Smart High-Side Power Switch
RM74200ES Datasheet

1.Basic Features

- Short circuit protection
- Current limitation
- Overload protection
- Over voltage protection
- Over temperature protection
- Under voltage 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)
- AEC-Q100 qualified

2.Description

RM74200ES is a Smart High-side Power Switch that guarantees smooth on-off of the power tube under all conditions, while being able to connect to inductive loads and having inductive load fast.

RM74200ES 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

- 12 V DC applications
- All types of resistive, inductive and capacitive loads
- Replaces electromechanical relays, fuses and discrete circuits

4.Product Summary

Overvoltage protection	$V_{s(AZ)}$	47	V
Operating voltage	$V_{S(OP)}$	5...36	V
On-state resistance	R_{ON}	200	mΩ
Nominal load current	$I_{L(NOM)}$	1.5	A
Short circuit current limitation	$I_{L(SC)}$	11	A
Typical current sense ratio	K_{ILIS}	390	

5.Ordering Code

Device	Package Type	Marking	Materials	Package			Package Qty
RM74200ES	ESOP8L	RM74200ES	Halogen free	Tape&reel	10 reels/box	40k/box	4000/reel

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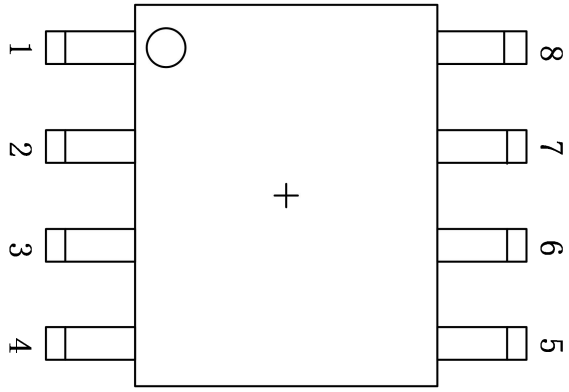
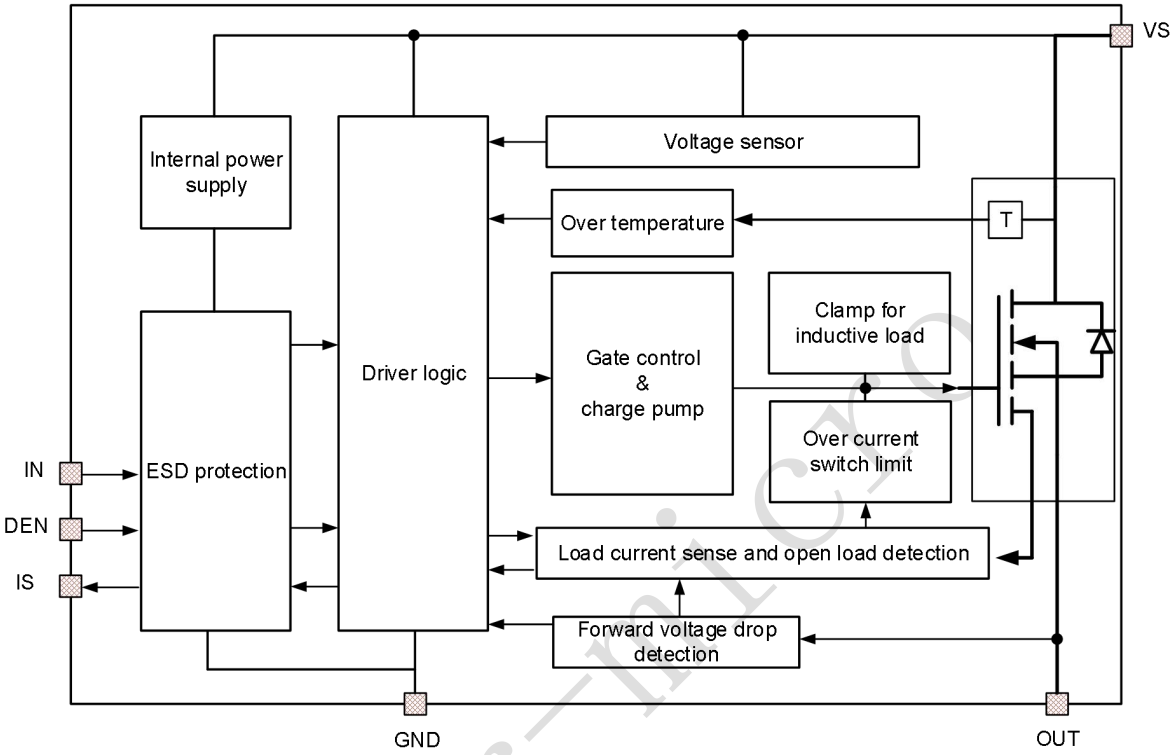
6.Pin Configuration



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

7.Block Diagram



8.Absolute Maximum Ratings[1)]

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

Parameter	Symbol	Values	Unit
Supply voltage	V_S	-0.3-28	V
Power dissipation (DC)	P_{tot}	1.8W	W
Maximum energy dissipation Single pulse	E_{AS}	40	mJ
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}	168.5	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, V_{bb}=13.5V; (unless otherwise specified)

