Smart High-Side Power Switch
RM77090DD Datasheet

1.Basic Features

- Dual channel Smart High side High Current Power Switch
- Very low standby current
- Reverse Polarity Low Power
- Switching on function in reverse current state
- Over temperature protection
- Undervoltage protection
- Overvoltage protection with external devices
- Load current detection
- Load on and off detection
- Battery short circuit to GND detection
- Feedback function of current sense ratio
- Electrostatic discharge (ESD) protection
- Green Product (RoHS compliant)
- AEC-Q100 qualified

2.Description

RM77090DD is a 90mΩ dual channel Smart High-side Power Switch, Reverse battery protection by self turn on of power MOSFET, current controlled input and diagnostic feedback with load current sense.It can connect to various loads such as inductive loads, resistive loads, capacitive loads, etc.

RM77090DD integrates multiple protection functions. Overload protection, Current limitation, Short circuit protection, Over temperature protection, Over voltage protection, Clamp of negative voltage at output, Fast deenergizing of inductive loads, Electrostatic discharge (ESD) protection.

3.Application

- Suitable for 24 V Trucks and Transportation System
- All types of resistive, inductive and capacitive loads
- Replaces electromechanical relays, fuses and discrete circuits

4.Product Summary

Overvoltage protection	$V_{bb(AZ)}$	67	V
Operating voltage range	$V_{S(OP)}$	4.5...42	V
On-state resistance (one channel) (two parallel channels)	R_{ON}	 150 75	mΩ
Nominal load current (one channel) (two parallel channels)	$I_{L(NOM)}$	 2.5 4	A
Current limitation (one channel)	$I_{L(SCR)}$	5	A

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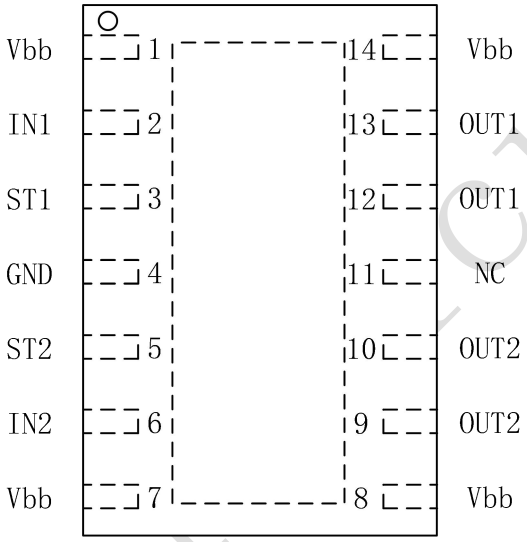
5.Ordering Code

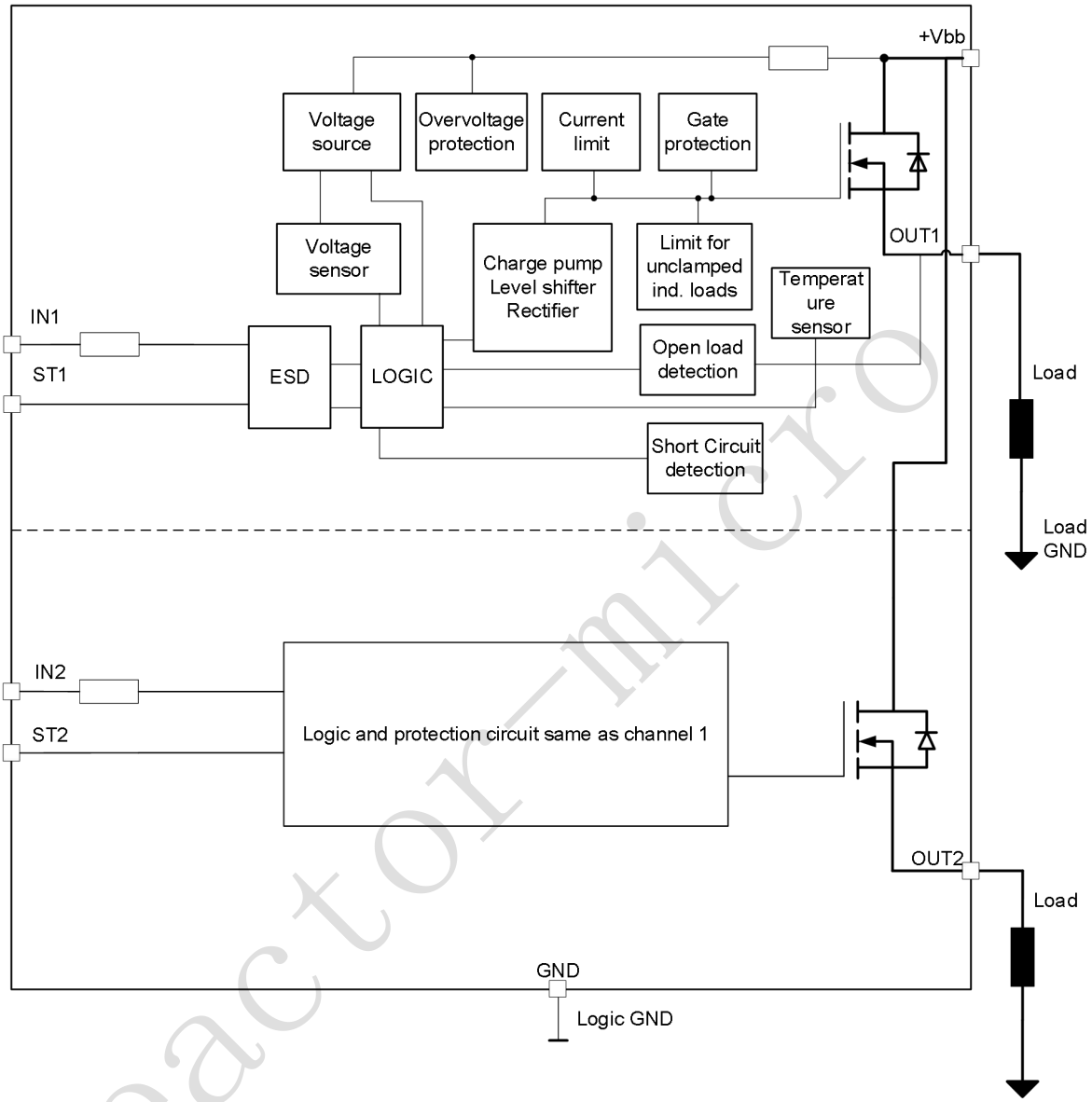
Product	Package	Marking	Materials	Package			Package Qty
RM77090DD	DFN9*6-14L	RM77090DD	Halogen free	Tape&reel	10 reels/box	30k/box	3000/reel

6.Pin Configuration



Pin	Symbol	Function
1/7/8/14	Vbb	Supply voltage;Positive power supply voltage
2	IN1	Input 1 activates channel 1 in case of logic high signal
3	ST1	Diagnostic feedback of channel 1 open drain
4	GND	GrouND;Ground connection
5	ST2	Diagnostic feedback of channel 2 open drain
6	IN2	Input 2 activates channel 2 in case of logic high signal
9/10	OUT2	Output 2 protected high-side power output of channel 2
11	NC	Not Connected; No internal connection to the chip
12/13	OUT1	Output 1 protected high-side power output of channel 1
PAD	Vbb	Supply voltage;Positive power supply voltage

7.Block Diagram



8.Absolute Maximum Ratings

T_j = 25°C; (unless otherwise specified)

