

# P-Channel Enhancement Mode Power MOSFET

## **DESCRIPTION**

The HM9435B uses advanced trench technology to provide excellent  $R_{\rm DS(ON)}$ , low gate charge and operation with gate voltages as low as 2.5V. This device is suitable for use as a load switch or in PWM applications.

## **GENERAL FEATURES**

•  $V_{DS} = -20V, I_{D} = -5A$ 

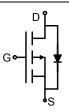
 $R_{DS(ON)} < 110 m\Omega @ V_{GS} = -4.5 V$ 

 $R_{DS(ON)}$  < 60m $\Omega$  @  $V_{GS}$ =-10V

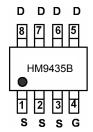
- High Power and current handing capability
- Lead free product is acquired
- Surface Mount Package

# **Application**

- PWM applications
- Load switch
- Power management



#### Schematic diagram



Marking and pin Assignment



SOP-8 top view

## **Package Marking And Ordering Information**

Device Marking	Device	Device Package	Reel Size	Tape width	Quantity
HM9435B	HM9435B	SOT-23	Ø180mm	8 mm	3000 units

## Absolute Maximum Ratings (TA=25℃unless otherwise noted)

Parameter	Symbol	Limit	Unit
Drain-Source Voltage	V <sub>DS</sub>	-20	V
Gate-Source Voltage	V <sub>GS</sub>	±12	V
Drain Current-Continuous	I <sub>D</sub>	-5	Α
Drain Current -Pulsed (Note 1)	I <sub>DM</sub>	-20	Α
Maximum Power Dissipation	P <sub>D</sub>	1	W
Operating Junction and Storage Temperature Range	T <sub>J</sub> ,T <sub>STG</sub>	-55 To 150	$^{\circ}$ C

#### **Thermal Characteristic**

Thermal Resistance, Junction-to-Ambient (Note 2)	R <sub>0JA</sub>	125	°C/W
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## Electrical Characteristics (TA=25℃ unless otherwise noted)

Parameter	Symbol	Condition	Min	Тур	Max	Unit
Off Characteristics						
Drain-Source Breakdown Voltage	BV <sub>DSS</sub>	V <sub>GS</sub> =0V I <sub>D</sub> =-250μA	-20	-24	-	V
Zero Gate Voltage Drain Current	I <sub>DSS</sub>	V <sub>DS</sub> =-20V,V <sub>GS</sub> =0V	-	-	-1	μΑ

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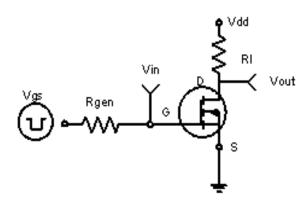


