1.Basic Features

- Very low stand-by current
- 3.3 V and 5 V compatible logic inputs
- Electrostatic discharge protection (ESD)
- Optimized electromagnetic compatibility
- Logic ground independent from load ground
- Very low power DMOS leakage current in OFF state
- Green Product (RoHS compliant)
- AEC-Q100 qualified

2.Description

The RM77030DS is a 30 mΩ single channel Smart High-Side Power Switch, embedded in a DFN9*6-14L, providing protective functions and diagnosis. The power transistor is built by an N-channel vertical power MOSFET with charge pump.

3.Application

- Suitable for resistive, inductive and capacitive loads
- Replaces electromechanical relays, fuses and discrete circuits
- Most suitable for loads with high inrush current, such as lamps
- Suitable for 12 V and 24 V trucks and transportation system

4.Product Summary

Overvoltage protection	$V_{S(AZ)}$	70	V
Operating voltage	$V_{S(OP)}$	5...48	V
On-state resistance	R_{ON}	30	mΩ
Nominal load current	$I_{L(NOM)}$	6	A
Short circuit current limitation	$I_{L(SC)}$	60	A
Typical current sense ratio	$I_L:I_{IS}$	2600	

5.Ordering Code

Device	Package Type	Marking	Materials	Package			Package Qty
RM77030DS	DFN9*6-14L	RM77030DS	Halogen free	Tape&reel	10 reels/box	30k/box	3000/reel

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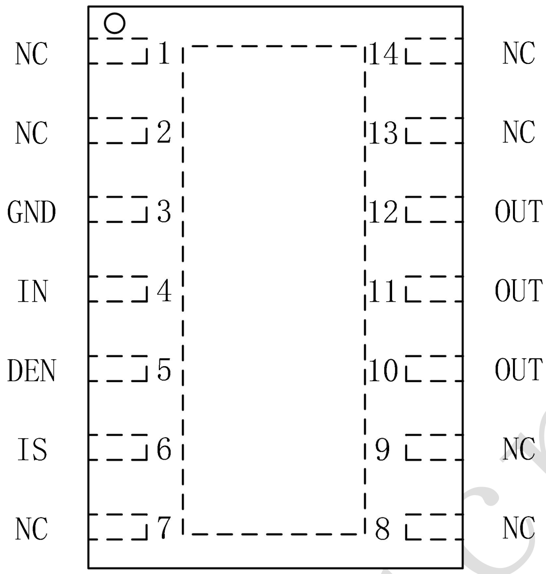
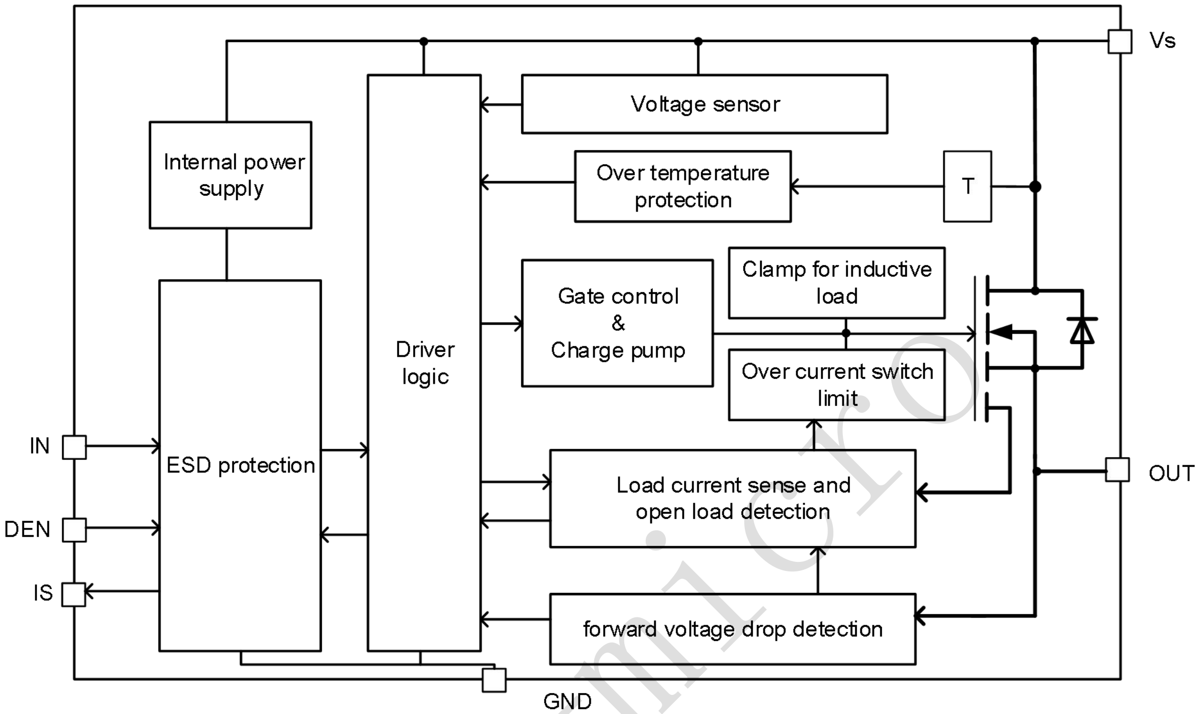
6.Pin Configuration



Pin	Symbol	Function
1/2/7/8/9/13/14	NC	Not Connected; No internal connection to the chip
3	GND	GrouND; Ground connection
4	IN	Input channel;Input signal for channel activation
5	DEN	Diagnostic ENable; Digital signal to enable/disable the diagnosis of the device
6	IS	Sense; Sense current of the selected channel
10/11/12	OUT	OUTput ; Protected high side power output channel
PAD	VS	Voltage Supply; Battery voltage

7.Block Diagram



8.Absolute Maximum Ratings[1)]

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

Parameter	Symbol	Values	Unit
Supply voltage	V_S	48	V
Supply voltage for shortcircuit protection	V_{bb}	36	V
Supply voltage for Load dump protection	$V_{S(LD)}$	65	V
Power dissipation(DC)	P_{TOT}	1.6	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}	146	K/W

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.