Parameter	Symbol	Values	Unit
Supply voltage	V_{bb}	63	V
Load dump protection $V_{LoadDump}=V_A+Vs$, $R_I=2\Omega$, $t_d=200ms$, V_{IN}=low or high, $V_A=13.5V$, $R_L=1.1\Omega$	$V_{Loaddump}$	80	V
Power dissipation(DC)	P_{tot}	3	W
Junction temperature	T_j	-40 to 150	℃
Ambient temperature	T_a	-40 to 125	℃
Storage temperature	T_{stg}	-55 to 150	℃
Thermal resistance junction - ambient (free air):	R_{thJA}	134.7	K/W

Notes:

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

9.Electrical Characteristics

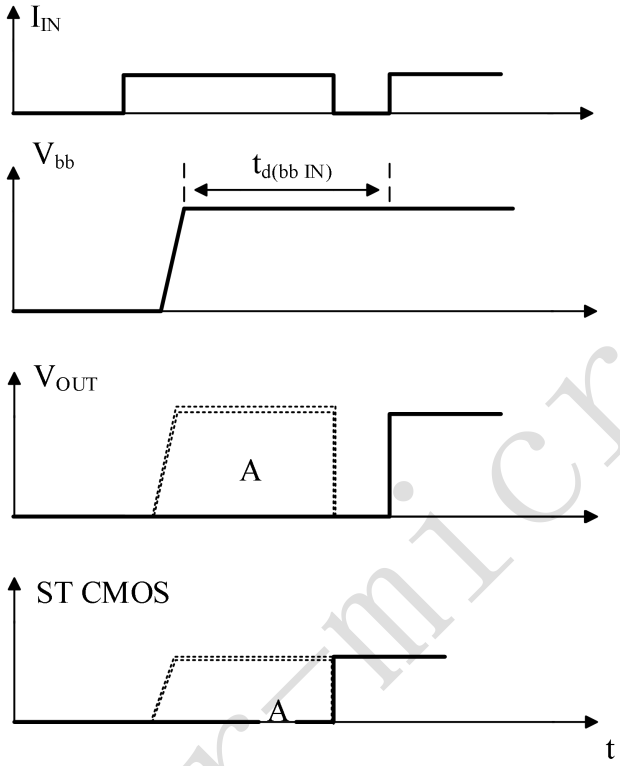
T_j = 25°C, V_{bb}=24V; (unless otherwise specified)

Symbol	Parameter	Test Condition	Values			Unit
			Min	Typ	Max	
R_{on}	On-state resistance	I_L=2A;V_{bb}>7V;T_j=25℃, (one channel)	-	90	150	mΩ
		I_L=2A;V_{bb}>7V;T_j=150℃, (one channel)		220	300	
		I_L=2A;V_{bb}>7V;T_j=25℃, (two parallel channels)		45	75	
$I_{L(NOM)}$	Nominal load current	T_A=85℃;T_j<150℃, (one channel)	2.5	2.9	-	A
		T_A=85℃;T_j<150℃, (two parallel channels)	4	4.2	-	A
$I_{L(GNDhigh)}$	Output current	V_{IN}=0V GND disconnected or pulled up	-	-	1	mA
t_{on}	Turn-ON time	R_L=12Ω, V_{IN}Turn-ON time to 90% V_{OUT}	-	-	130	us
t_{off}	Turn-OFF time	R_L=12Ω, V_{IN}Turn-OFF time to 10% V_{OUT}	-	-	80	us
$dV/dt_{(on)}$	Turn-ON Slew rate	R_L=12Ω, From 10% to 30% V_{OUT}	2	4	-	V/us
$dV/dt_{(off)}$	Turn-OFF Slew rate	R_L=12Ω, From 70% to 40% V_{OUT}	2	7	-	V/us
$V_{bb(on)}$	Operating voltage	T_j=-40...+150℃	4.5	-	42	V
$V_{bb(under)}$	Undervoltage shutdown	T_j=-40...+150℃	2.9	-	4.3	V
$V_{bIN(urst)}$	Undervoltage restart of charge pump	T_j=-40...+150℃	2.9	-	5.1	V
$\Delta V_{bb(under)}$	Undervoltage threshold	$\Delta V_{bb(under)}=V_{bIN(urst)}-V_{bb(under)}$ T_j=-40...+150℃	-	0.2	-	V
$I_{bb(off)}$	Standby current	V_{IN}=0, I_{ST}=0, T_j=25℃	-	-	23	uA
$I_{L(SCp)}$	Initial peak short circuit current limit	one channel	-	15	-	A
		two parallel channels	-	15	-	A
$t_{d(SC)}$	Short circuit shutdown delay after input pos. slope	V_{ON}>$V_{ON(SC)}$, T_j=-40...+150℃	80	-	400	us
$V_{ON(CL)}$	Output clamp (inductive load switch off)	V_{OUT}=V_{bb}-$V_{ON(CL)}$, I_L=30mA	50	60	70	V
T_{jt}	Thermal overload trip temperature		150	-	-	℃
$V_{bb(over)}$	Overvoltage shutdown	T_j=-40...+150℃	42	-	52	V
$V_{bb(o\ rst)}$	Overvoltage restart	T_j=-40...+150℃	42	-	-	V
$\Delta V_{bb(over)}$	Overvoltage hysteresis	T_j=-40...+150℃	-	0.2	-	V
$V_{bb(AZ)}$	Overvoltage protection	I_{bb}=4mA T_j=-40...+150℃	63	67	-	V

$I_{L(off)}$	Leakage output current (included in $I_{bb(off)}$)	V_{IN}=0	-	-	15	uA
I_{GND}	Operating current	V_{IN}=5V, (one channel)	-	0.6	1	mA
		V_{IN}=5V, (two parallel channels)	-	1.2	2	mA
$-V_{bb}$	Reverse battery voltage		-	-	32	V
$V_{IN(ON)}$	Input turn-on threshold voltage	T_j=-40...+150℃	1.5	-	2.4	V
$V_{IN(OFF)}$	Input turn-off threshold voltage	T_j=-40...+150℃	1.0	-	-	V
ΔV_{IN}	Input threshold hysteresis	T_j=-40...+150℃	0.2	0.5	0.6	V
$I_{IN(off)}$	Off state input current	V_{IN}=0.4V	10	-	30	uA
$I_{IN(on)}$	On state input current	V_{IN}=5V	10	-	50	uA
$t_{d(ST)}$	Status invalid after positive input slope	T_j=-40...+150℃	-	-	1000	us
$I_{L(OL)}$	Open load detection current		-	-	200	mA
$V_{ST(high)}$	Status output (CMOS)	T_j=-40...+150℃,I_{ST}=-50uA	4.4	5.1	6.5	V
$V_{ST(low)}$		T_j=-40...+150℃,I_{ST}=1.6mA	-	-	0.4	V
$-I_{ST}$		current source (out)	-	-	0.25	mA
$+I_{ST}$		current sink (in)	-	-	1.6	mA

10.Timing diagrams

Figure 1a: Vbb turn on



In case of too early V_{IN}=high the device may not turn on (curve A)

