	10	uA
$I_{L(SCp)}$	Initial peak short circuit current limit	V_{bb}=30V, V_{IN}=5V, T_j=25℃	0.7	1.2	2.4	A
$V_{ON(CL)}$	Output clamp (inductive load switch off)	V_{bb}=30V, V_{IN}=5V, f=20Hz, D=10%, R_L=1H	62	68	-	V
T_{jt}	Thermal overload trip temperature	V_{bb}=12V, V_{IN}=5V, R_L=18Ω	135	-	-	℃
ΔT_{jt}	Thermal hysteresis		-	10	-	℃
$V_{bb(AZ)}$	Over voltage protection	V_{IN}=5V, R_{GND}=330Ω	47	53	-	V
$V_{IN(T+)}$	Input turn-on threshold voltage		-	2.5	3	V
$V_{IN(T-)}$	Input turn-off threshold voltage		1.7	2.3	-	V
$V_{IN(T)}$	Input threshold hysteresis		-	0.2	1.0	V
$I_{IN(on)}$	ON state input current	V_{bb}=15V, R_L=47Ω, V_{IN}=3V	10	-	110	uA
$I_{IN(off)}$	OFF state input current	V_{bb}=15V, R_L=47Ω, V_{IN}=1.7V	10	-	110	uA

$t_{d(Vbbon)}$	Input delay time at switch on V_{bb}	V_{bb}=15V, V_{IN}=5V, R_L=47Ω	150	230	-	us
$-V_{ON}$	Drain-source diode voltage	V_{bb}=24V, T_j=25℃	-	-	1.2	V