On Characteristics (Note 3)           Gate Threshold Voltage         V <sub>GS(th)</sub> V <sub>DS</sub> =V <sub>GS,ID</sub> =-250µA         -0.4         -0.7         -1           Drain-Source On-State Resistance         R <sub>DS(ON)</sub> V <sub>GS</sub> =-4.5V, I <sub>D</sub> =-1A         -         64         110           Forward Transconductance         g <sub>FS</sub> V <sub>DS</sub> =-5V, I <sub>D</sub> =-1A         -         64         110           Powers Transconductance         g <sub>FS</sub> V <sub>DS</sub> =-5V, I <sub>D</sub> =-1A         -         55         60           Dynamic Characteristics (Note4)         C <sub>Iss</sub> V <sub>DS</sub> =-10V, V <sub>GS</sub> =0V, F=1.0MHz         -         405         -           Output Capacitance         C <sub>Iss</sub> V <sub>DS</sub> =-10V, V <sub>GS</sub> =0V, F=1.0MHz         -         75         -           Reverse Transfer Capacitance         C <sub>Iss</sub> V <sub>DS</sub> =-10V, V <sub>GS</sub> =0V, F=1.0MHz         -         1         -         75         -           Switching Characteristics (Note 4)           Turn-on Delay Time         t <sub>d</sub> (on)         V <sub>DD</sub> =-10V, I <sub>D</sub> =-1A         -         35         -           Turn-Off Delay Time         t <sub>d</sub> (off)         V <sub>GS</sub> =-4.5V, R <sub>GEN</sub> =10Ω         -         30         -           Turn-Off Fall Time         t <sub>f</sub> -         10         -         -<	Gate-Body Leakage Current	I <sub>GSS</sub>	$V_{GS}=\pm 10V, V_{DS}=0V$	-	-	±100	nA
Drain-Source On-State Resistance   R <sub>DS(ON)</sub>	On Characteristics (Note 3)			•			
Drain-Source On-State Resistance         R <sub>DS(ON)</sub> V <sub>GS</sub> =-F€V, I <sub>D</sub> =-Í A         -         55         60           Forward Transconductance         g <sub>FS</sub> V <sub>DS</sub> =-5V,I <sub>D</sub> =-2.8A         -         9.5         -           Dynamic Characteristics (Note4)           Input Capacitance         C <sub>Iss</sub> V <sub>DS</sub> =-10V,V <sub>GS</sub> =0V, F=1.0MHz         -         405         -           Output Capacitance         C <sub>rss</sub> T <sub>C</sub> =1.0MHz         -         75         -           Reverse Transfer Capacitance         C <sub>rss</sub> T <sub>C</sub> =1.0MHz         -         75         -           Switching Characteristics (Note 4)           Turn-on Delay Time         t <sub>d(on)</sub> T <sub>C</sub> =1.10V,I <sub>D</sub> =-1A         -         35         -           Turn-Off Delay Time         t <sub>d(off)</sub> V <sub>GS</sub> =-4.5V,R <sub>GEN</sub> =10Ω         -         30         -           Turn-Off Fall Time         t <sub>f</sub> V <sub>DS</sub> =-10V,I <sub>D</sub> =-3A, V <sub>GS</sub> =-2.5V         -         3.3         12           Gate-Drain Charge         Q <sub>gs</sub> V <sub>DS</sub> =-2.5V         -         3.3         12           Drain-Source Diode Characteristics           Diode Forward Voltage (Note 3)         V <sub>SD</sub> V <sub>SS</sub> =0V,I <sub>S</sub> =1.3A         -	Gate Threshold Voltage	V <sub>GS(th)</sub>	V <sub>DS</sub> =V <sub>GS</sub> ,I <sub>D</sub> =-250μA	-0.4	-0.7	-1	V
V <sub>GS</sub> =-F€V, I <sub>D</sub> =-Í A   -   55   60	Drain Source On State Registance	R <sub>DS(ON)</sub>	V <sub>GS</sub> =-4.5V, I <sub>D</sub> =-I A	-	64	110	mΩ
Dynamic Characteristics (Note4)	Dialii-Source Oil-State Resistance		V <sub>GS</sub> =-F€V, I <sub>D</sub> =-Í A	-	55	60	mΩ
Input Capacitance	Forward Transconductance	<b>g</b> FS	V <sub>DS</sub> =-5V,I <sub>D</sub> =-2.8A	-	9.5	-	S
Output Capacitance         Coss         V <sub>DS</sub> =-10V,V <sub>GS</sub> =0V, F=1.0MHz         - 75         - 71         - 75         - 75         - 75         - 75         - 75         - 75         - 7	Dynamic Characteristics (Note4)						
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	Input Capacitance	C <sub>lss</sub>	\/ - 10\/\/ -0\/	-	405	-	PF
Reverse Transfer Capacitance   Crss   -   55   -	Output Capacitance	$C_{oss}$		-	75	-	PF
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	Reverse Transfer Capacitance	C <sub>rss</sub>	F = 1.0IVII 12	-	55	-	PF
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	Switching Characteristics (Note 4)						
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	Turn-on Delay Time	$t_{d(on)}$		-	11	-	nS
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	Turn-on Rise Time	t <sub>r</sub>	V <sub>DD</sub> =-10V,I <sub>D</sub> =-1A	-	35	-	nS
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	Turn-Off Delay Time	$t_{d(off)}$	$V_{GS}$ =-4.5V, $R_{GEN}$ =10 $\Omega$	-	30	1	nS
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	Turn-Off Fall Time	t <sub>f</sub>		-	10	ı	nS
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	Total Gate Charge	$Q_g$	\/= 10\/ I== 2A	-	3.3	12	nC
Gate-Drain Charge         Qgd         -         1.3         -           Drain-Source Diode Characteristics           Diode Forward Voltage (Note 3)         VSD         VGS=0V,IS=1.3A         -         -         -1.2	Gate-Source Charge	$Q_{gs}$		-	0.7	ı	nC
Diode Forward Voltage (Note 3) V <sub>SD</sub> V <sub>GS</sub> =0V,I <sub>S</sub> =1.3A1.2	Gate-Drain Charge	$Q_{gd}$	V <sub>GS</sub> 2.5V	-	1.3	-	nC
	<b>Drain-Source Diode Characteristics</b>						
Diode Forward Current (Note 2)	Diode Forward Voltage (Note 3)	V <sub>SD</sub>	V <sub>GS</sub> =0V,I <sub>S</sub> =1.3A	-	-	-1.2	V
2 Stode Forward Current (16to 2)	Diode Forward Current (Note 2)	Is		-	-	-1.3	Α