Symbol	Parameter	Test Condition	Values			Unit
			Min	Typ	Max	
R_{on}	On-state resistance	I_L=1.0A; V_{IN}=4.5V; T_j=150℃	-	360	400	mΩ
		I_L=1.0A; V_{IN}=4.5V; T_j=25℃		200	250	
$I_{L(NOM)}$	Nominal load current	T_a=85℃; T_j<150℃	-	1.5	-	A
$V_{DS(NL)}$	Output voltage drop limitation at small load currents	I_L=25mA	-	10	22	mV
$V_{DS(AZ)}$	Drain to source clamping voltage	$V_{DS(AZ)}$=V_S-V_{OUT}; I_{DS}=20mA;	41	47	53	V
$I_{S(OFF)}$	Standby current	V_{IN} floating; V_{OUT}=0V; T_j≤85℃	-	0.1	0.5	uA
		V_{IN} floating; V_{OUT}=0V; T_j=150℃	-	1	5	uA
dV/d_{ton}	Turn-ON Slew rate	V_S=13.5V; R_L=25Ω; From 10% to 30%V_{OUT}	1	-	-	V/us
$-dV/d_{toff}$	Turn-OFF Slew rate	V_S=13.5V; R_L=25Ω; From 70% to 40%V_{OUT}	2	-	-	V/us
t_{on}	Turn-ON time	V_S=13.5V; R_L=25Ω; IN Turn-ON time to V_{OUT} = 90% V_S	-	-	100	us
t_{off}	Turn-OFF time	V_S=13.5V; R_L=25Ω; IN Turn-OFF time to V_{OUT} = 10% V_S	-	-	100	us
t_{ON_delay}	Turn-ON time to V_{OUT} = 10% V_S	V_S=13.5V; R_L=25Ω; Turn-ON time to V_{OUT} = 10% V_S	-	5	70	us
t_{OFF_delay}	Turn-OFF time to V_{OUT} = 90% V_S	V_S=13.5V; R_L=25Ω; Turn-OFF time to V_{OUT} = 90% V_S	-	5	70	us
V_{bbON}	Operating voltage	V_{IN}=4.5V; R_L=25Ω; V_{DS}<0.5V	5	-	36	V
$V_{S(UV)}$	Under voltage shutdown	V_{IN}=4.5V; V_{DEN}=0V; R_L=25Ω; From V_{DS}<1V to I_{OUT}=0A	3	-	4.5	V
$V_{S(OP)\_MIN}$	Minimum functional supply voltage	V_{IN}=4.5V; R_L=25Ω; From I_{OUT}=0A to V_{DS}<0.5V;	3.9	-	4.9	V
$I_{OUT(GND)}$	Output leakage current while GND disconnected	V_S=36V; GND floating; Tj=25℃	-	-	10	uA
$V_{DS(REV)}$	Drain source diode voltage during reverse polarity	I_L=-1.0A; T_j=25℃	200	-	700	mV
I_{GND_1}	Operating current channel active	V_{IN}=5.5V; V_{DEN}=5.5V; V_S=18V	-	-	2	mA
$V_{S(AZ)}$	Over voltage protection	I_{SOV}=5mA	41	47	53	V
$I_{L5(SC)}$	Load current limitation	V_{DS}=5V	9	11	14	A
$T_{j(SC)}$	Over temperature protection	I=1A	150	-	200	℃
V_S-$V_{OL(OFF)}$	Open load detection threshold in OFF	V_{IN}=0V; V_{DEN}=4.5V	3	-	5	V

	state					
$I_{IS\_(DIS)}$	IS pin leakage current when sense is disabled	V_{IN}=4.5V; V_{DEN}=0V; I_L=1A	-	-	1	uA
$t_{sIS(ON\_DEN)}$	Current sense settling time with load current stable and transition of the DEN	V_{IN}=4.5V; R_{IS}=1.2kΩ; C_{SENSE}<100pF; I_L=0.5A From V_{DEN}=0 to 4.5V;	-	-	40	us
I_{IS_FAULT}	Sense signal maximum current in fault condition	V_{IN}=V_{IS}=0V; V_{OUT}=V_S>10V; V_{DEN}=4.5V;	7	-	16	mA
K_{ilis1}	Current sense ratio I_{L0}=0.2A	V_{IN}=V_{DEN}=4.5V; T_j=-40℃...150℃	330	390	450	
K_{ilis2}	Current sense ratio I_{L1}=0.5A	V_{IN}=V_{DEN}=4.5V; T_j=-40℃...150℃	340	390	440	
K_{ilis3}	Current sense ratio I_{L2}=1A	V_{IN}=V_{DEN}=4.5V; T_j=-40℃...150℃	350	390	430	
$V_{IN(H)}$	High level input voltage range		1	-	2.7	V
$V_{IN(L)}$	Low level input voltage range		0.8	-	2.3	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	10	25	uA
$V_{DEN(H)}$	DEN High level input voltage range		1	-	2.7	V
$V_{DEN(L)}$	DEN Low level input voltage range		0.8	-	2.3	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	10	25	uA