Timing diagrams

Figure 1:Vbb turn on

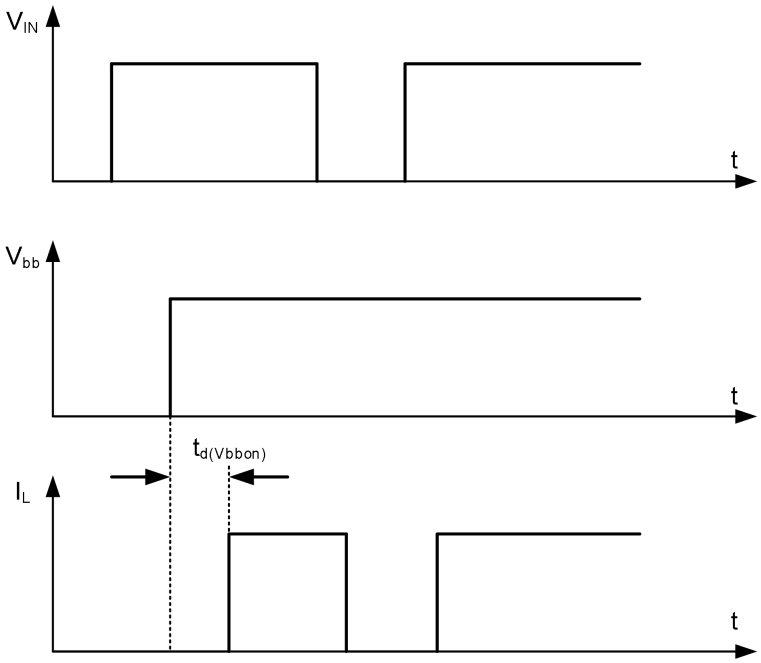


Figure 2a: Switching a resistive load, turn-on/off time and slew rate definition

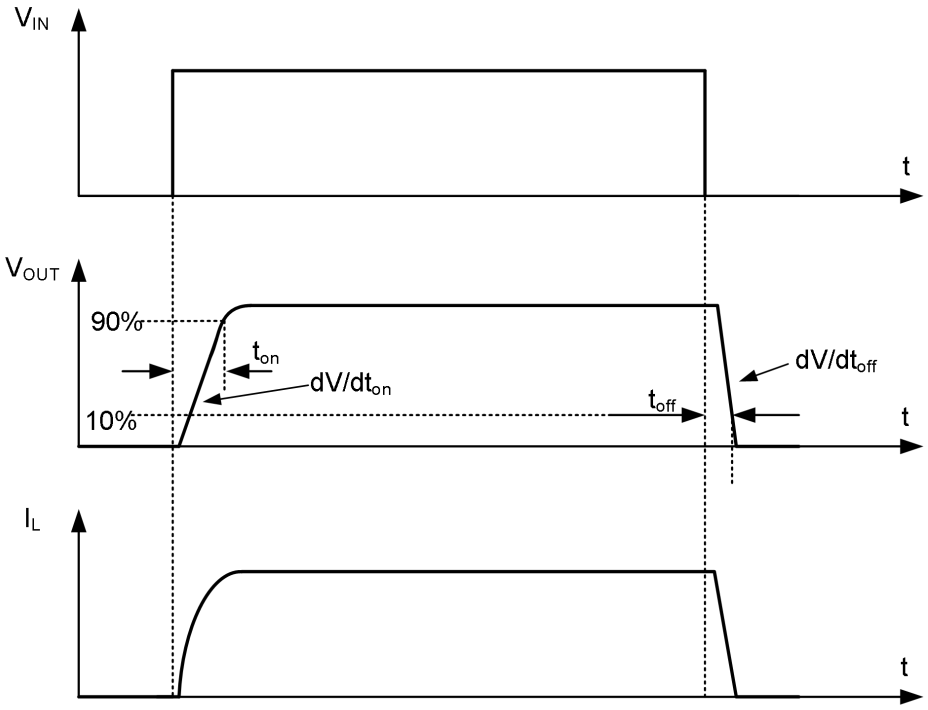


Figure 2b: Switching a lamp

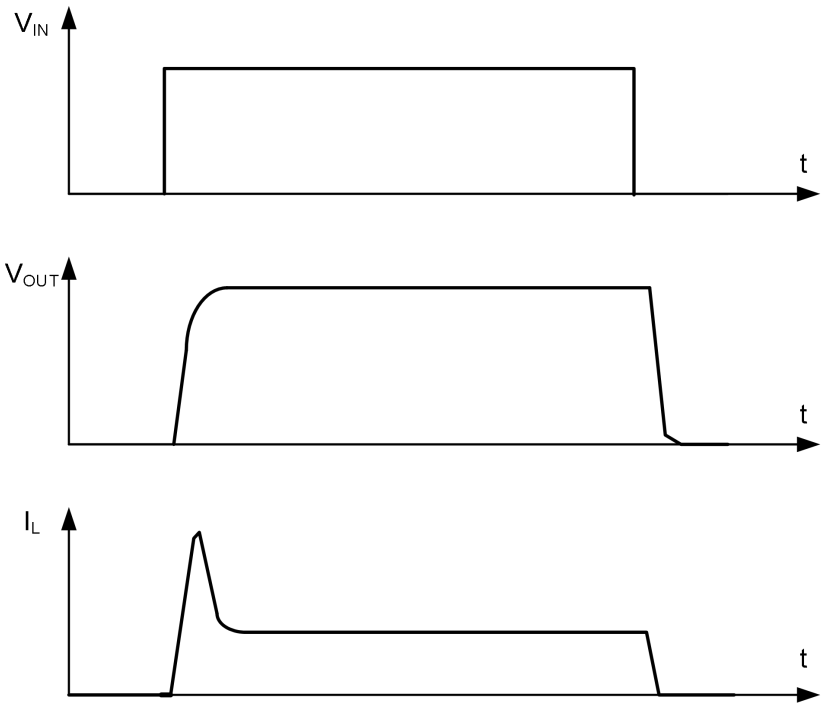