9.Electrical Characteristics

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

Symbol	Parameter	Test Condition	Values Min	Values Typ	Values Max	Unit
R_{ON}	ON-state resistance	I_L=7A, V_{IN}=4.5V, T_j=150℃	-	55	62	mΩ
		T_j=25℃	-	-	30	
$V_{DS(NL)}$	Output voltage drop limitation at small load currents	V_S=28V, I_L=50mA	-	10	22	mV
Supply Voltages:						
V_S	Supply voltage	V_{IN}=4.5V, R_L=12Ω, V_{DS}<0.5V	5	-	48	V
$V_{S(AZ)}$	Overvoltage protection	I_{SOV}=5mA	65	70	75	V
$V_{S(UV)}$	Undervoltage shutdown	V_{IN}=4.5V, R_L=12Ω, From V_{DS}<1V to I_{OUT}=0A	2.9	3.9	5	V
$V_{S(OP)\_MIN}$	Minimum functional supply voltage	V_{IN}=4.5V, R_L=12Ω, From I_{OUT}=0A to V_{DS}<0.5V	3.7	4.5	5	V
$I_{L(NOM)}$	Nominal load current	T_a=85℃, T_j<150℃	-	6	-	A
$I_{S(OFF)}$	Standby current for whole device with load	V_S=36V, V_{OUT}=0V, T_j≤85℃, V_{IN}, V_{DEN} floating	-	0.1	0.5	uA
$I_{S(OFF)\_150}$	Maximum standby current for whole device with load	V_S=36V, V_{OUT}=0V, T_j=150℃, V_{IN}, V_{DEN} floating	-	-	15	uA
$V_{DS(AZ)}$	Drain to source clamping voltage	I_{DS}=20mA	65	70	75	V
$I_{L(OFF)}$	Output leakage current	V_{IN} floating V_{OUT}=0V, T_j≤85℃	-	0.05	0.5	uA
$I_{OUT(GND)}$	Output leakage current while GND disconnected	V_S=36V	-	-	5	uA
I_{GND}	Operating current channel active	V_S=36V, V_{IN}=V_{DEN}=5.5V	-	1	3	mA
Input logic signal						
$V_{IN(H)}$	High level input voltage range		1.4	-	2.3	V
$V_{IN(L)}$	Low level input voltage range		0.9	-	1.9	V
$V_{IN(HYS)}$	Input voltage hysteresis		-	0.4	-	V
$I_{IN(H)}$	High level input current	V_{IN}=5.5V	1	10	25	uA
$I_{IN(L)}$	Low level input current	V_{IN}=0.8V	1	5	25	uA
$V_{DEN(H)}$	DEN High level input voltage range		1.4	-	2.3	V
$V_{DEN(L)}$	DEN Low level input voltage range		0.9	-	1.9	V
$V_{DEN(HYS)}$	DEN Input voltage hysteresis		-	0.4	-	V
$I_{DEN(H)}$	DEN High level input current	V_{DEN}=5.5V	1	10	25	uA
$I_{DEN(L)}$	DEN Low level input current	V_{DEN}=0.8V	1	5	25	uA
dV/dt_{ON}	Turn-ON Slew rate	R_L=12Ω, V_S=28V, From 30% to 70%V_S	0.3	-	1.8	V/us

$-dV/dt_{OFF}$	Turn-OFF Slew rate	R_L=12Ω, V_S=28V, From70% to 30%V_S	0.3	-	1.8	V/us
t_{ON}	Turn-ON time	R_L=12Ω, V_S=28V From V_{IN}=V_{IN_H} to V_{OUT}=90%V_S	-	-	150	us
t_{OFF}	Turn-OFF time	R_L=12Ω, V_S=28V From V_{IN}=V_{IN_L} to V_{OUT}=10%V_S	-	-	150	us
Δt_{SW}	Turn-ON / OFF matching	t_{OFF}-t_{ON}, R_L=12Ω, V_S=28V	-50	0	50	us
t_{ON_delay}	Turn-ON delay time	R_L=12Ω, V_S=28V From V_{IN}=V_{IN_H} to V_{OUT}=10%V_S	-	30	70	us
t_{OFF_delay}	Turn-OFF delay time	R_L=12Ω, V_S=28V From V_{IN}=V_{IN_L} to V_{OUT}=90%V_S	-	30	70	us
Detection characteristic						
$t_{sIS(ON)}$	Current sense settling time to k_{ILIS} function stable after positive input slope on both INput and DEN	V_{DEN}=V_{IN}=0 to 4.5V, V_S=28V, R_{IS}=1.2kΩ, C_{SENSE}<100pF I_L=4A	-	-	150	us
$t_{sIS(ON\_DEN)}$	Current sense settling time with load current stable and transition of the DEN	V_{IN}=4.5V, V_{DEN}=0 to 4.5V, R_{IS}=1.2kΩ, C_{SENSE}<100pF, I_L=4A	-	-	65	us
$t_{sIS(LC)}$	Current sense settling time to I_{IS} stable after positive input slope on current load	V_{IN}=4.5V, V_{DEN}=4.5V, R_{IS}=1.2kΩ, C_{SENSE}<100pF, I_L=2A to I_L=4A	-	-	50	us
$I_{IS\_(DIS)}$	IS pin leakage current when sense is disabled	V_{IN}=4.5V, V_{DEN}=0V, I_L=7A	-	-	1	uA
$I_{IS(FAULT)}$	Sense signal maximum current in fault condition	V_{IS}=V_{IN}=0V, V_{OUT}=V_S>10V, V_{DEN}=4.5V	-	13	30	mA
$t_{sIS(FAULT\_OL\_OFF)}$	Current sense settling time to I_{IS} stable for open load detection in OFF state	V_{IN}=0V, V_{DEN}=0 to 4.5V, R_{IS}=1.2kΩ C_{SENSE}<100pF, V_{OUT}=V_S=28V	-	-	250	us
$t_{sIS(FAULT)}$	Current sense settling time to I_{IS} stable for overload detection	V_{IN}=V_{DEN}=0 to 4.5V, R_{IS}=1.2kΩ, C_{SENSE}<100pF, V_{DS}=24V	-	-	500	us
$t_{sIS(OFF)}$	Diagnostic disable time DEN transition to I_{IS} < 50% I_L /k_{ILIS}	V_{IN}=4.5V, V_{DEN}=4.5V to 0V R_{IS}=1.2kΩ, C_{SENSE}<100pF, I_L=4A	0	-	20	us
Protection function						
$I_{L5(SC)}$	Load current limitation	V_{DS}=5V	-	30	-	A
$I_{L28(SC)}$	Load current limitation	V_{DS}=28V	-	60	-	A
$T_{j(SC)}$	Thermal shutdown temperature		-	150	-	℃
V_S-$V_{OL(OFF)}$	Open load detection threshold in OFF state	V_{IN}=0V, V_{DEN}=4.5V	3	-	5	V
$V_{IS(AZ)}$	Sense pin maximum voltage	I_{IS}=5mA	65	70	75	V
k_{ILIS1}	Current sense ratio	I_{L1}=1.0A, T_j=25℃	1980	2650	3320	

k_{ILIS2}		I_{L2}=2.0A, T_j=25℃	2350	2680	3010	
k_{ILIS3}		I_{L3}=4.0A, T_j=25℃	2370	2600	2830	
k_{ILIS4}		I_{L4}=7.0A, T_j=25℃	2390	2600	2810	
E_{AS}	Maximum energy dissipation single pulse	I_L=6A, T_j=150℃, V_S=28V	-	-	85	mJ
$V_{DS(REV)}$	Drain source diode voltage during reverse polarity	I_L=-2A, T_j=150℃	200	510	700	mV