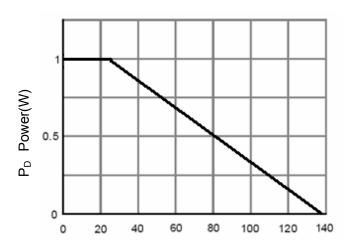
## Notes:

- 1. Repetitive Rating: Pulse width limited by maximum junction temperature.
- 2. Surface Mounted on FR4 Board, t ≤ 10 sec.
- **3.** Pulse Test: Pulse Width ≤  $300\mu$ s, Duty Cycle ≤ 2%.
- 4. Guaranteed by design, not subject to production

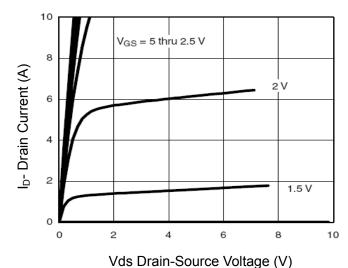
## TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS



**Figure 1:Switching Test Circuit** 



 $T_J$ -Junction Temperature (°C) Figure 3 Power Dissipation



**Figure 5 Output CHARACTERISTICS** 

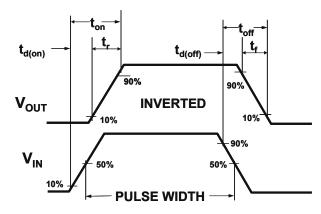
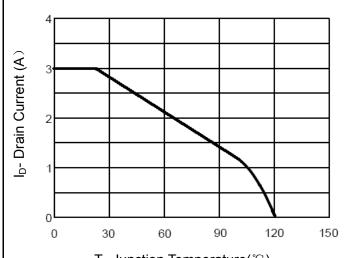


Figure 2:Switching Waveforms



 $T_J$ -Junction Temperature(°C) Figure 4 Drain Current

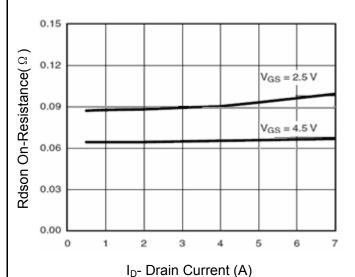
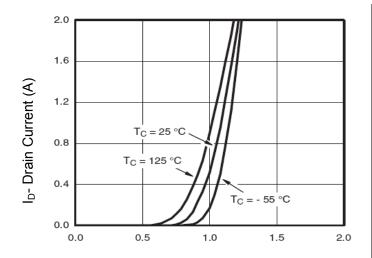


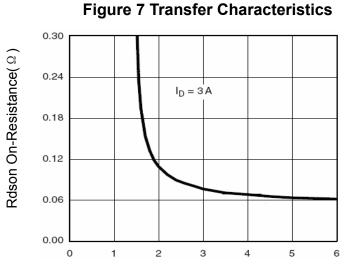
Figure 6 Drain-Source On-Resistance

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Vgs Gate-Source Voltage (V)



Vgs Gate-Source Voltage (V)