Figure 2c: Switching an inductive load

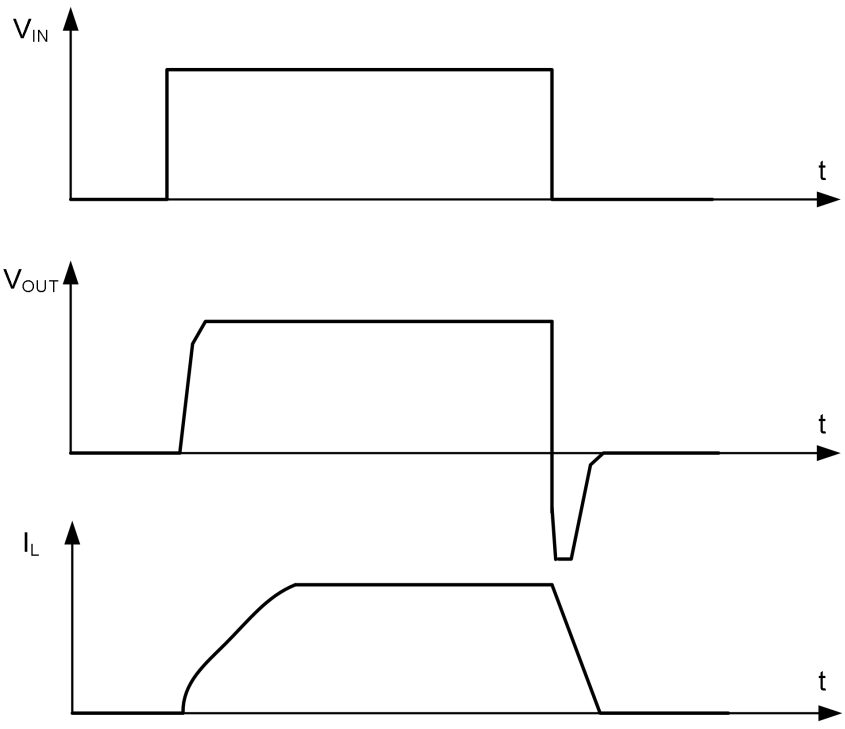


Figure 3a: Turn on into short circuit, shut down by overtemperature, restart by cooling

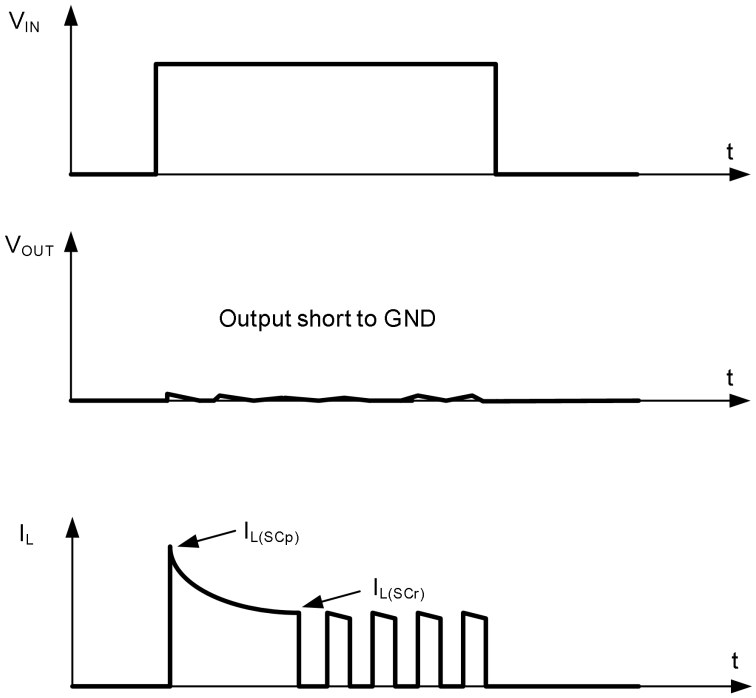


Figure3b: Short circuit in on-state shut down by overtemperature, restart by cooling