10.Timing diagrams

Figure 1: Switching a Resistive Load Timing

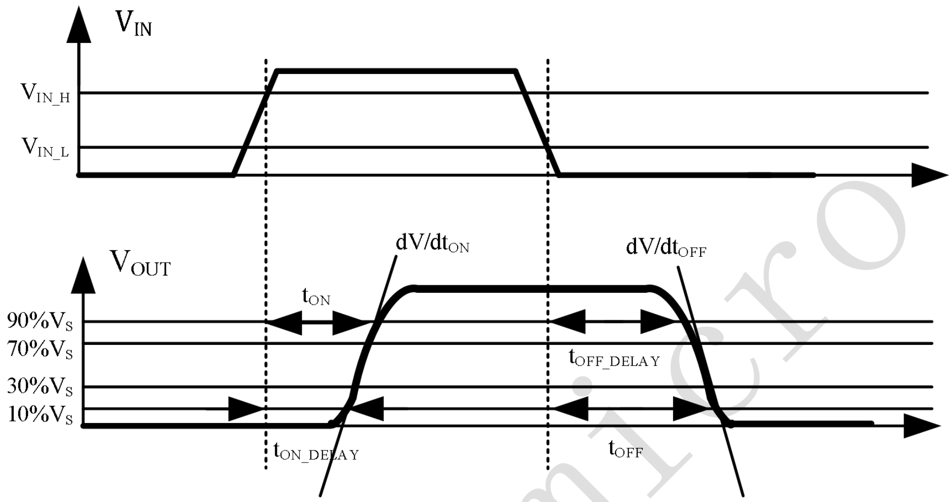


Figure 2: Switching an Inductive Load Timing

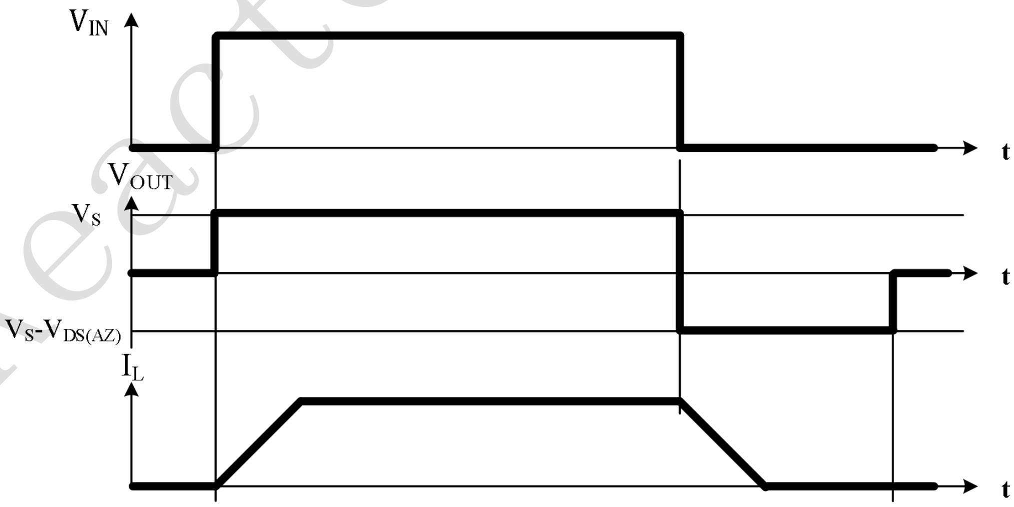


Figure 3: Current Sense Settling / Disabling Timing