Figure 2a:Switching a lamp

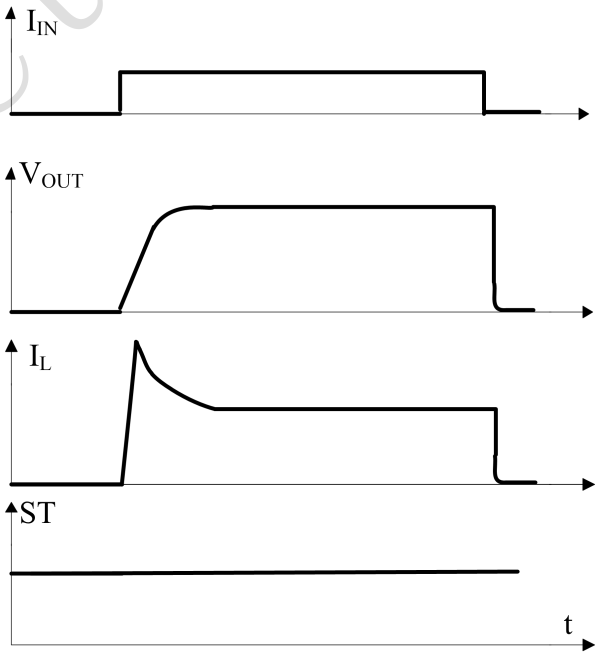


Figure 2b:Switching an inductive load

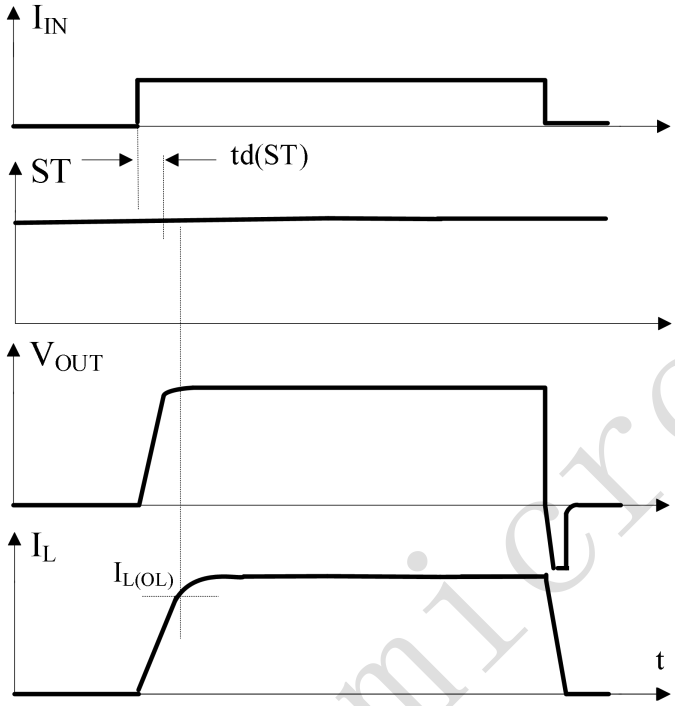
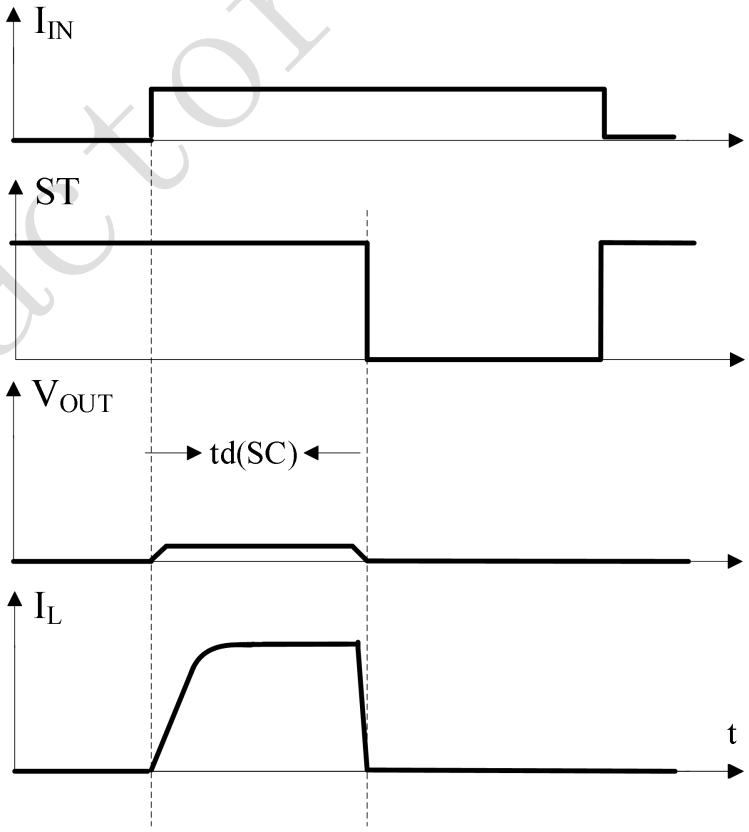