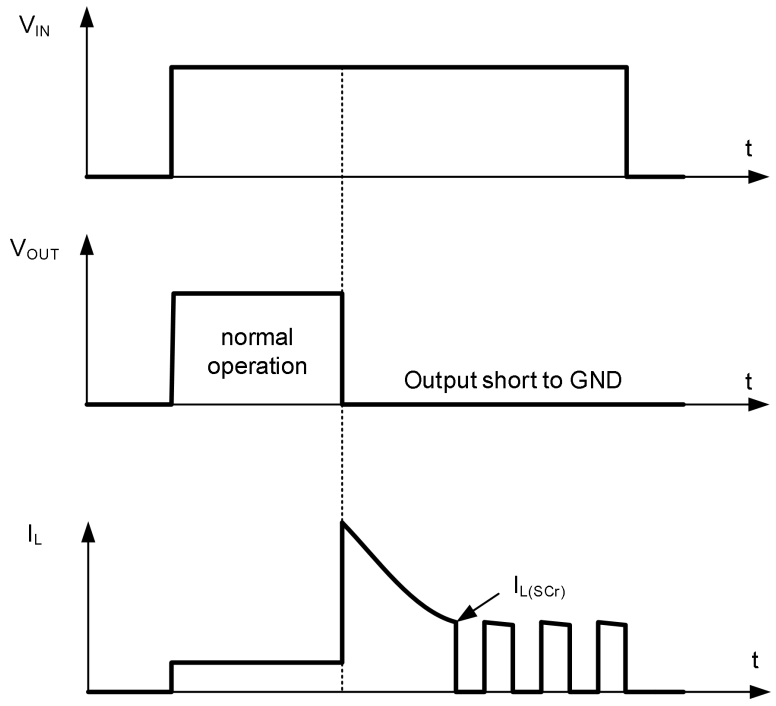


Figure4:Overtemperature: Reset if $T_j<T_{jt}$

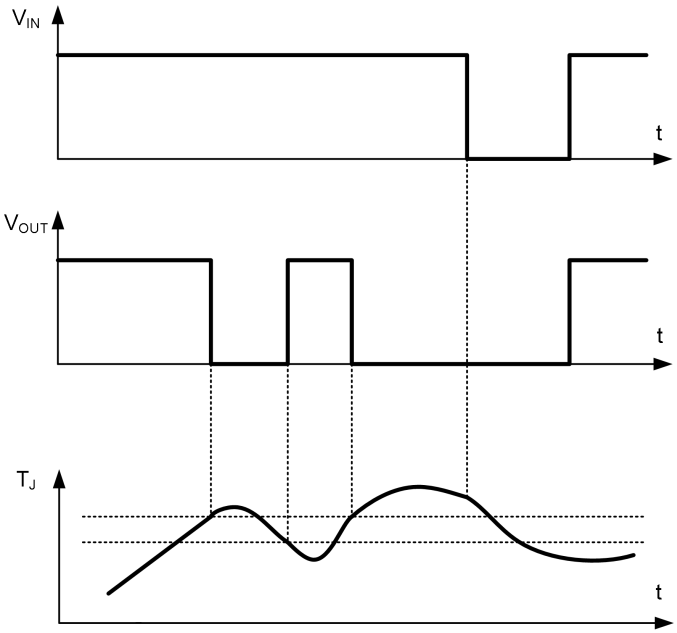
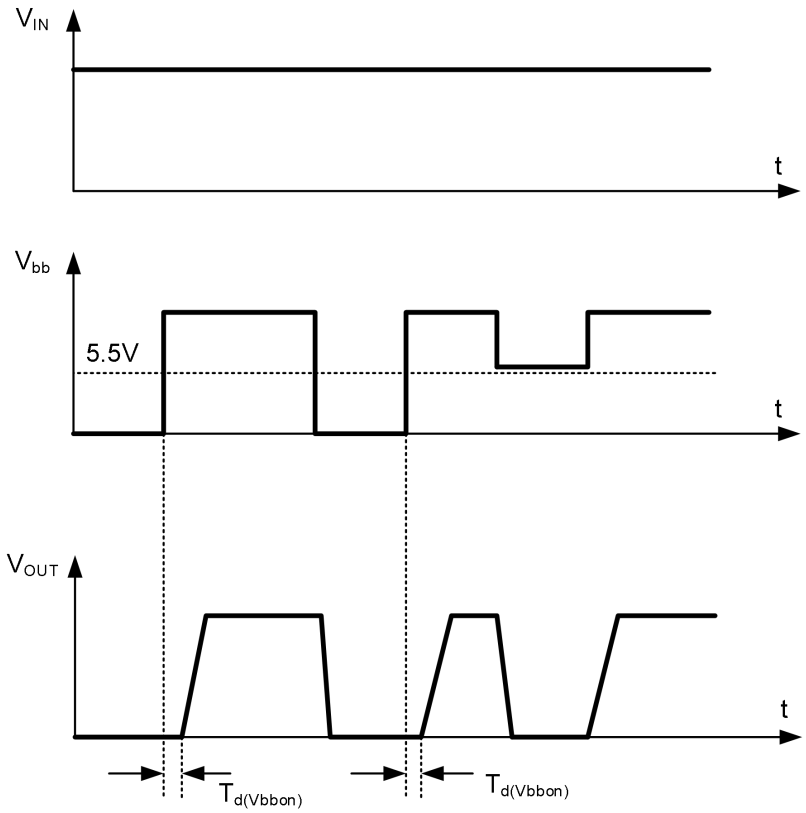
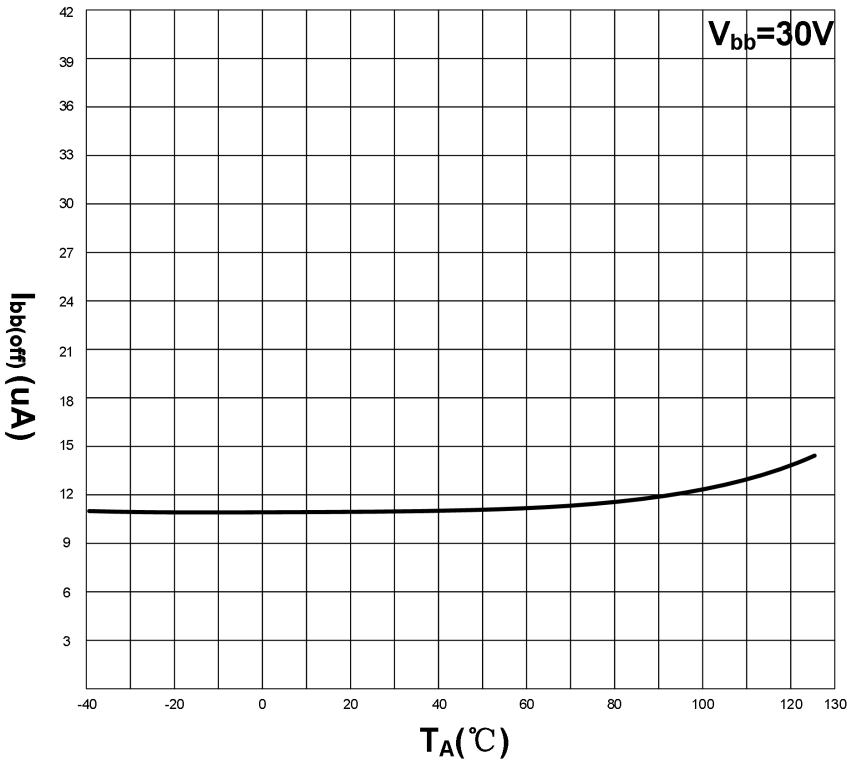