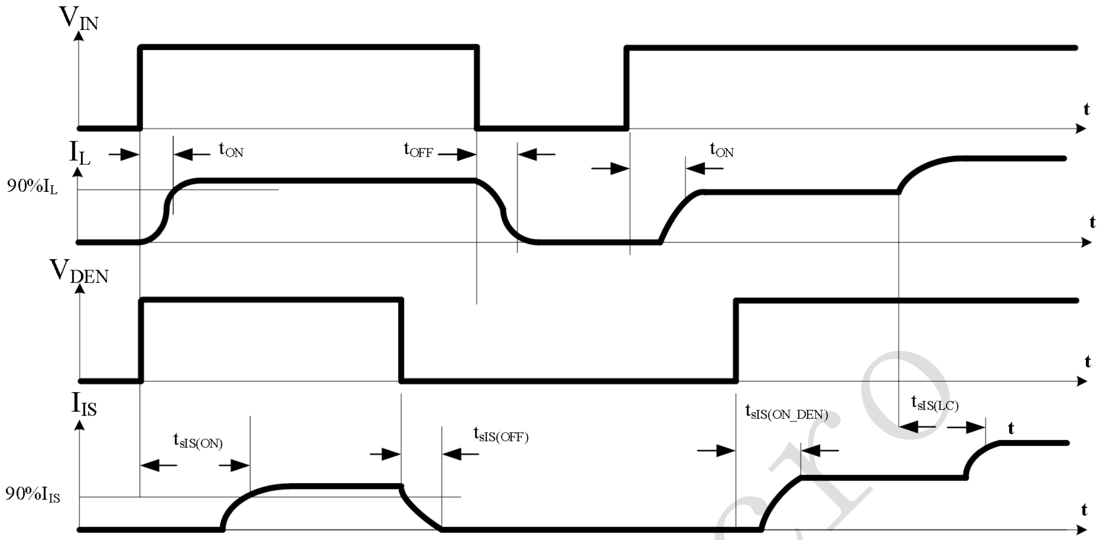


Figure 4: Sense Signal in Open Load Timing

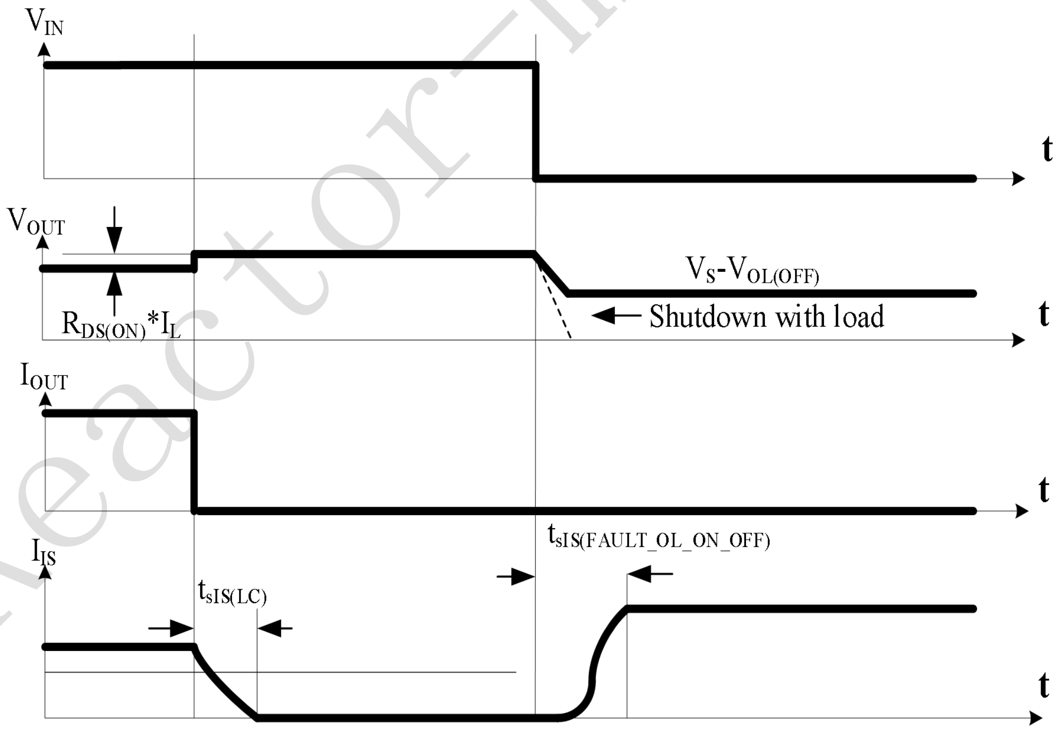


Figure 5: Over temperature Protection

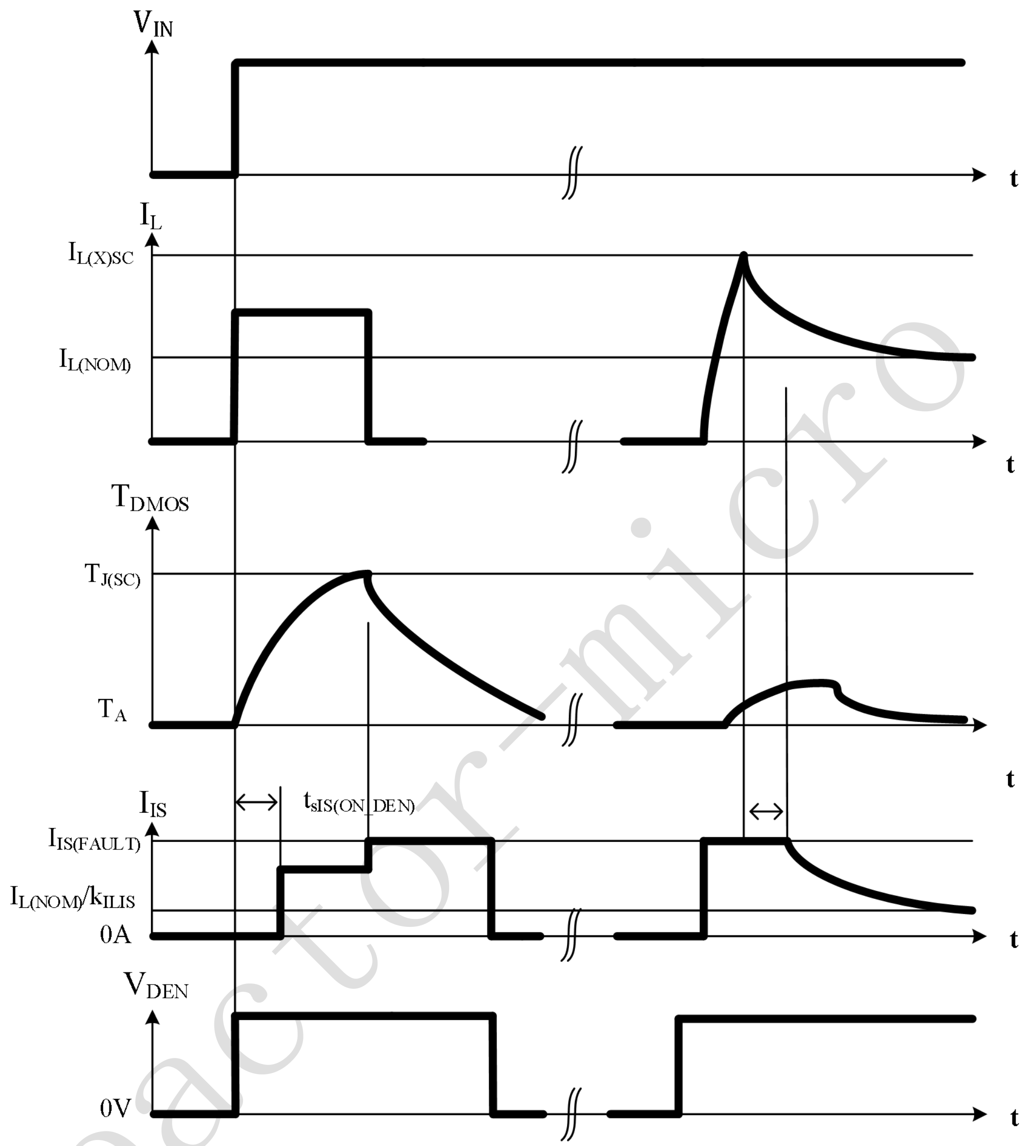
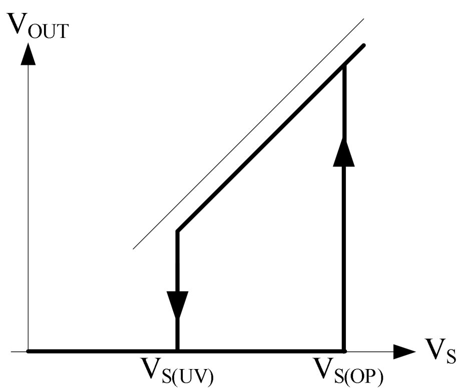