Figure 3a:Short circuit



V_{bb}-V_{OUT}>8.3V, $t_{d(SC)}$=200us

Figure 3b: Turn on into overload

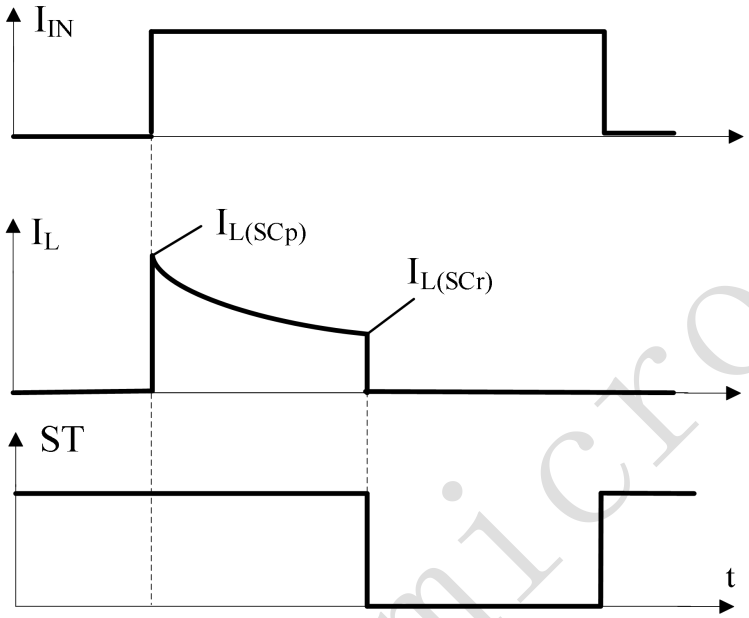


Figure3c: Short circuit while on

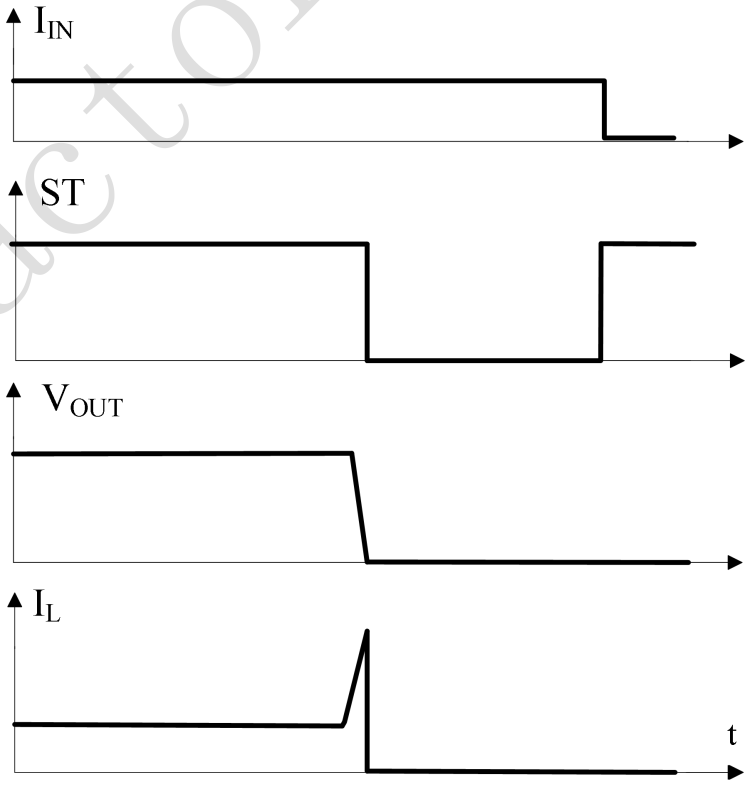


Figure4a: Overtemperature

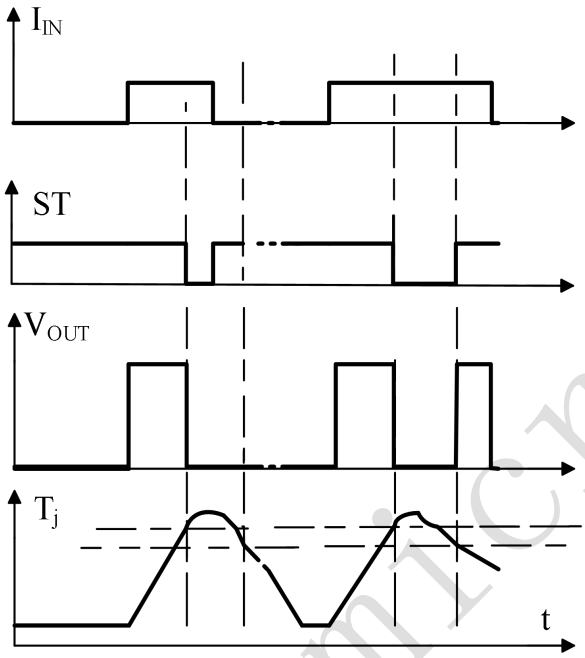


Figure5a: Open load: detection in ON-state, turn on/off to open load

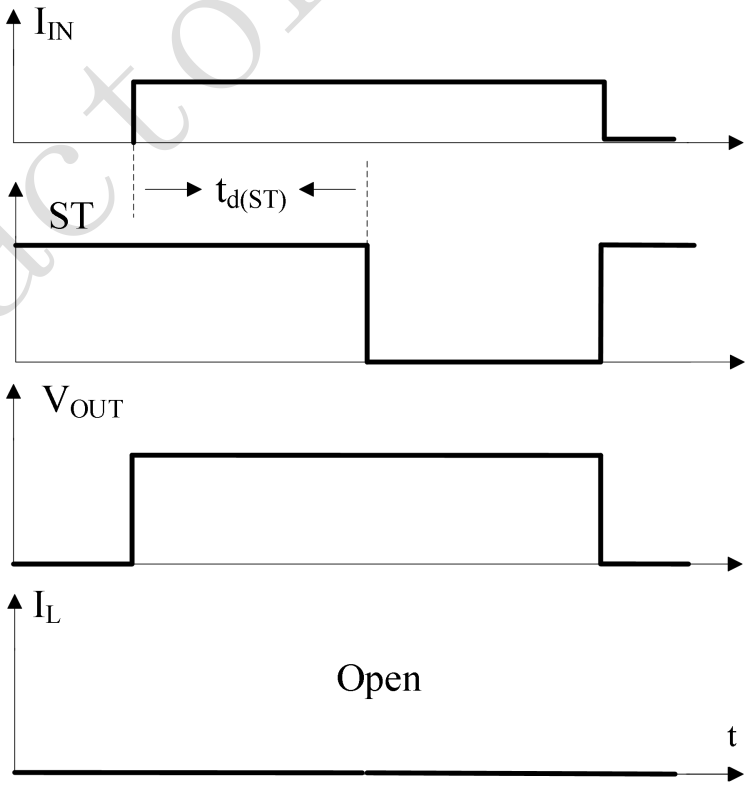


Figure5b: Open load: detection in ON-state, open load occurs in on-state

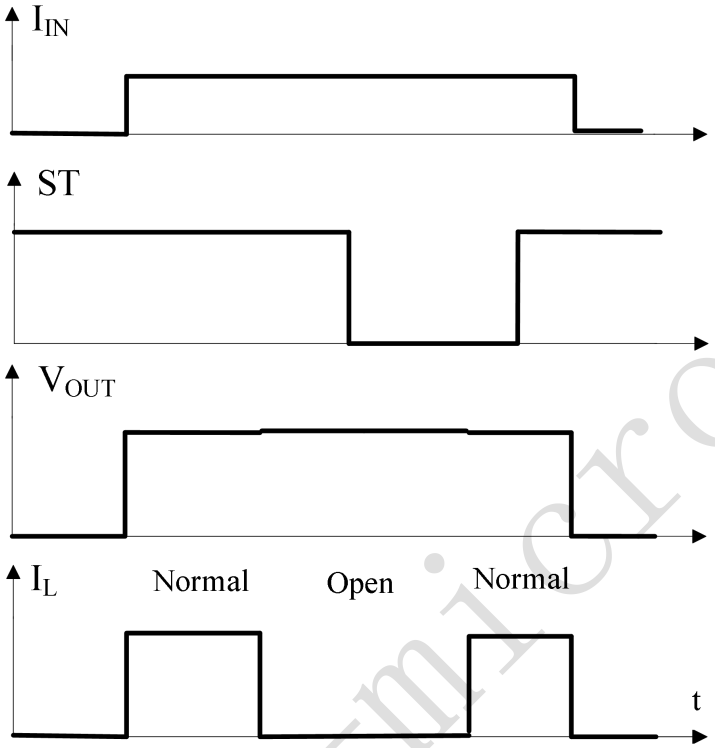


Figure6a: Undervoltage

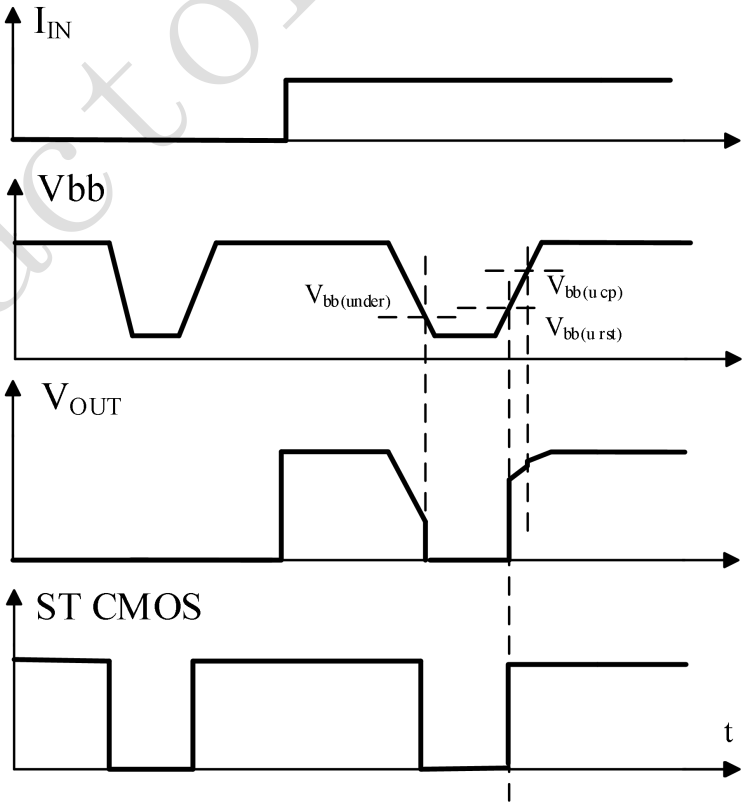


Figure6b:Undervoltage restart of charge pump

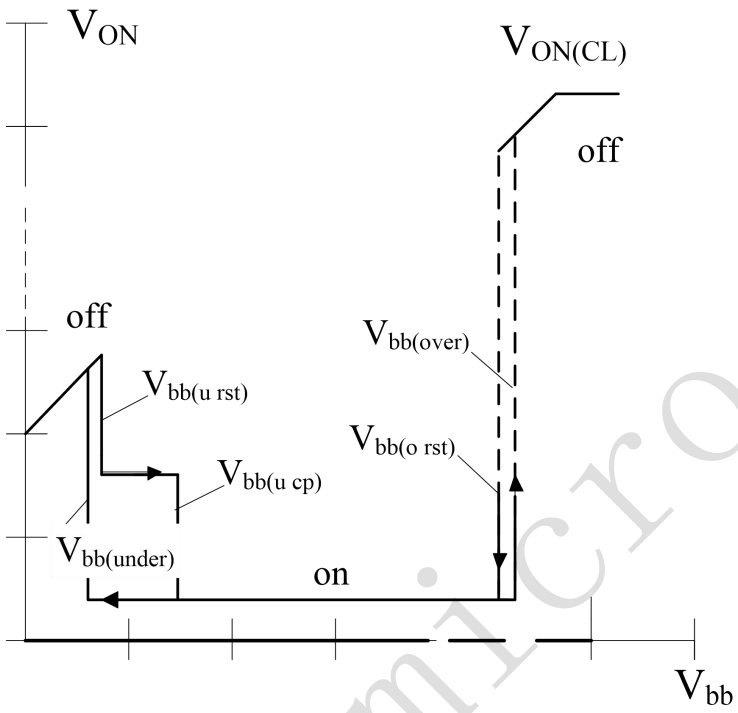
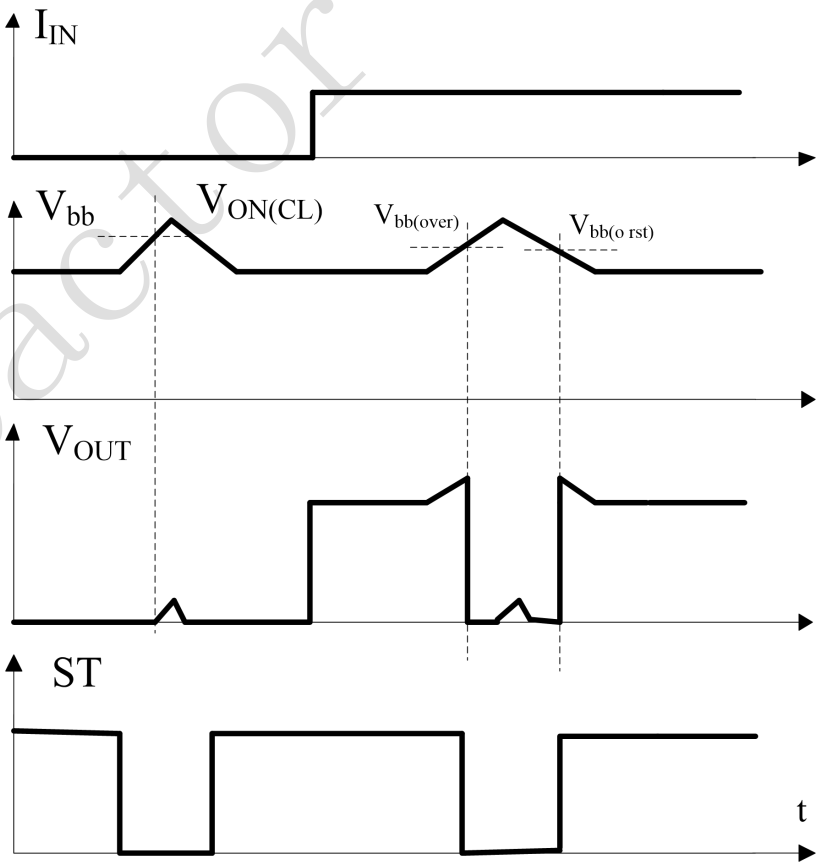