Figure5: Undervoltage shutdown and restart

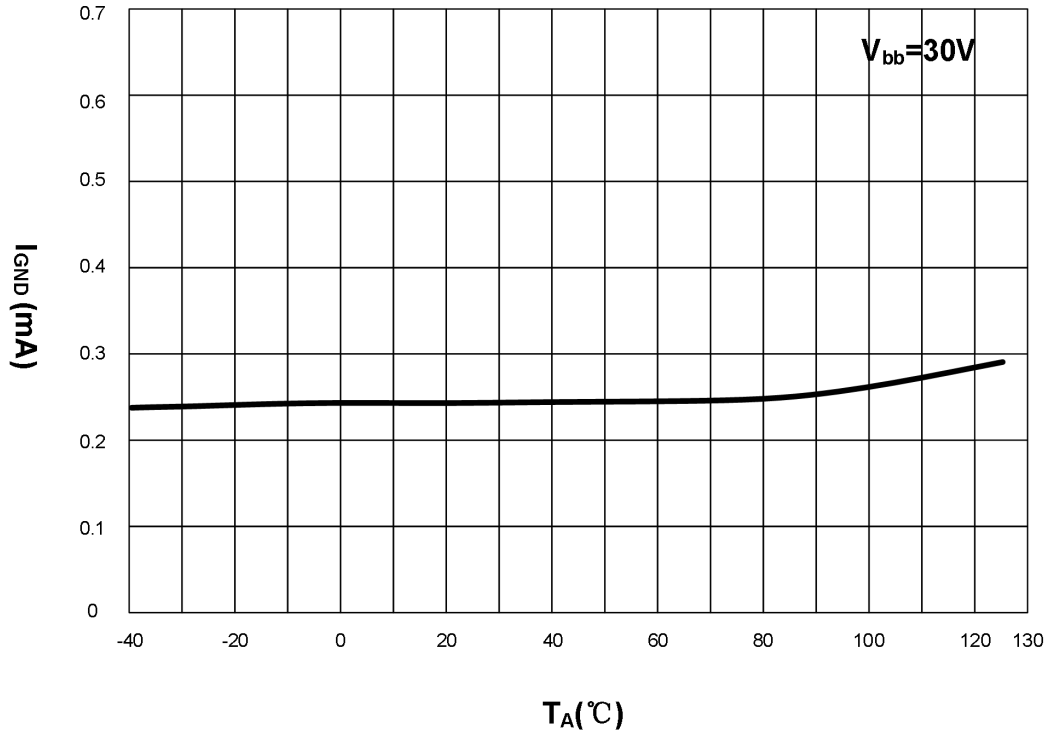


General Product Characteristics

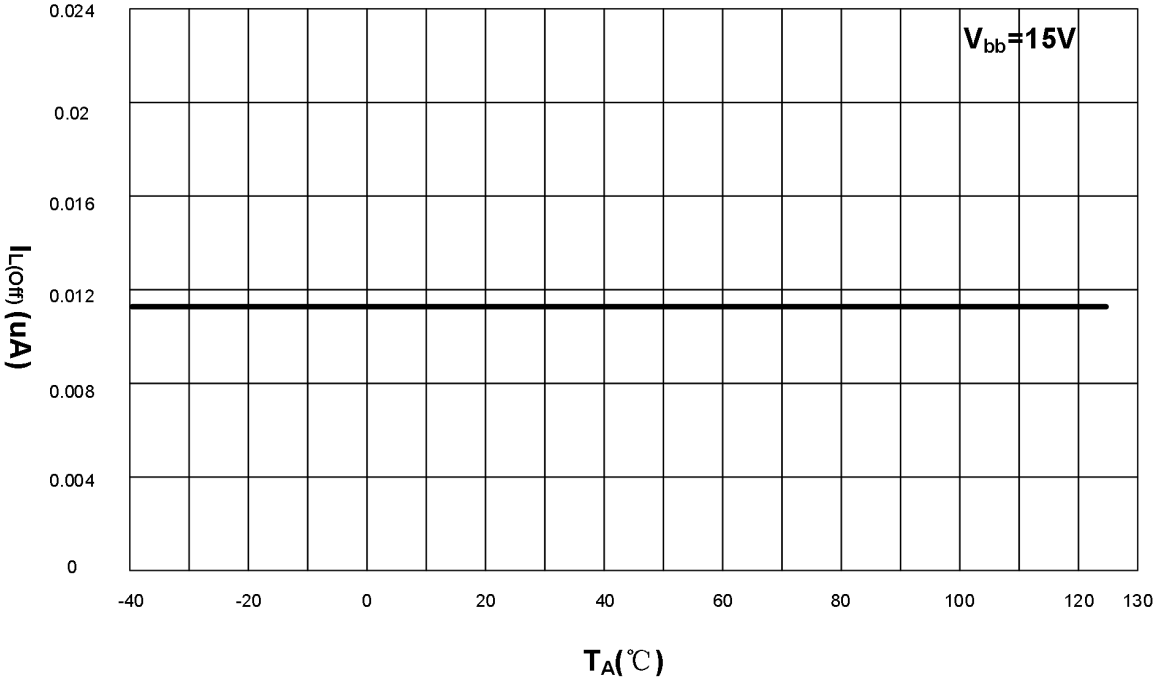
Standby Current



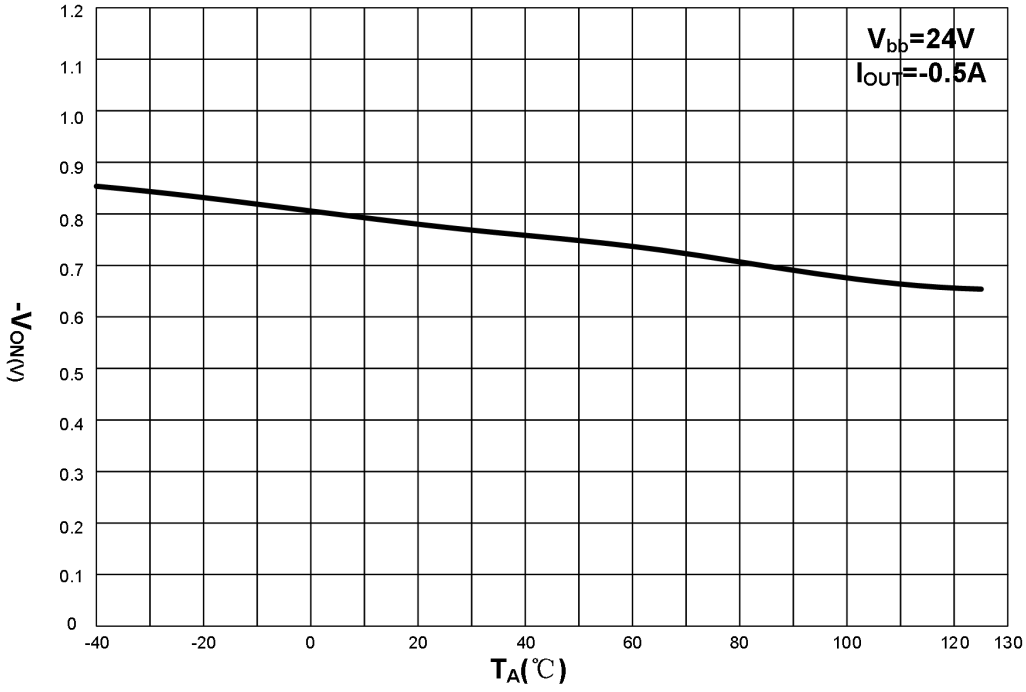
Operating current



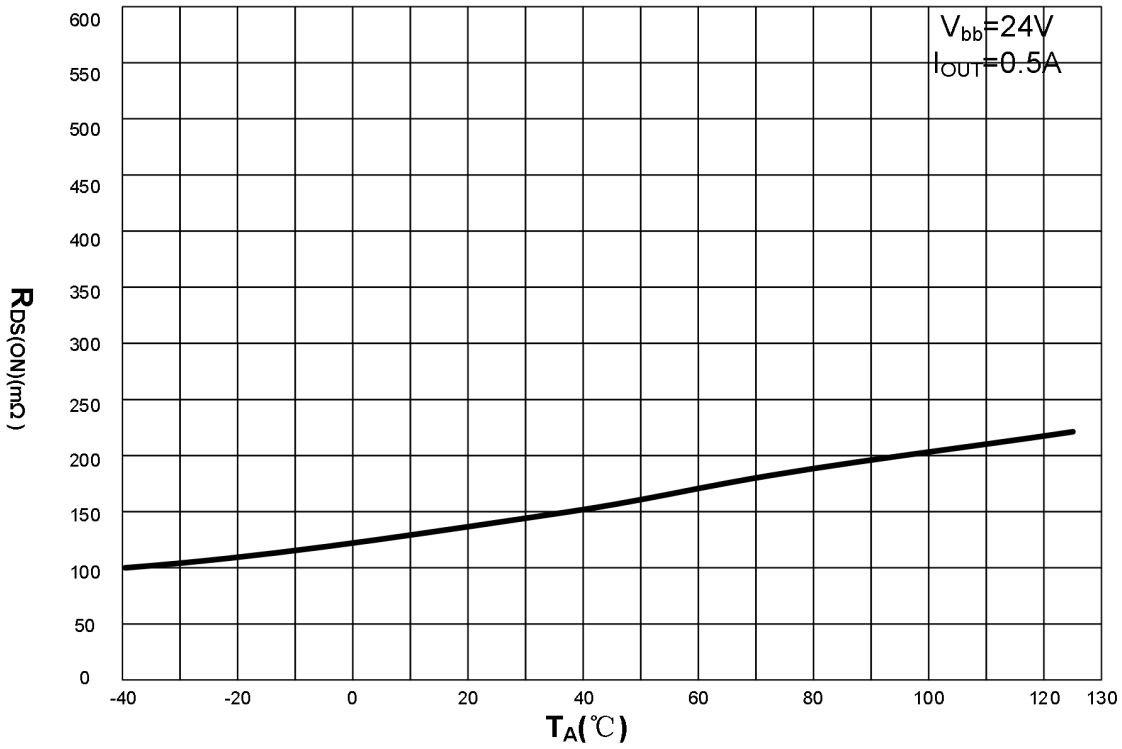
Leakage output current



Drain-source diode voltage

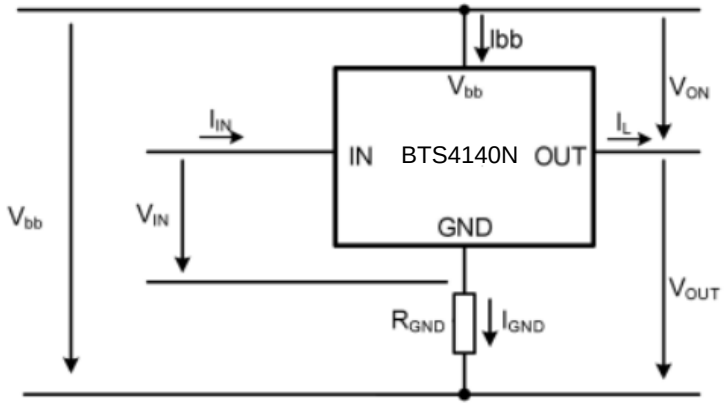


Typical ON-State Resistance

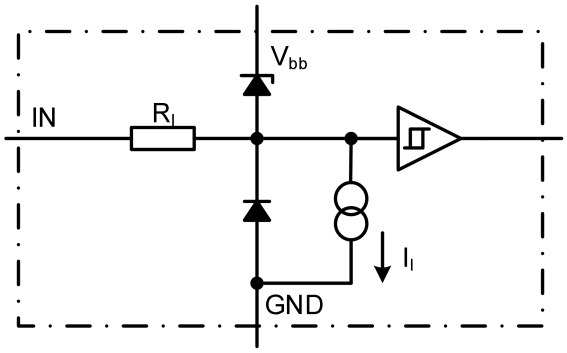