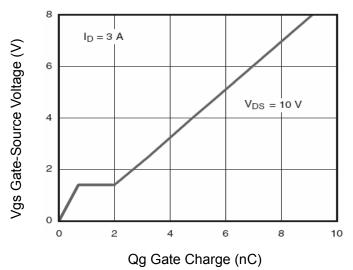


Figure 11 Gate Charge

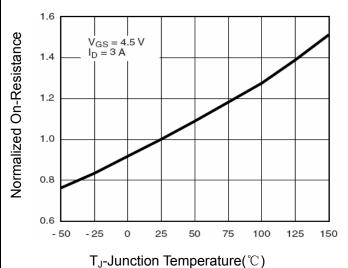
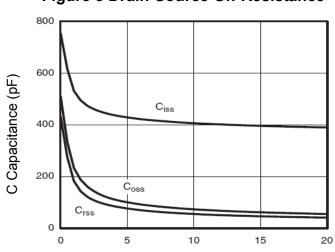


Figure 8 Drain-Source On-Resistance



Vds Drain-Source Voltage (V)

Figure 10 Capacitance vs Vds

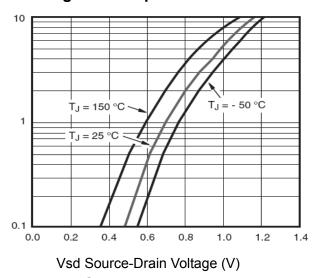
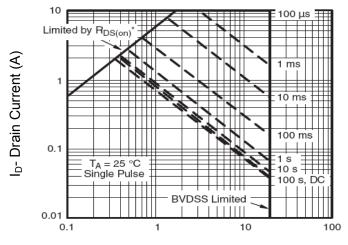


Figure 12 Source- Drain Diode Forward

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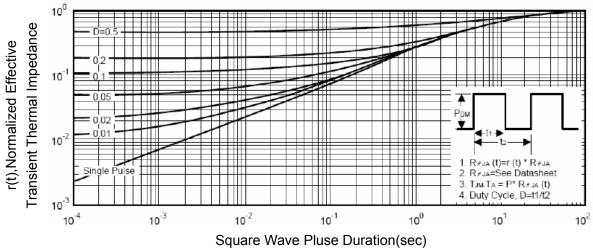
Is- Reverse Drain Current (A)

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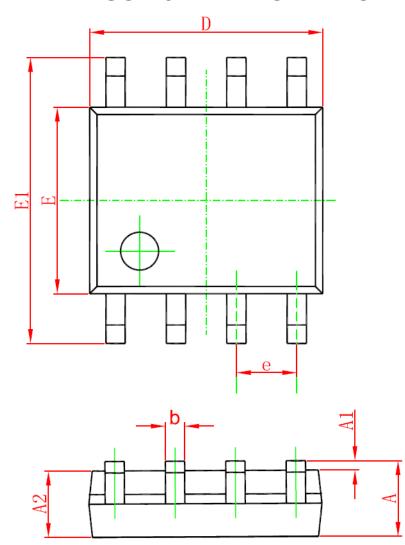
Vds Drain-Source Voltage (V)

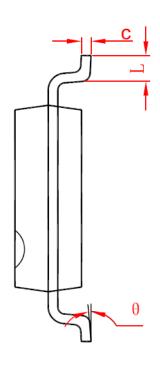
Figure 13 Safe Operation Area



**Figure 14 Normalized Maximum Transient Thermal Impedance** 

# **SOP-8 PACKAGE IN FORMATION**





Comb of	Dimensions In	n Millimeters	Dimensions In Inches		
Symbol	Min	Max	Min	Max	
А	1. 350	1. 750	0. 053	0. 069	
A1	0. 100	0. 250	0. 004	0. 010	
A2	1. 350	1. 550	0. 053	0. 061	
b	0. 330	0. 510	0. 013	0. 020	
С	0. 170	0. 250	0. 006	0. 010	
D	4. 700	5. 100	0. 185	0. 200	
E	3. 800	4. 000	0. 150	0. 157	
E1	5. 800	6. 200	0. 228	0. 244	
e	1. 270 (BSC)		0. 050 (BSC)		
L	0. 400	1. 270	0. 016	0. 050	
θ	0°	8°	0°	8°	

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