10.Timing diagrams

Figure 1: Switching a Resistive Load Timing

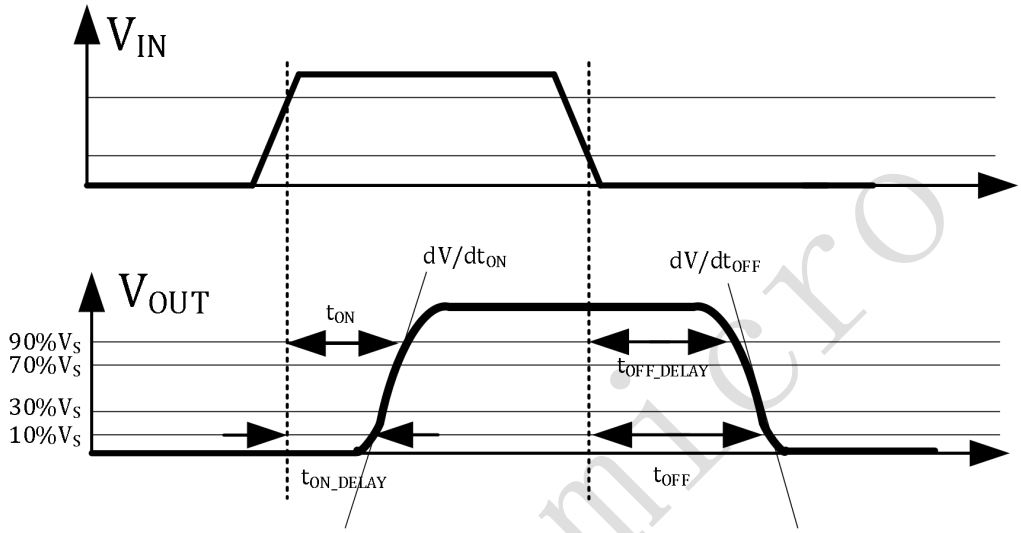


Figure 2: Switching an Inductive Load Timing

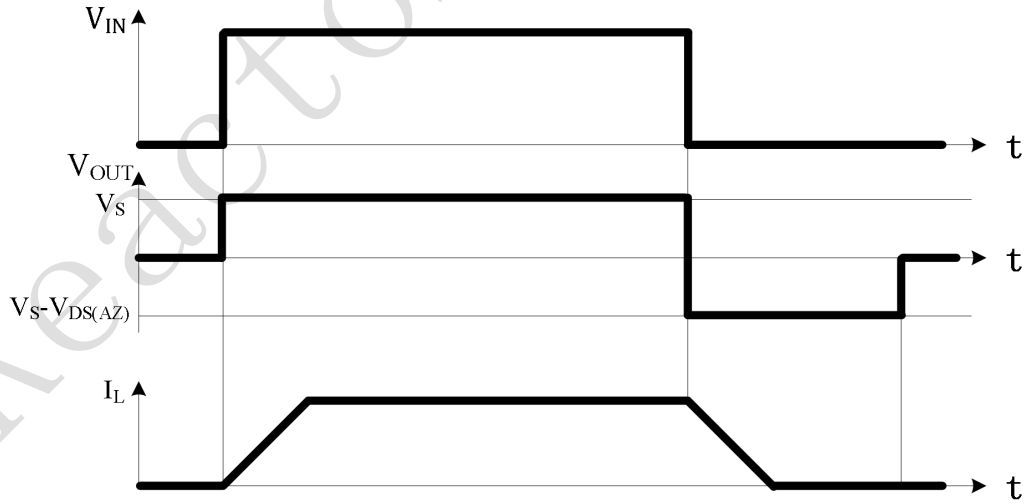


Figure 3: Current Sense Settling / Disabling Timing