Functions

Terms

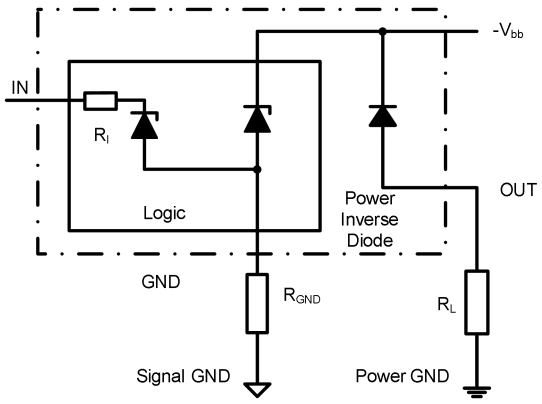


Input circuit (ESD protection)



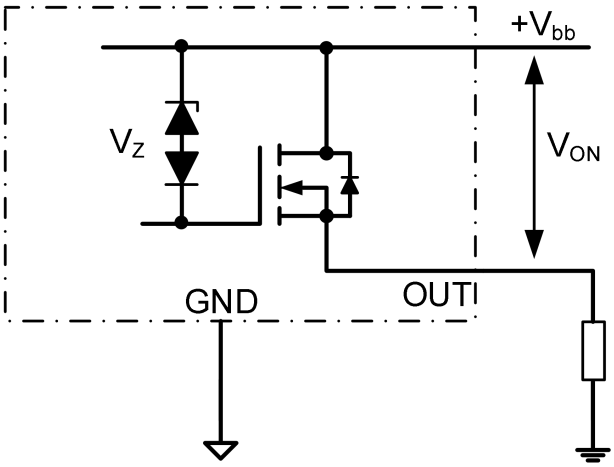
The use of ESD zener diodes as voltage clamp at DC conditions is not recommended

Reverse battery protection



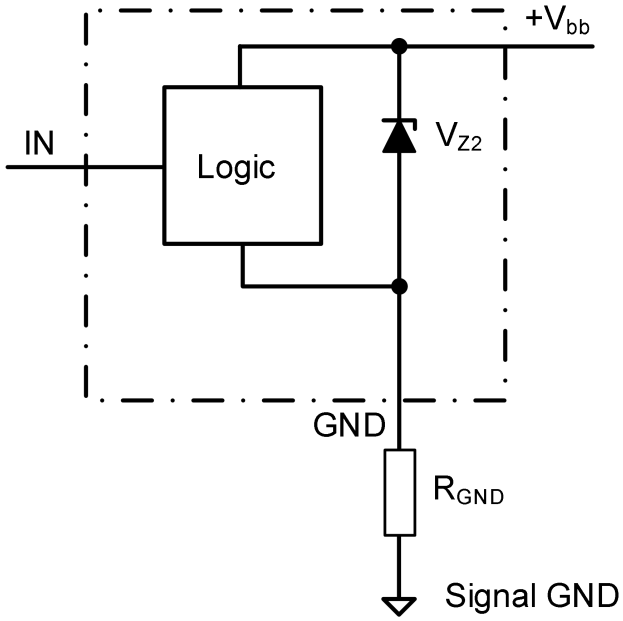
R_{GND}=330Ω, R_I=3kΩ typ.Temperature protection is not active during inverse current.

Inductive and overvoltage output clamp



V_{ON} clamped to 62 V min.