Figure7a: Overvoltage



11.Truth Table

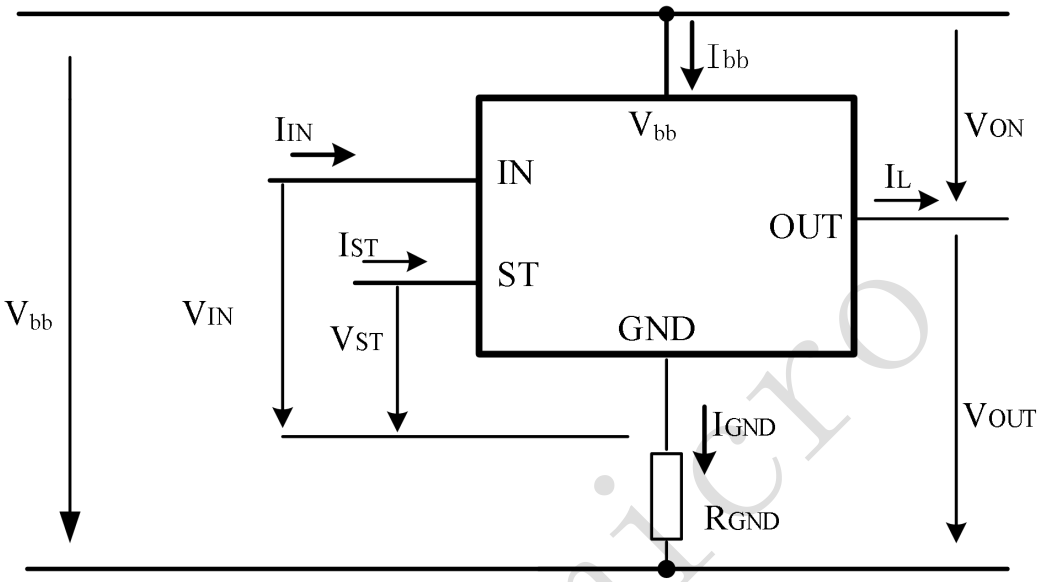
Channel1	Input1	Output1	Status1
Channel2	**Input2**	**Output2**	**Status2**
Operation Mode	Input	output	status
Normal operation	L H	L H	H H
Open Load	L H	Z[1)] H	H L
Short circuit to GND	L H	L L	H L
Short circuit to Vbb	L H	H H	H L[2)]
Overtemperature	L H	L L	H L
Undervoltage	L H	L L	L[3)] L[3)]
Overvoltage	L H	L L	H H

L = "Low" Level, H = "High" Leve

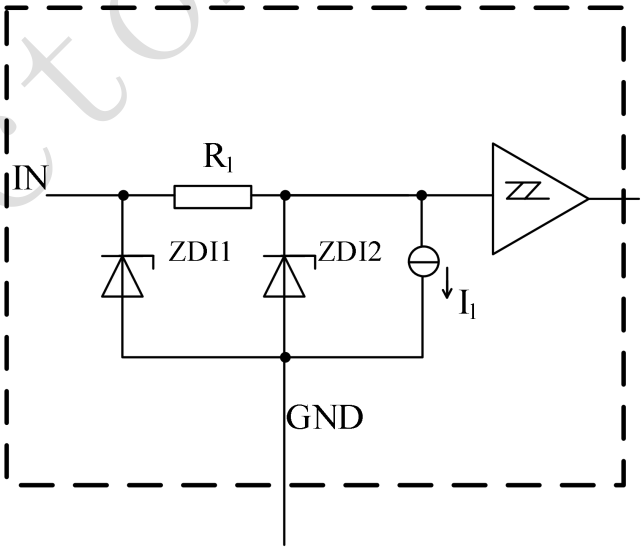
1) Power Tube Off, Output High Resistance
2) When the low resistance is short of vbb and out, it can be detected by the open circuit detection function
3) Undervoltage shutdown without sinking current capability