Figure 6: Undervoltage Behavior



11.Truth Table

Operation Mode	Input level Channel	DEN	Output Level	Diagnostic Output
Normal operation	L H	H	L ~V_S	L $I_{IS}=I_L/k_{ILIS}$
Short circuit to GND	L H	H	~GND ~GND	L $I_{IS(FAULT)}$
Overtemperature	L H	H	L L	L $I_{IS(FAULT)}$
Short circuit to V_S	L H	H	V_S V_S	$I_{IS(FAULT)}$ $I_{IS}<I_L/k_{ILIS}$
Open Load	L L H	H	$<V_{OL(OFF)}$ $>V_{OL(OFF)}$ 1) ~V_S 2)	L $I_{IS(FAULT)}$ $I_{IS}<I_{IS(OL)}$
Inverse current	L H	H	~V_{INV} ~V_{INV}	$I_{IS(FAULT)}$ $I_{IS}<I_{IS(OL)}$ 3)
Current limitation	H	H	$<V_S$	$I_{IS(FAULT)}$
Underload	H	H	~V_S 4)	$I_{IS(OL)}<I_{IS}<I_L/k_{ILIS}$

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

1) Stable with additional pull-up resistor.
2) The output current has to be smaller than $I_{L(OL)}$.
3) After maximum t_{INV} .
4) The output current has to be higher than $I_{L(OL)}$.

12.Functions

12.1 Terms

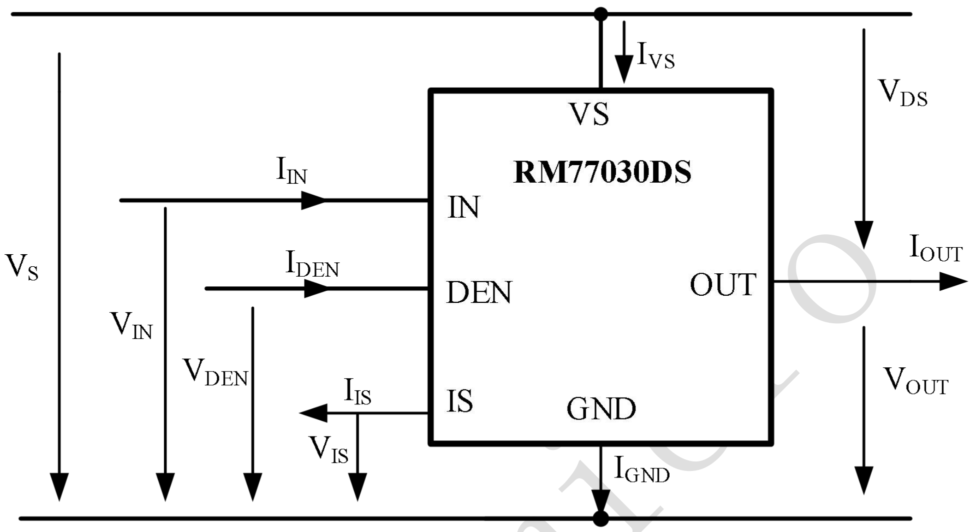
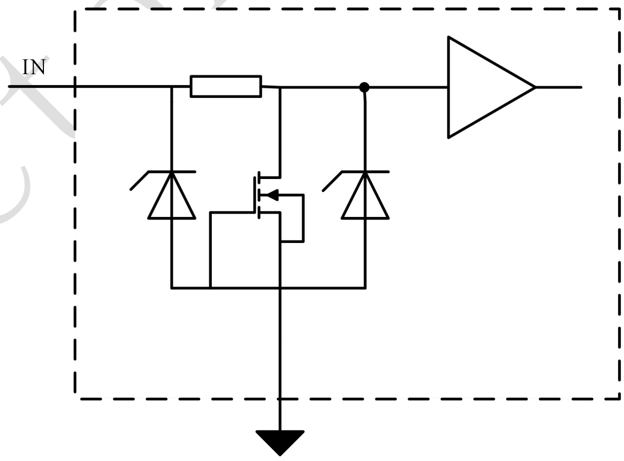


Figure shows voltage and current used in this data sheet.

12.2 Input circuit (ESD protection)

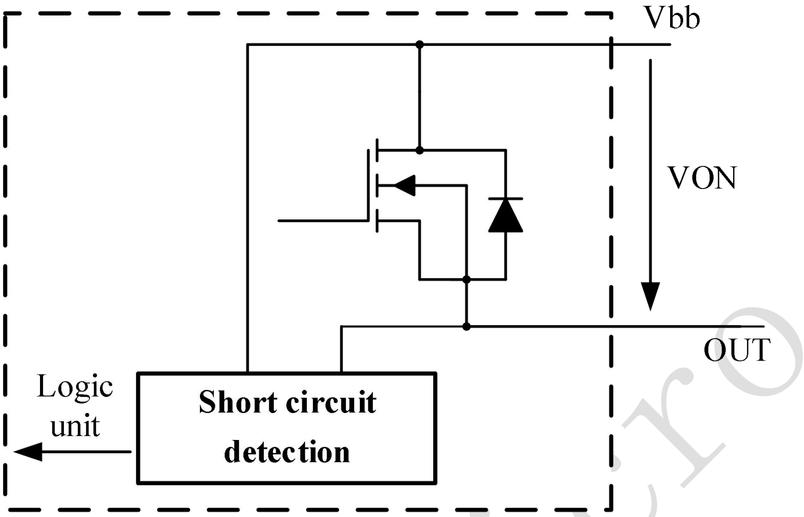


The input circuitry is compatible with 3.3 and 5V microcontrollers. An implemented Schmitt trigger avoids any undefined state if the voltage on the input pin is slowly increasing or decreasing

In case the pin is not needed, it must be left opened, or must be connected to device ground (and not module ground) via an input resistor.