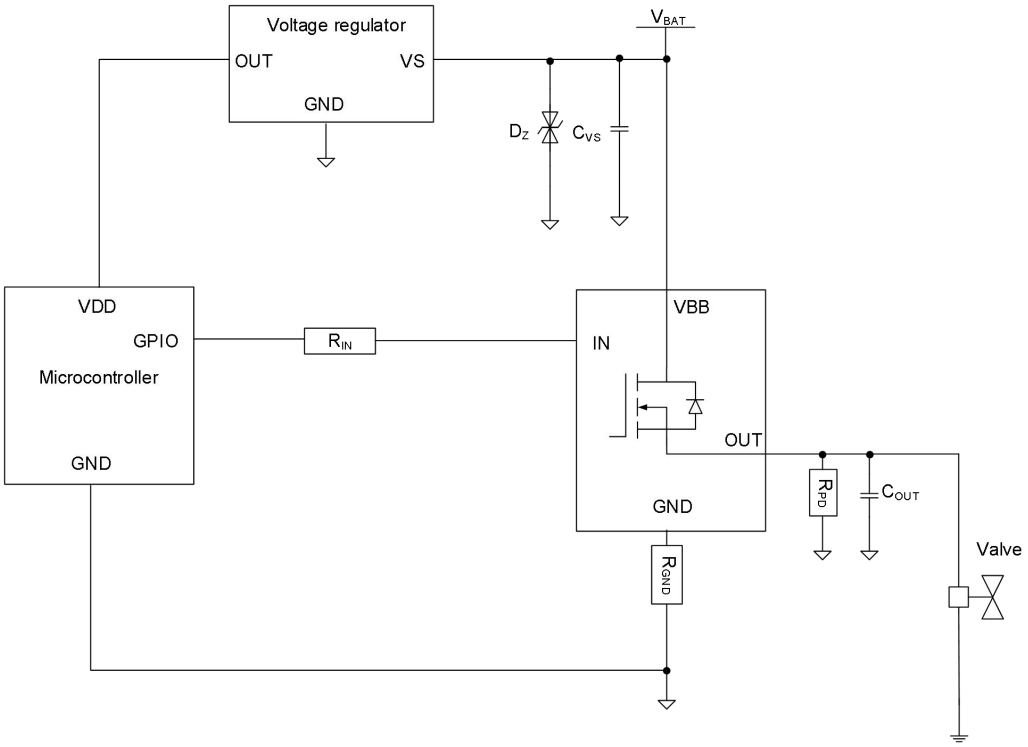
Over voltage protection of logic part



$V_{Z2}=V_{bb(AZ)}$=47V min., R_I=3 kΩ typ., R_{GND}=330Ω

Application Information

Note: The following information is given as a hint for the implementation of the device only and shall not be regarded as a description or warranty of a certain functionality,condition or quality of the device.



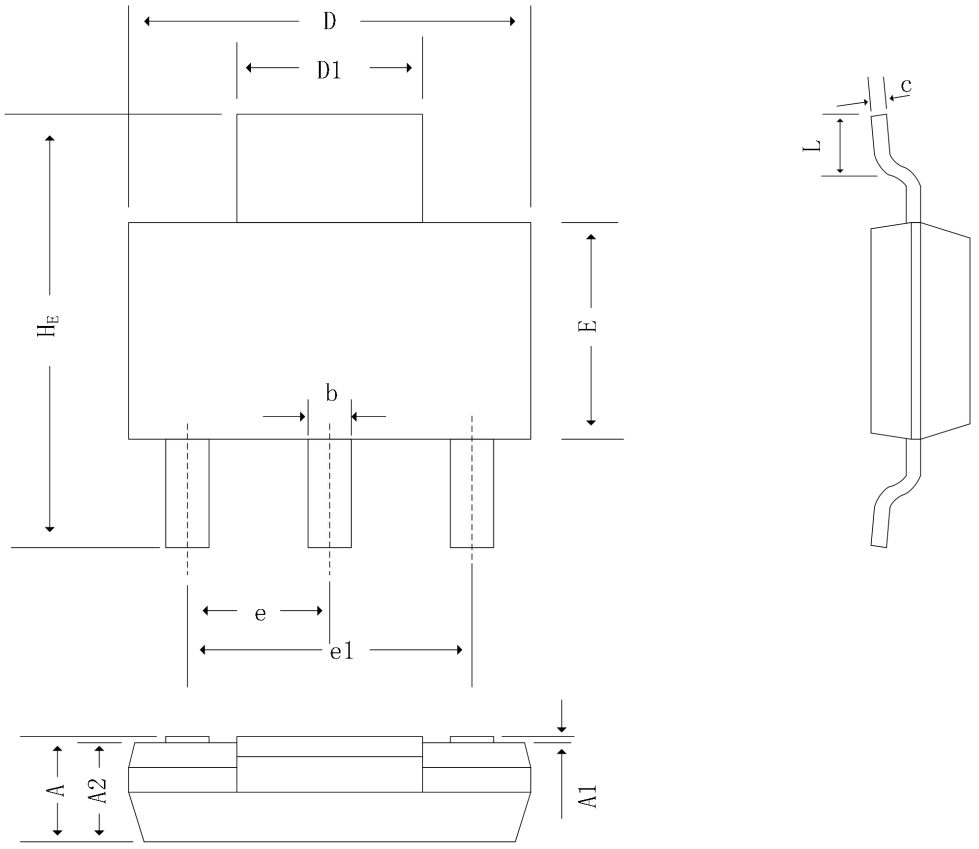
Note: This is a very simplified example of an application circuit.The function must be verified in the real application.