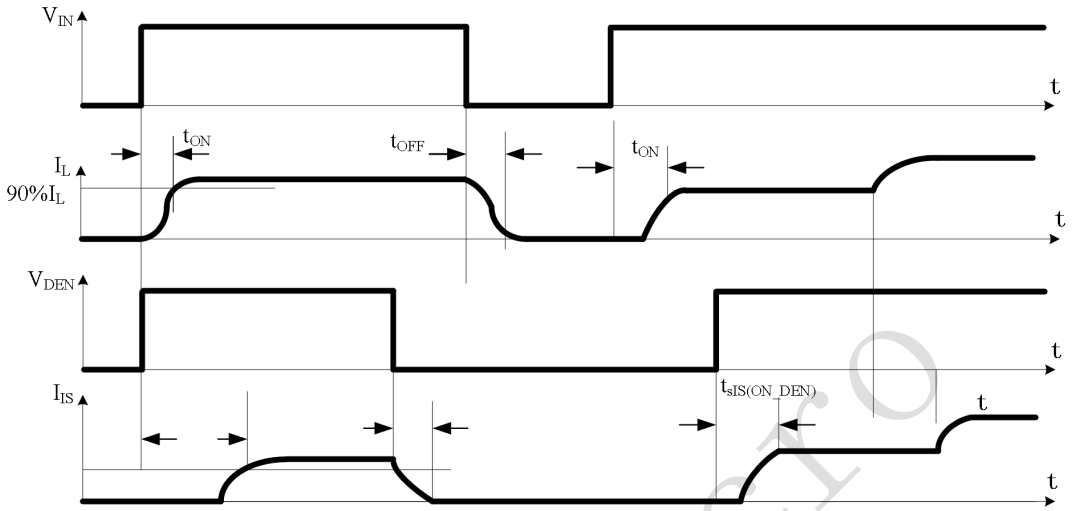


Figure 4: Sense Signal in Open Load Timing

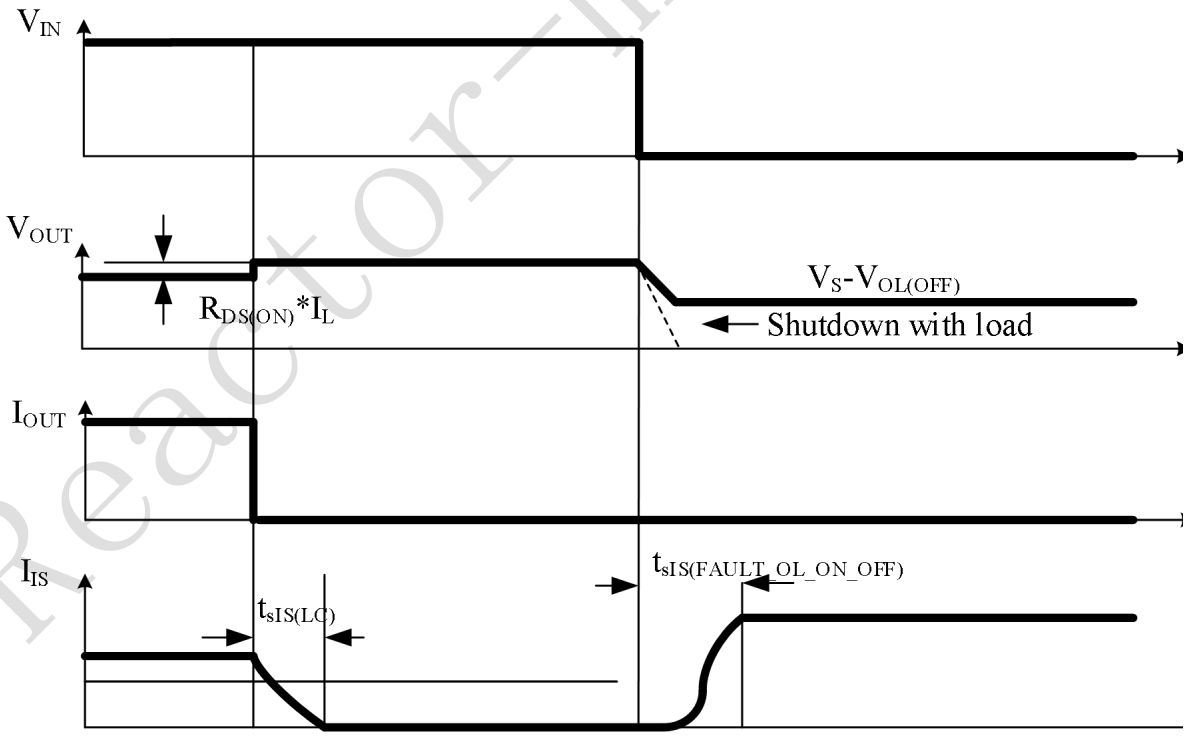
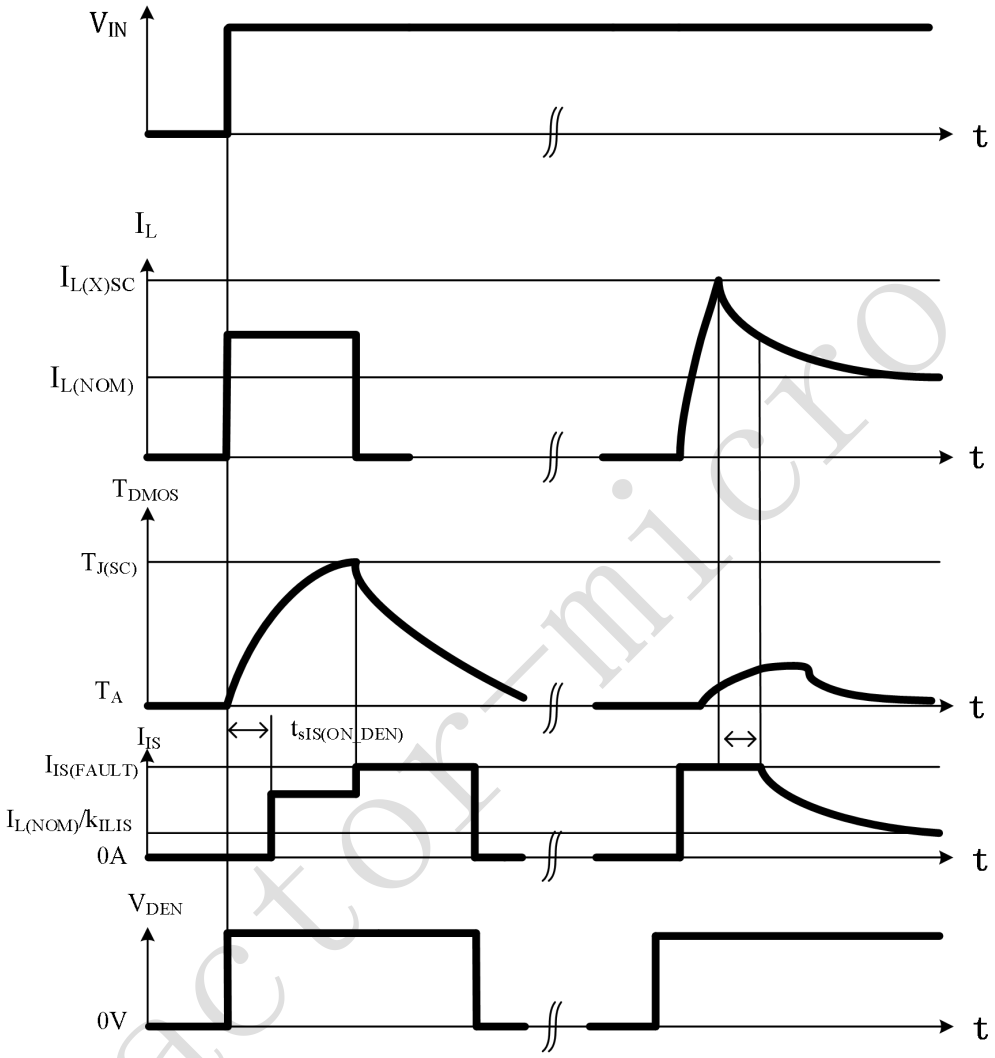
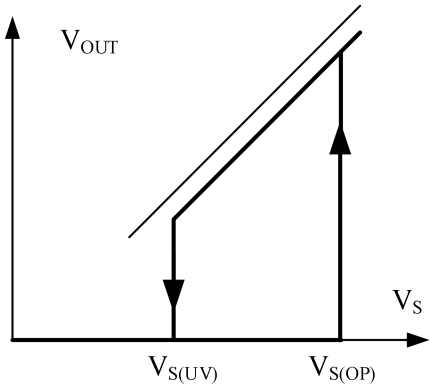