12.Functions

12.1 Terms

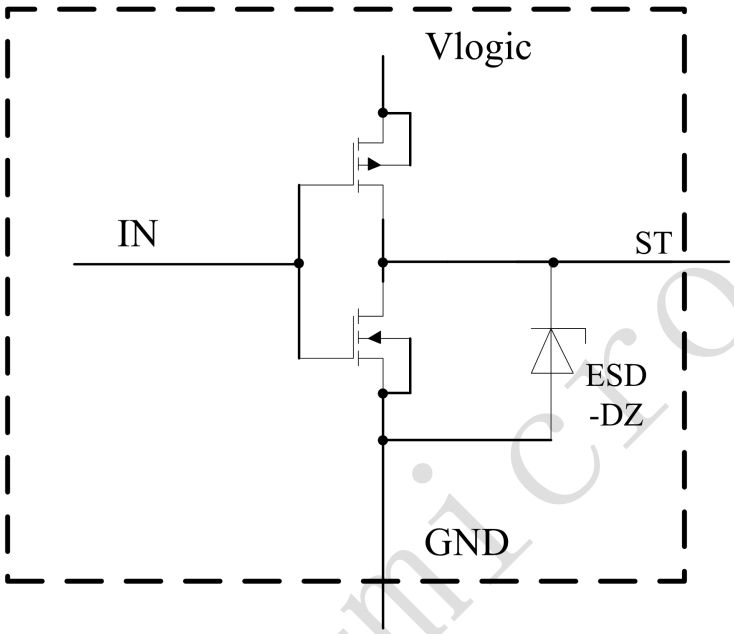


12.2 Input circuit (ESD protection)



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

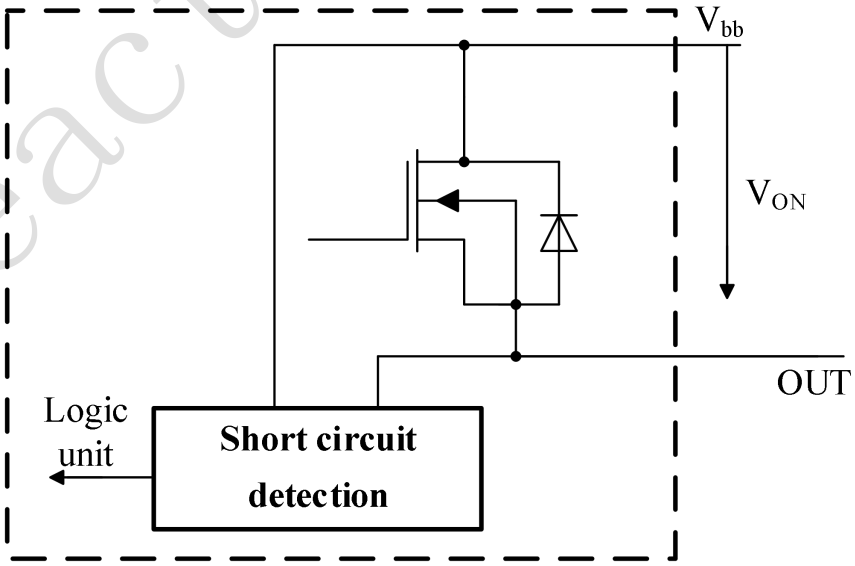
12.3 Status output



ESD-Zener diode: 6.1 V typ; Vlogic:5V typ

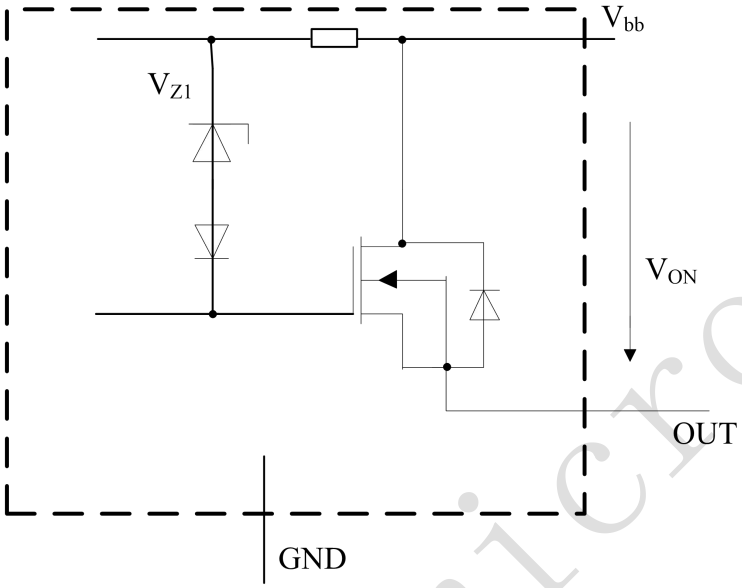
The use of ESD zener diodes as voltage clamp at DC conditions is not recommended.

12.4 Short circuit detection



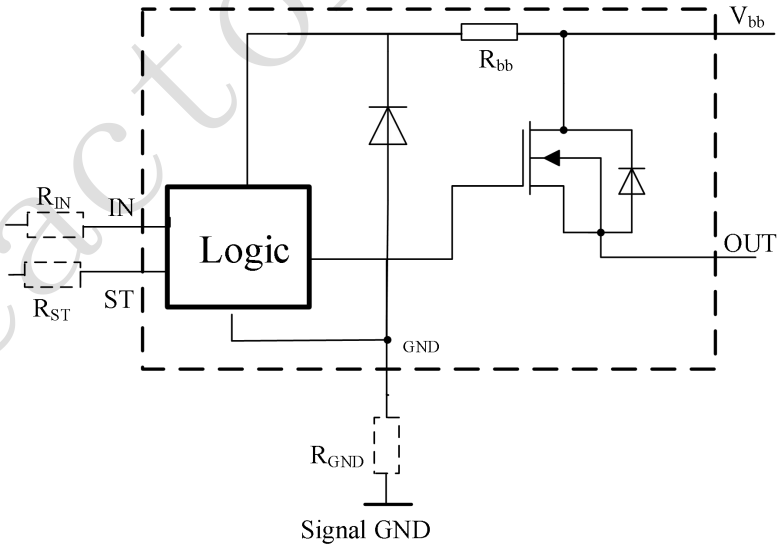
Fault Signal at ST-Pin: V_{ON}>$V_{ON(SC)}$ typ

12.5 Inductive and overvoltage output clamp



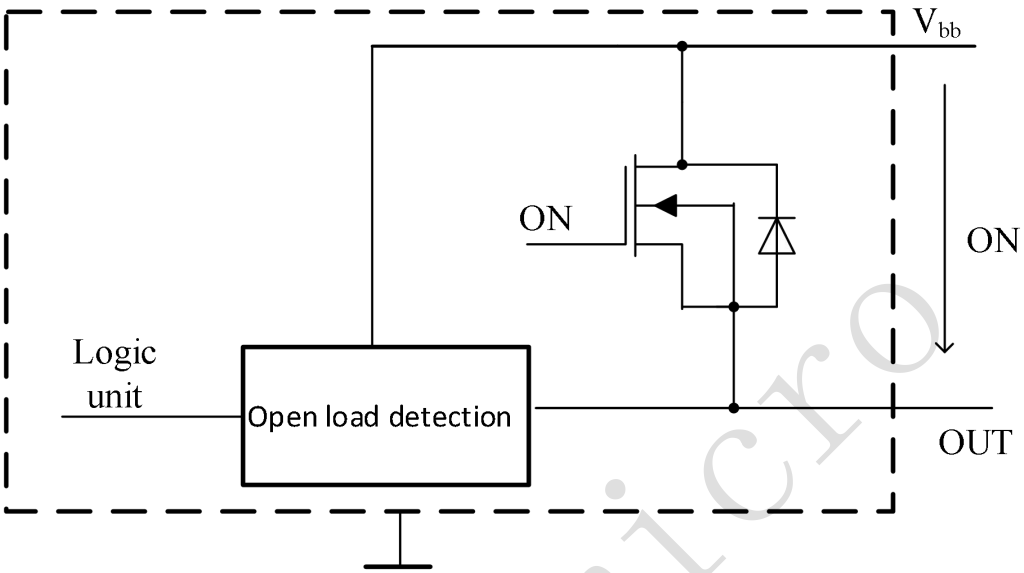
V_{ON} is clamped to $V_{ON(CL)}$ =60V typ