Bill of Material

Reference	Value	Reference	Value
R_{IN}	10kΩ	D_Z	58V Zener diode
R_{GND}	330Ω	C_{VS}	100nF
R_{PD}	47kΩ	C_{OUT}	10nF

Package

SOT-223



Unit :mm

Symbol	MIN	NOM	MAX
A	/	/	1.80
A1	0.02	/	0.10
A2	1.50	1.60	1.70
b	0.66	0.71	0.84
c	0.23	0.30	0.35
D	6.30	6.50	6.70
D1	2.90	3.00	3.10
E	3.30	3.50	3.70
H_E	6.70	7.00	7.30
e	2.300(BSC)		
e1	4.600(BSC)		
L	0.750	/	/

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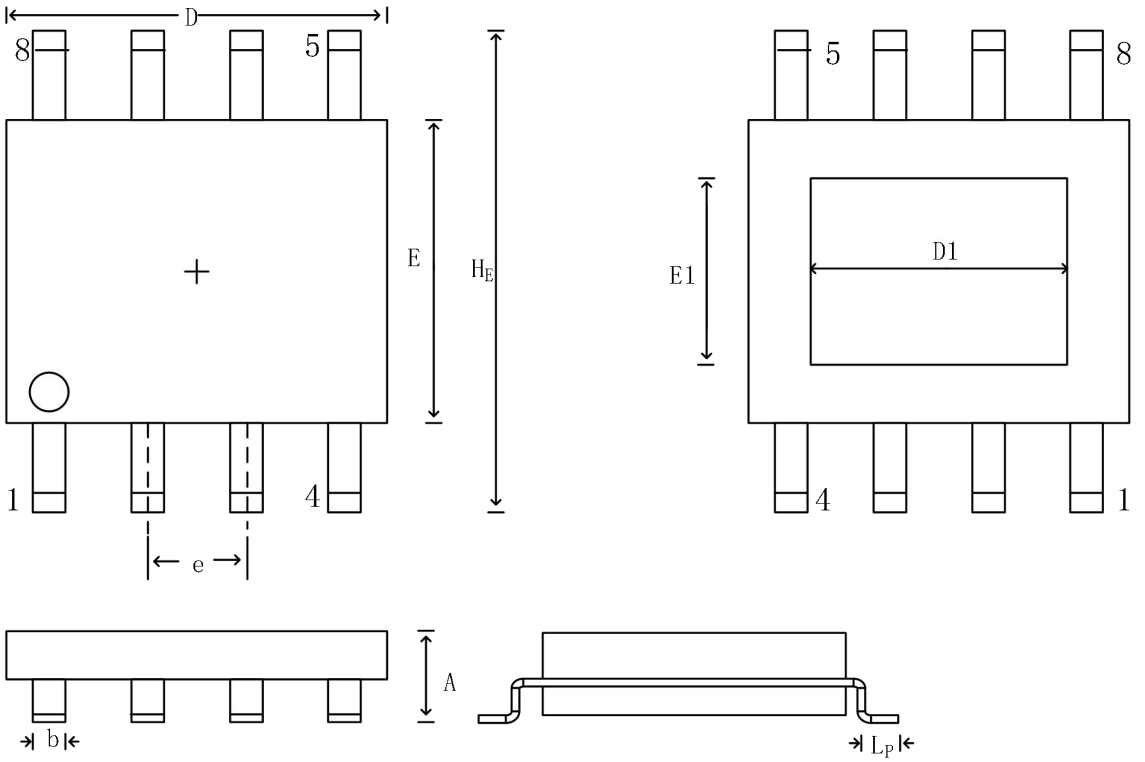
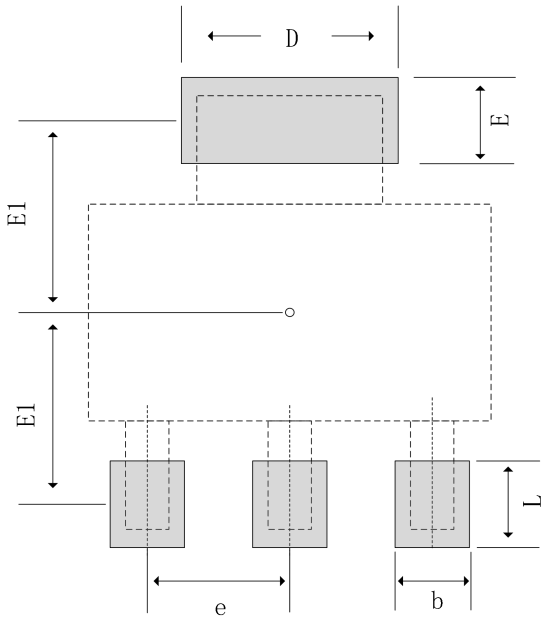


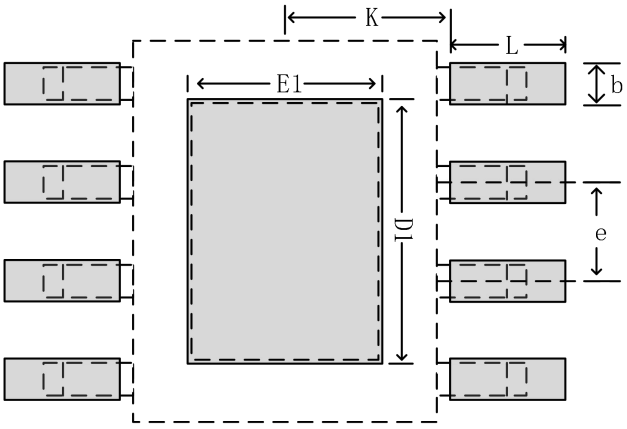
Unit :mm

Symbol	MIN	NOM	MAX
D	4.70	4.90	5.10
E	3.70	3.90	4.10
H_E	6.00	6.20	6.40
e		1.27BSC	
D1	3.10	3.30	3.50
E1	2.20	2.40	2.60
A	1.35	1.55	1.75
b	0.35	0.42	0.49
L_P	0.40	0.825	1.25

Recommended Soldering Footprint



Symbol	NOM	Symbol	NOM
D1	3.0	E	1.4
E1	3.1	L	1.4
b	0.71	e	2.3



Symbol	NOM	Symbol	NOM
e	1.27	D1	3.30
b	0.42	E1	2.7
L	1.8	K	2.1