Figure 5: Over temperature Protection



Shut down remains latched until next reset via input

Figure 6: Undervoltage Behavior



11.Truth Table

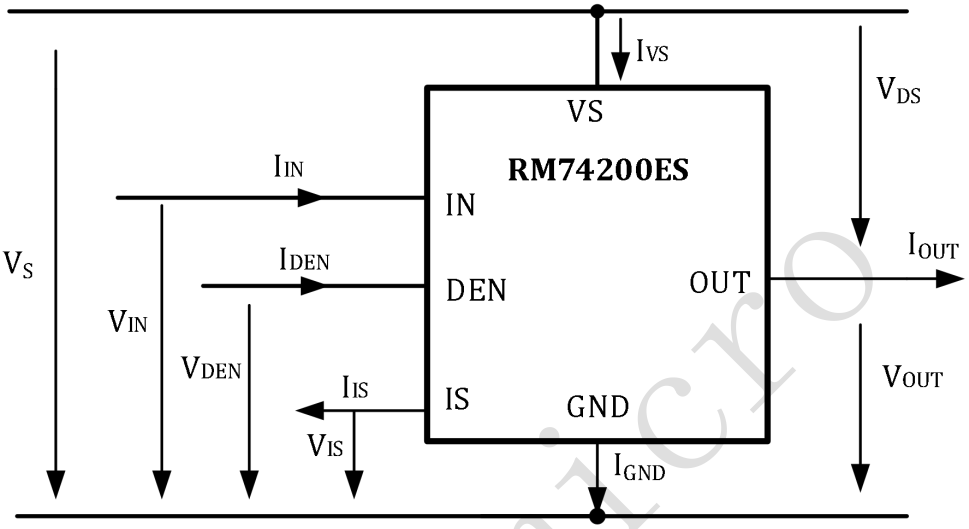
Operation Mode	Input level Channel	DEN	Output Level	Diagnostic Output
Normal operation	L H	H	L ~V_S	L $I_{IS}=I_L/K_{ilis}$
Short circuit to GND	L H	H	~GND ~GND	L $I_{IS(FAULT)}$
Overtemperature	L H	H	L L	L $I_{IS(FAULT)}$
Short circuit to VS	L H	H	V_S V_S	$I_{IS(FAULT)}$ $I_{IS}<I_L/K_{ilis}$
Open Load	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

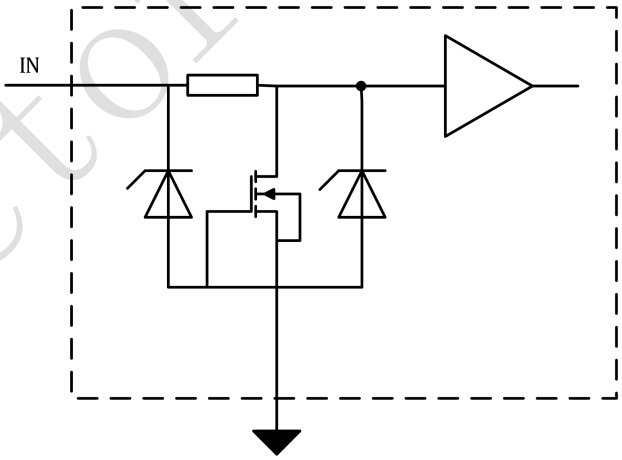
1) Stable with additional pull-up resistor.
2) The output current has to be smaller than $I_{L(OL)}$.
3) After maximum t_{INV} .
4) The output current has to be higher than $I_{L(OL)}$

12.Functions

12.1 Terms



12.2 Input circuit (ESD protection)

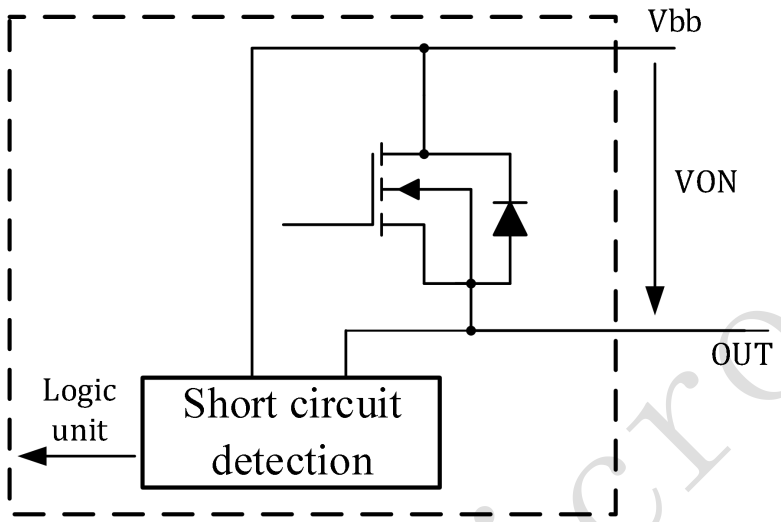


The input circuitry is compatible with 3.3 and 5 V microcontrollers. The concept of the input pin is to react tovoltage thresholds. An implemented Schmitt trigger avoids any undefined state if the voltage on the input pinis slowly increasing or decreasing. The output is either OFF or ON but cannot be in a linear or undefined state.