12.6 Overvoltage reverse battery protection



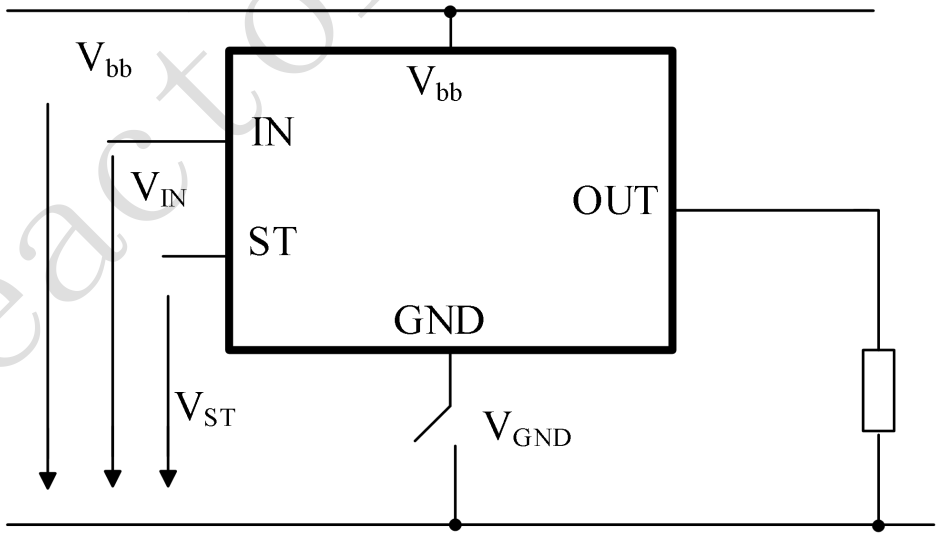
R_{bb}=120Ω typ, V_Z+R_{bb}*40mA=67V typ.

12.7 Open load detection

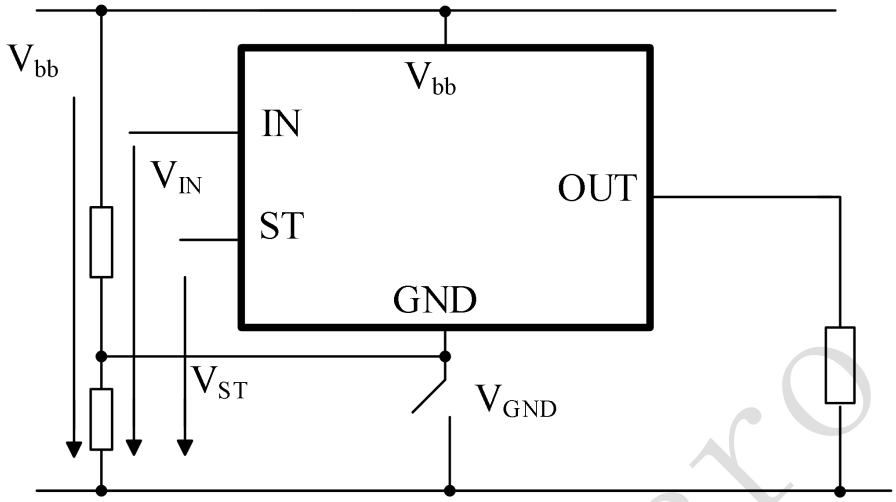


Fault Condition: $V_{ON}<R_{ON}*I_{L(OL)}$

12.8 GND disconnect

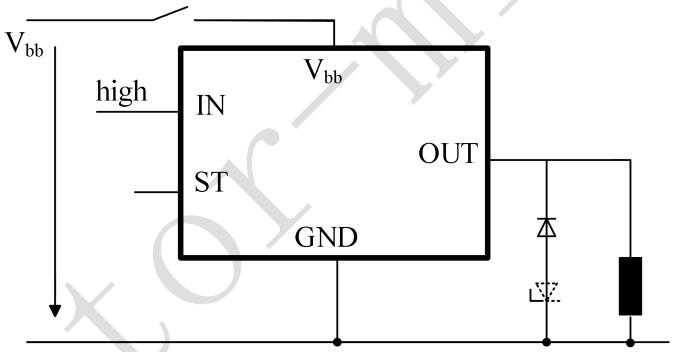


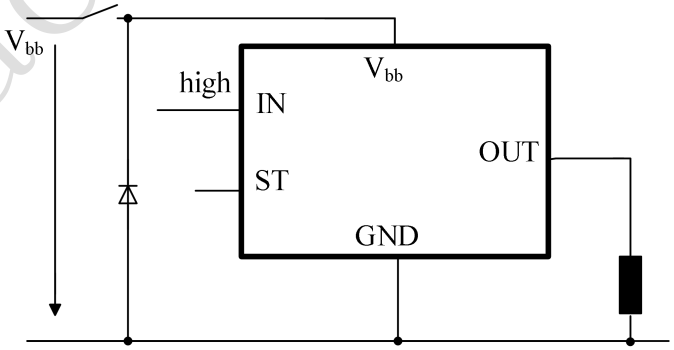
12.9 GND disconnect with GND pull up



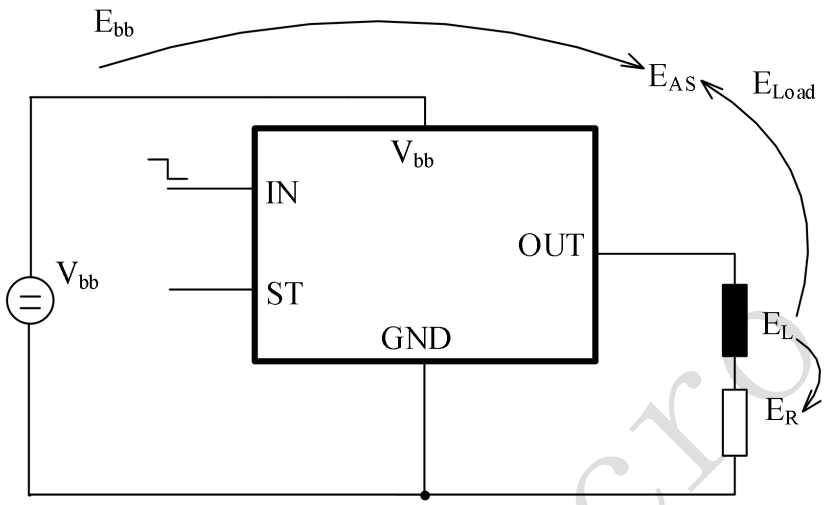
If V_{GND} > V_{IN} - $V_{IN(ON)}$ device stays off Due to V_{GND} > 0, no V_{ST} = low signal available.