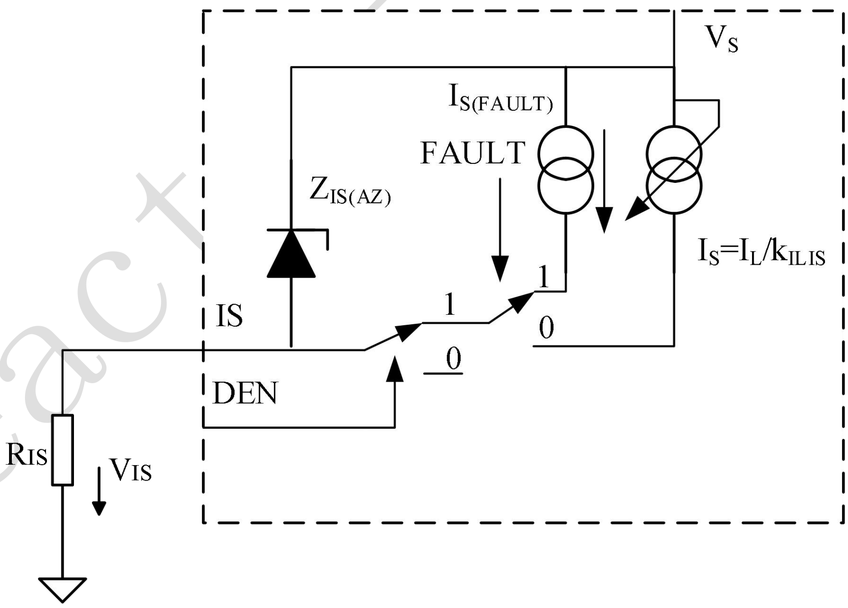
DEN pin have the same structure as IN pin.

12.3 Short circuit detection



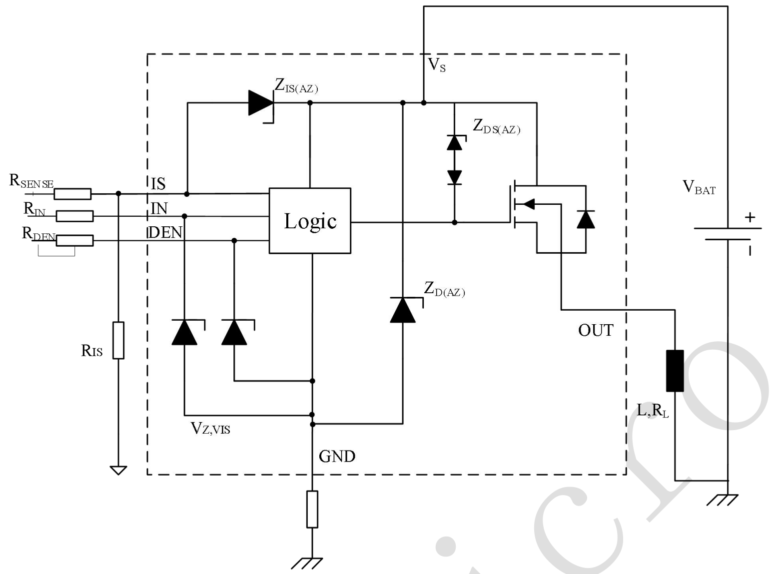
Short circuit detection condition:V_{ON}>$V_{ON(SC)}$ (typical value:6V), t>$t_{d(sc)}$(80-350)μs

12.4 Current detection output



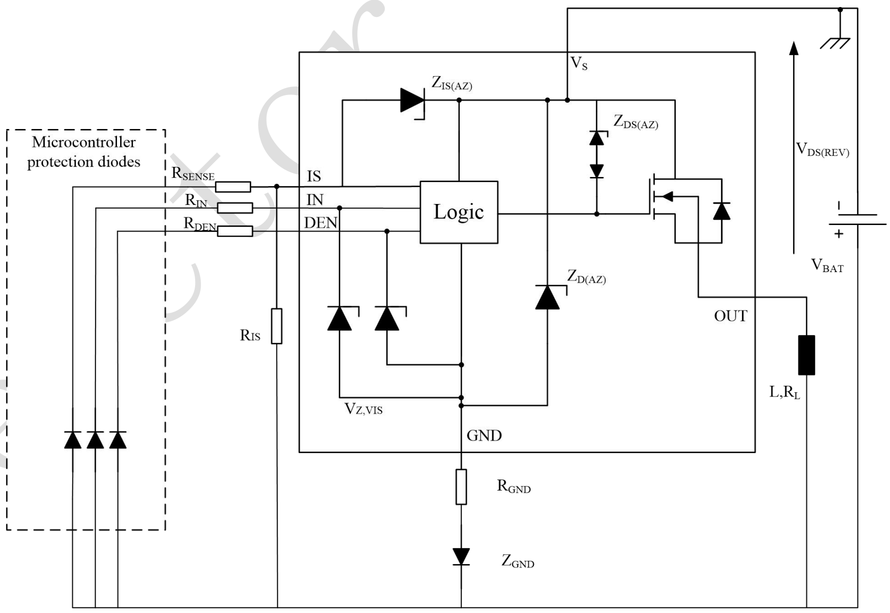
As long as no “hard” failure mode occurs a proportional signal to the load current (ratio k_{ILIS} = I_L / I_{IS}) is provided.The accuracy of the sense current depends on temperature and load current.

12.5 Overvoltage Protection



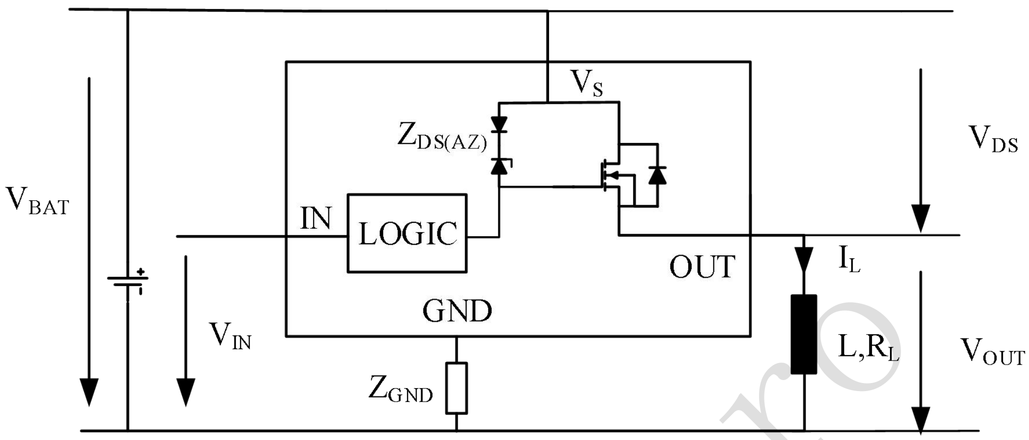
There is an integrated clamp mechanism for overvoltage protection ($Z_{D(AZ)}$). To guarantee this mechanism operates properly in the application, the current in the Zener diode has to be limited by a ground resistor.