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 4.7 kΩ input resistor.

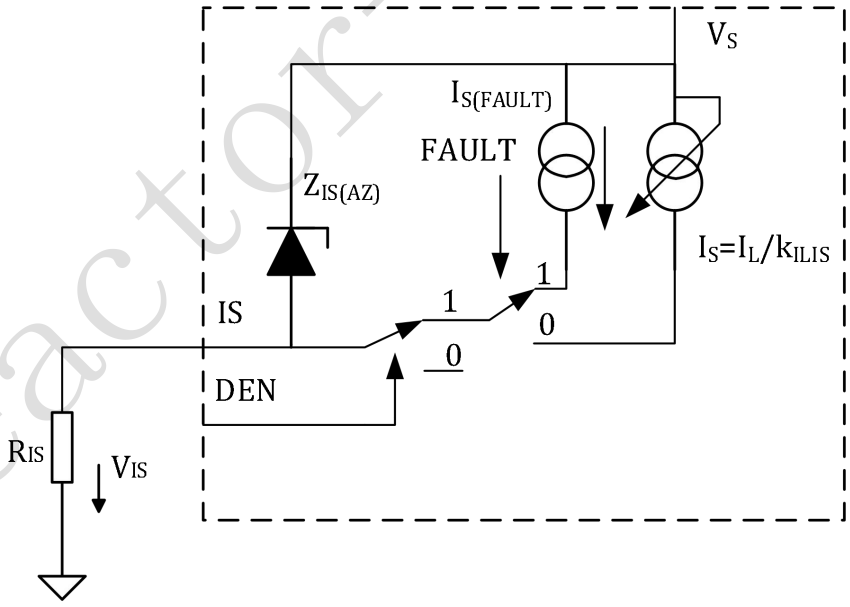
The DEN pins enable and disable the diagnostic functionality of the device. This pin has the same structure as the input pin.

12.3 Short circuit detection



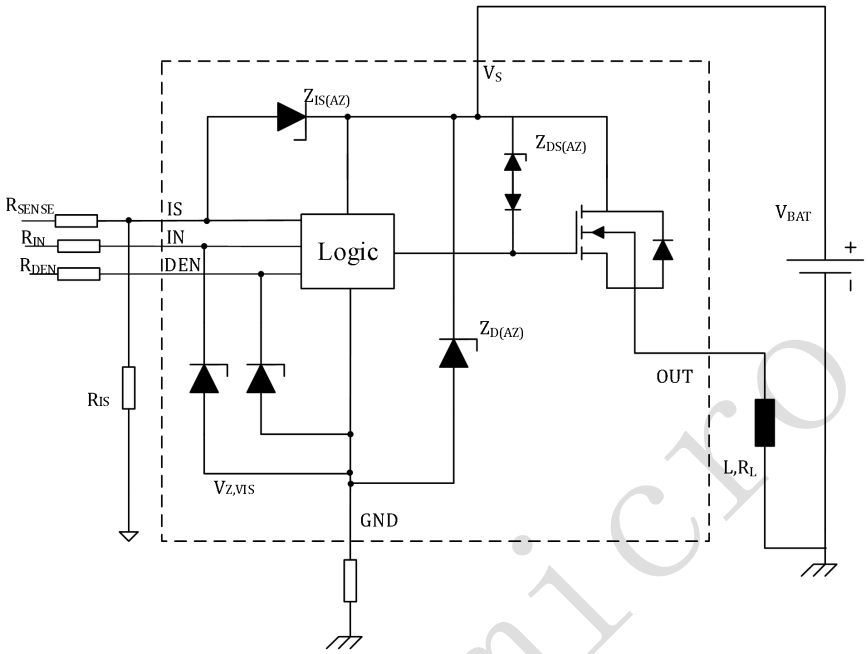
Fault Condition: $V_{ON} > V_{ON(SC)}$ (6 $V_{typ.}$) and $t > t_{d(SC)}$(80 ~350 μs)

12.4 Current sense status output



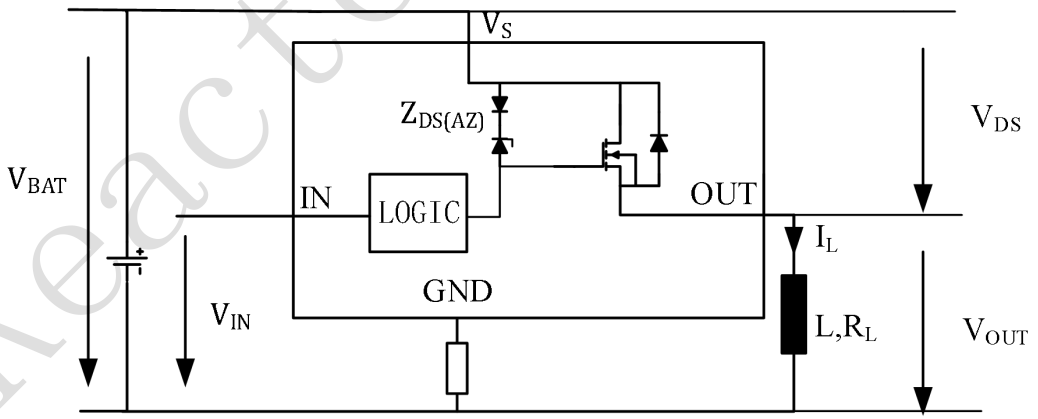
As long as no “hard” failure mode occurs a proportional signal to the load current (ratio kILIS = IL / IIS) is provided; The accuracy of the sense current depends on temperature and load current.