12.10 Vbb disconnect with energized inductive load





12.11 Inductive load switch-off energy dissipation



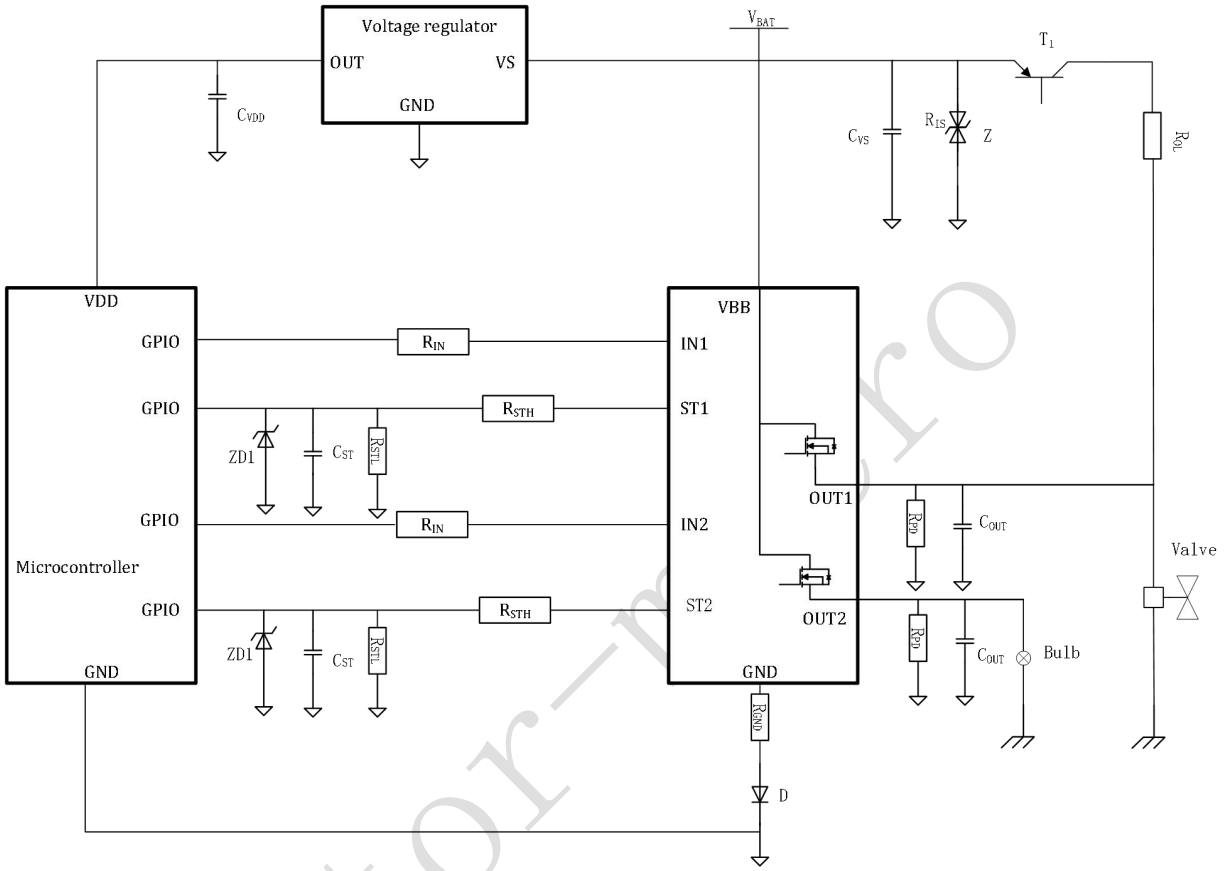
While demagnetizing load inductance, the energy dissipated in RM77090DD is :

$$E_{AS} = E_{bb} + E_L - E_R$$

$$E_{Load} < E_L$$

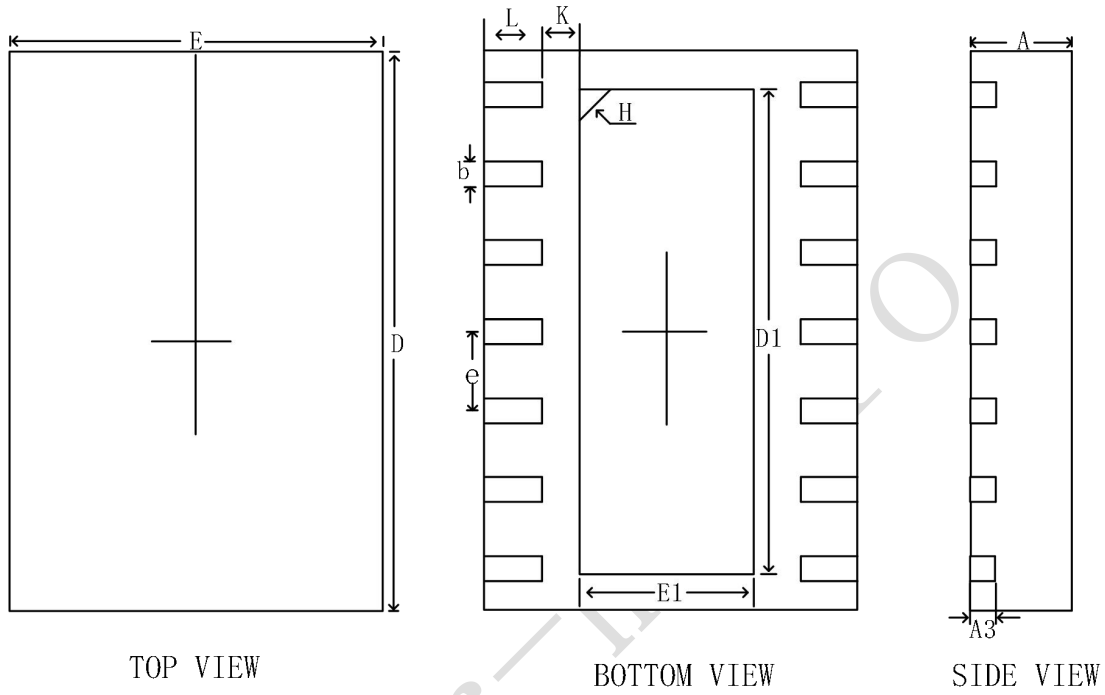
$$E_L = \frac{I_L^2 * L}{2}$$

13.Application Information



14.Package

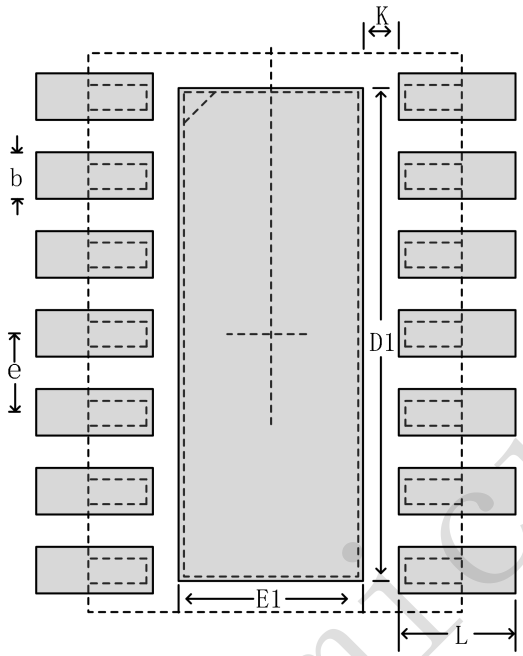
DFN9*6-14L



Unit :mm

Symbol	MIN	NOM	MAX
E	5.800	6.000	6.200
D	8.800	9.000	9.200
E1	2.775	2.800	2.825
D1	7.775	7.800	7.825
K	0.575	0.6	0.625
b	0.375	0.400	0.425
e	-	1.270	-
A	0.900	1.000	1.120
A3	-	0.250	-
L	0.975	1	1.025

15.Recommended Soldering Footprint



Unit : mm

Symbol	NOM	Symbol	NOM
E1	2.9	b	0.5
D1	8.0	e	1.27
K	0.5	L	1.3

16.Revision History

Version	Change Description	Date
1.0	Initial Version	2024/08/07