12.6 Reverse Polarity Protection



In case of reverse polarity, the intrinsic body diode of the power DMOS causes power dissipation.The current in this intrinsic body diode is limited by the load itself.The current into the logic pins has to be limited to the external resistor.The recommended value for $R_{IN}=R_{DEN}=R_{SENSE}$=10K. Z_{GND} is recommended to be a resistor in series to a diode. During reverse polarity, no protection functions are available.

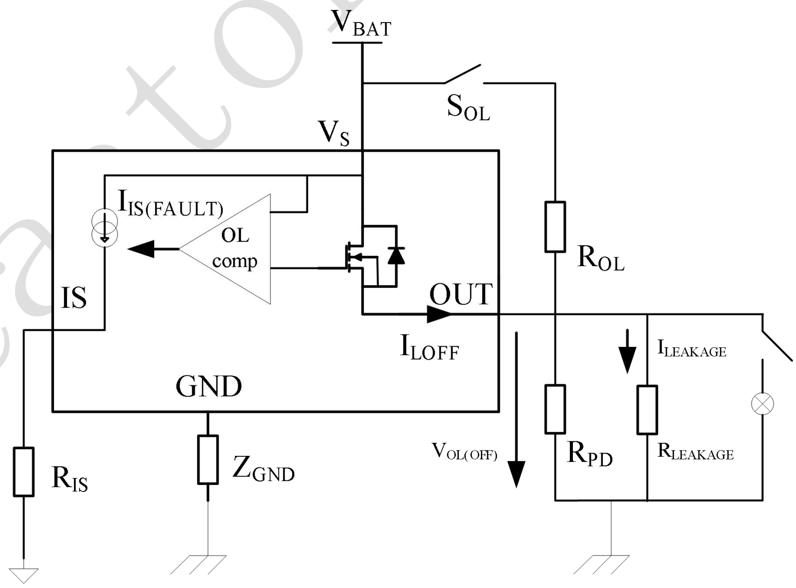
12.7 Output Clamping



When switching OFF inductive loads with high side switches, the voltage V_{OUT} drops below ground potential.To prevent the destruction of the device by avalanche due to high voltages, there is a voltage clamp mechanism $Z_{DS(AZ)}$ implemented that limits negative output voltage to a certain level (V_S - $V_{DS(AZ)}$).

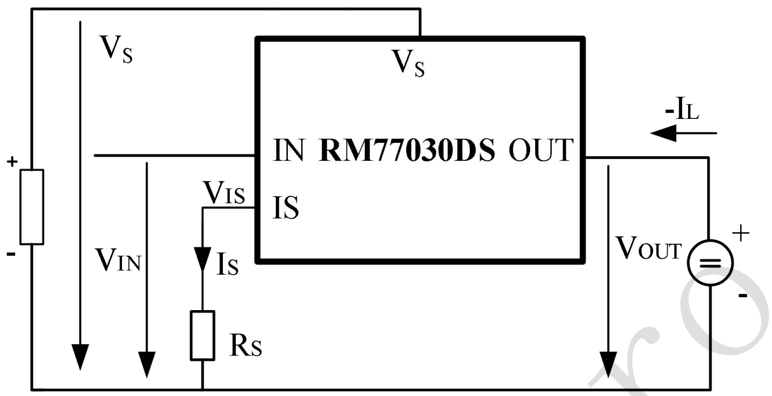
The maximum allowed load inductance is limited.

12.8 Open Load in OFF Diagnostic



For open load diagnosis in OFF-state, an external output pull-up resistor (R_{OL}) is recommended. For the calculation of pull-up resistor value, the leakage currents have to be taken into account.The voltage threshold is in $3V<V_S-V_{OL(OFF)}<6V$, IS pin keep $I_{IS(FAULT)}$.

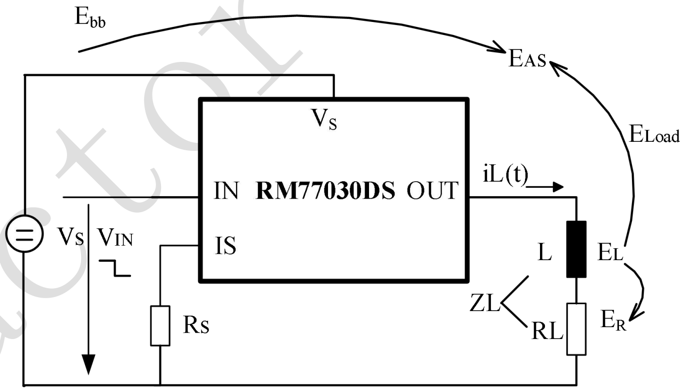
12.9 Reverse polarity load current



When V_{OUT}>V_S>0V, the device work reverse polarity.When the V_{IN} is high voltage, only the power diode is on, which will cause an increase in power consumption.

Note: During reverse polarity, no protection functions are available.

12.10 Inductive load switch-off energy dissipation



Energy stored in load inductance:

$$E = \frac{1}{2} * L * I^2$$

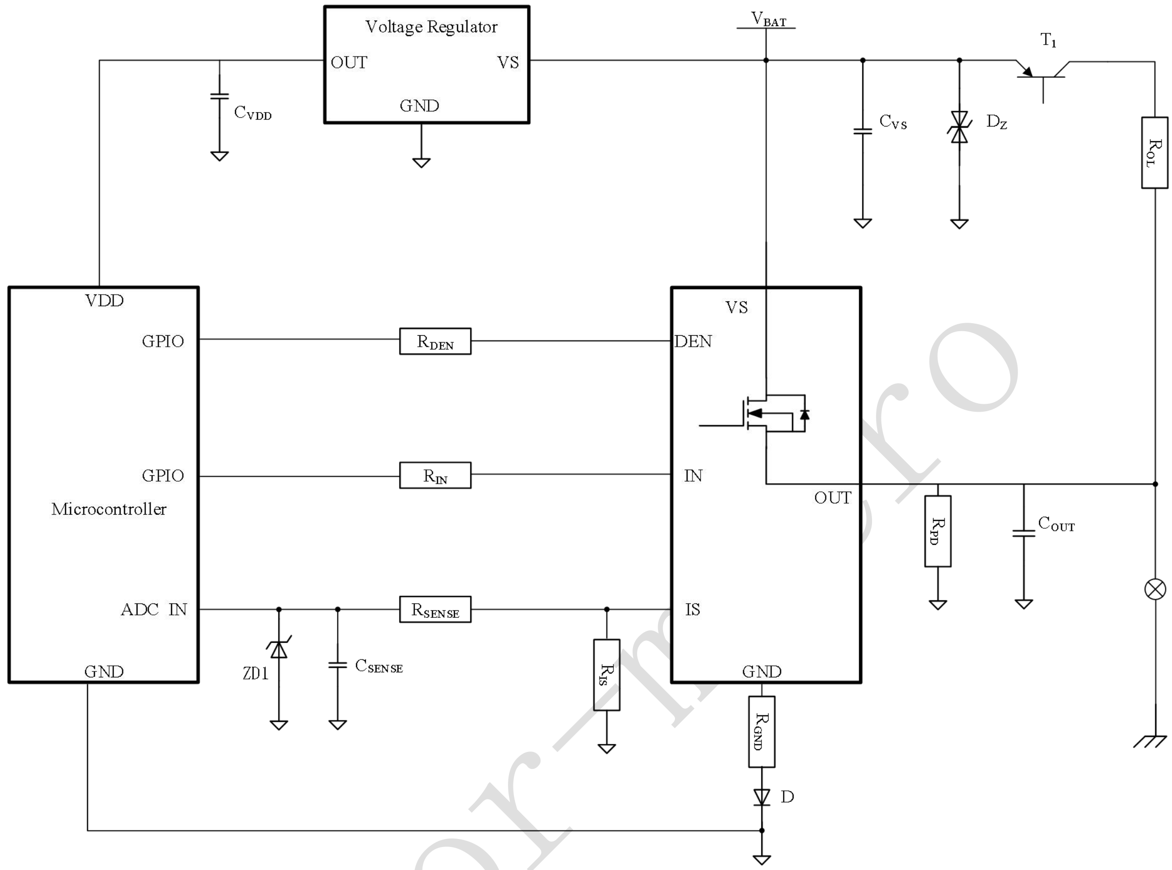
While demagnetizing load inductance, the energy dissipated in RM77030DS is:

$$E_{AS} = E_{bb} + E_L - E_R = \int V_{ON(CL)} * i_L(t)dt$$

with an approximate solution for RL > 0Ω:

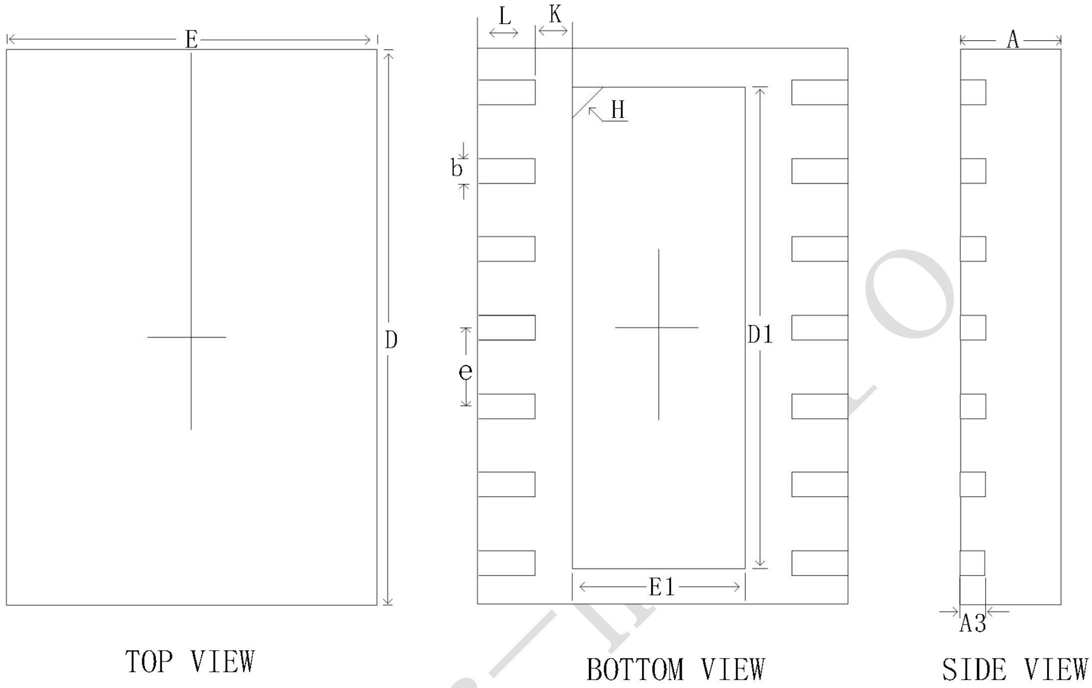
$$E_{AS} = \frac{I_L * L}{2 * R_L}(V_{bb} + |V_{OUT(CL)}|)\ln\left(1 + \frac{I_L * R_L}{|V_{OUT(CL)}|}\right)$$

13.Application Information



14.Package

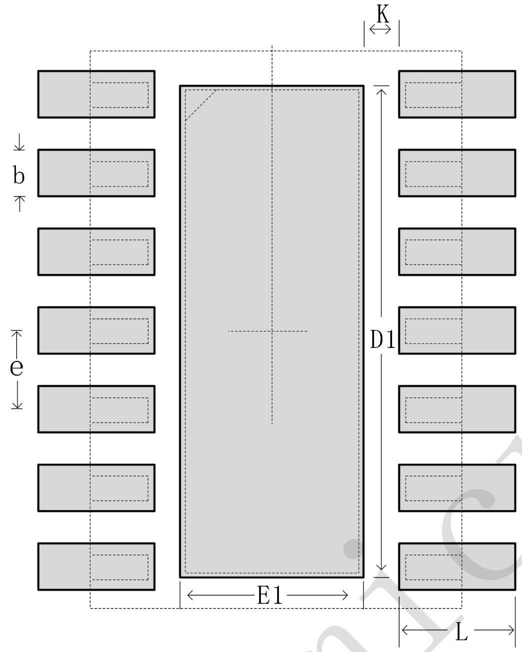
DFN9*6-14L



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