12.5 Over voltage protection of logic part



There is an integrated clamp mechanism for overvoltage protection (ZD(AZ)). To guarantee this mechanism operates properly in the application, the current in the Zener diode has to be limited by a ground resistor.VS(AZ)=47V.

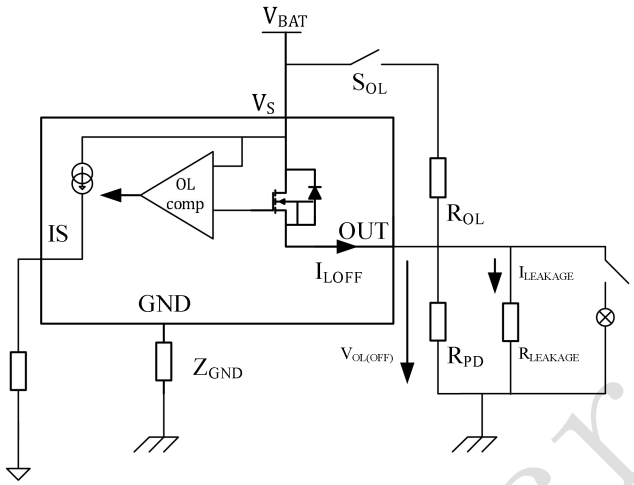
12.6 Output Clamping



When switching OFF inductive loads with high side switches, the voltage V_{OUT} drops below ground potential, because the inductance intends to continue driving the current. 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 - $V_{DS(AZ)}$).

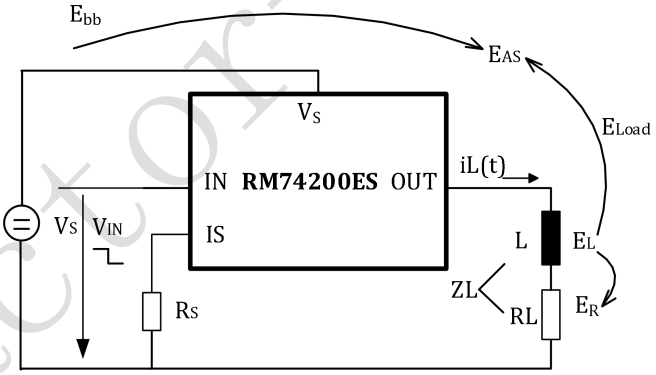
The maximum allowed load inductance is limited.

12.7 Open Load Detection in OFF Electrical Equivalent Circuit



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 and the open load threshold voltage $V_{OL(OFF)}$ have to be taken into account.

12.8 Inductive load switch-off energy dissipation



Energy stored in load inductance:

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

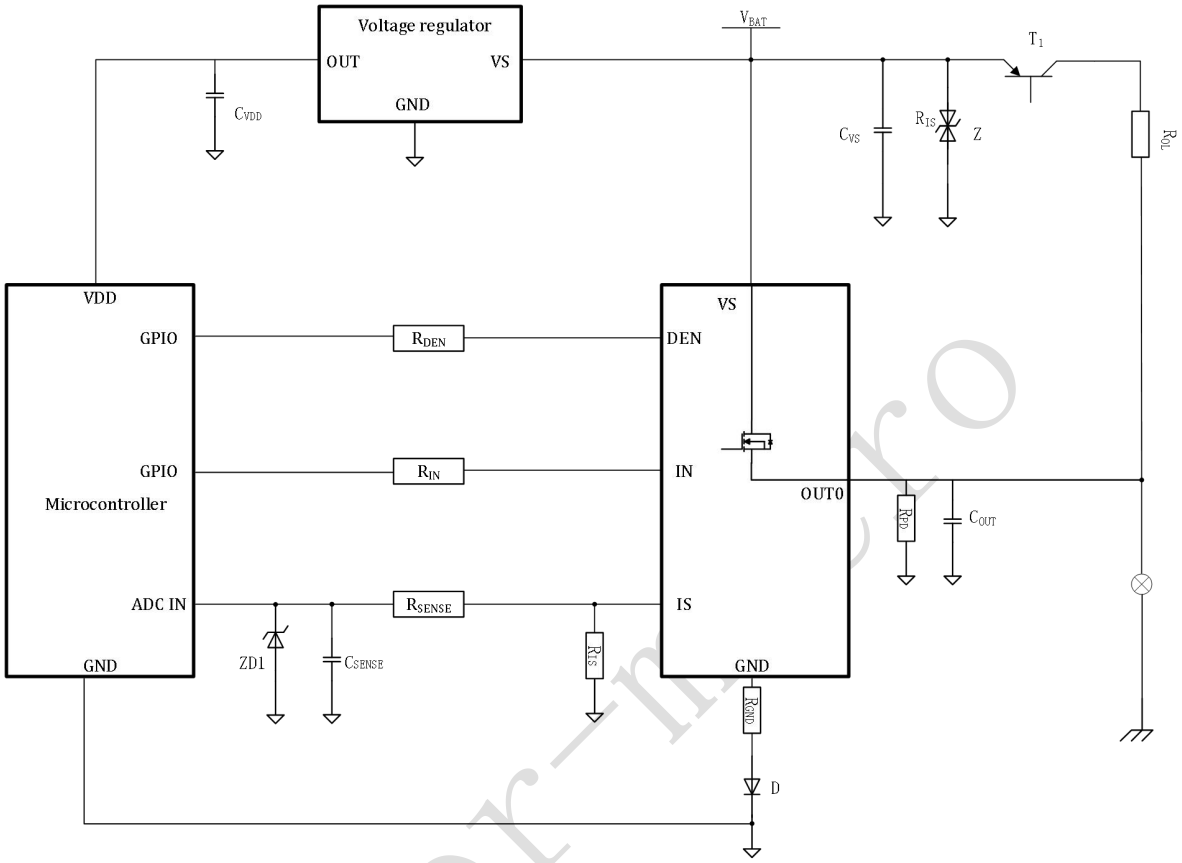
While demagnetizing load inductance, the energy dissipated in RM74200ES is:

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

with an approximate solution for $R_L > 0\ \Omega$:

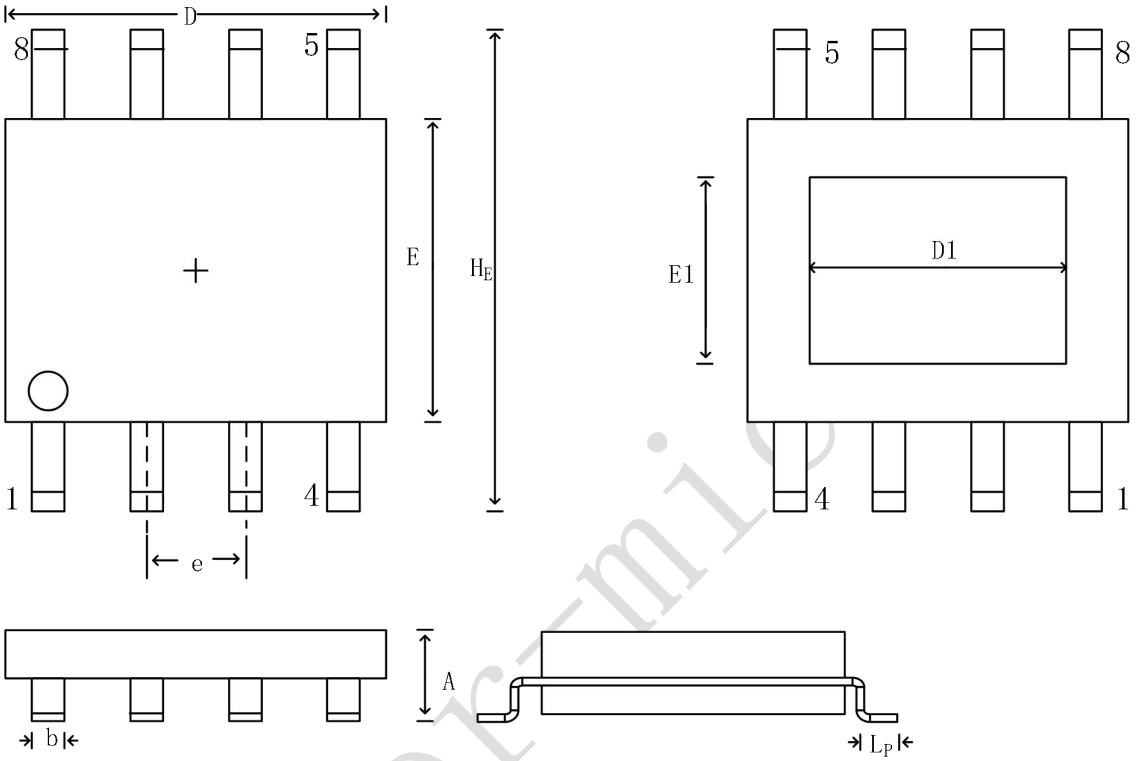
$$E_{AS} = \frac{I_L * L}{2 * R_L} (V_{bb} + |V_{OUT(CL)}|) \ln\left(1 + \frac{I_L * R_L}{|V_{OUT(CL)}|}\right)$$

13.Application Information



14.Package

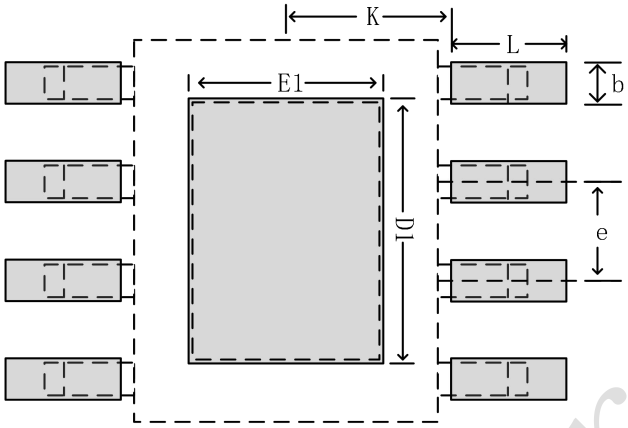
ESOP8L



Unit :mm

Symbol	MIN	NOM	MAX
D	4.70	4.90	5.10
E	3.70	3.90	4.10
H_E	6	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

15.Recommended Soldering Footprint



Unit : mm

Symbol	NOM	Symbol	NOM
e	1.27	D1	3.6
b	0.6	E1	2.7
L	1.8	K	2.1

16.Revision History

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