

## 20V Full-Bridge of MOSFET

### Description

The NP2002 uses advanced trench technology to provide excellent  $R_{DS(ON)}$  and low gate charge. The complementary MOSFETs may be used to form a H-Bridge, and for a host of other applications.

### General Features

- ◆ **N-channel:**  
 $V_{DS} = 20V, I_D = 3A$   
 $R_{DS(ON)} = 32m\Omega$  (typical) @  $V_{GS} = 4.5V$   
 $R_{DS(ON)} = 42m\Omega$  (typical) @  $V_{GS} = 2.5V$
- ◆ **P-Channel:**  
 $V_{DS} = -20V, I_D = -3A$   
 $R_{DS(ON)} = 60m\Omega$  (typical) @  $V_{GS} = -4.5V$   
 $R_{DS(ON)} = 75m\Omega$  (typical) @  $V_{GS} = -2.5V$
- ◆ Excellent gate charge x  $R_{DS(ON)}$  product(FOM)
- ◆ Very low on-resistance  $R_{DS(ON)}$
- ◆ 150 °C operating temperature
- ◆ Pb-free lead plating
- ◆ 100% UIS tested

### Application

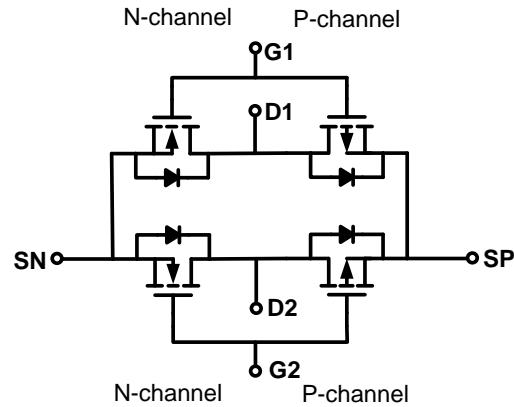
- ◆ Complementary MOSFET for DC FAN, Motor
- ◆ Wireless Charging

### Package

- ◆ SOP-8

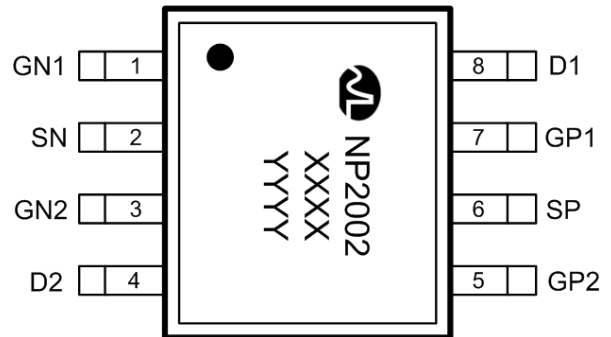
*100% UIS TESTED!*  
*100%  $\Delta V_{ds}$  TESTED!*

### Schematic diagram



### Marking and pin assignment

#### SOP-8 (TOP VIEW)



Note: XXXX is the date code,  
 YYYY is the Quality Code



### Ordering Information

Part Number	Storage Temperature	Package	Devices Per Reel
NP2002SR	-55°C to +150°C	SOP-8	3000
NP2002SF	-55°C to +150°C	SOP-8	4000

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

Parameter	Symbol	Limit		Unit
		N	P	
Drain-source voltage	$V_{DS}$	20	-20	V

Gate-source voltage		$V_{GS}$	$\pm 12$	$\pm 12$	V
Drain Current-Continuous (Silicon Limited)	$T_A=25^\circ\text{C}$	$I_D$	3	-3	A
	$T_A=75^\circ\text{C}$		2.5	-2.5	
Pulsed Drain Current (Package Limited)		$I_{DM}$	12	-12	A
Power Dissipation	$T_A=25^\circ\text{C}$	$P_D$	2	2	W
	$T_A=75^\circ\text{C}$		1.3	1.3	
Junction and Storage Temperature Range		$T_J, T_{STG}$	-55—150		$^\circ\text{C}$

## Thermal Characteristics

Parameter		Symbol	Typ	Max	Unit
Maximum Junction-to-Ambient <sup>A</sup>	$\leq 10\text{s}$	$R_{\theta JA}$	33	40	$^\circ\text{C/W}$
Maximum Junction-to-Ambient <sup>A</sup>	Steady-State		59	75	
Maximum Junction-to-Lead <sup>B</sup>	Steady-State	$R_{\theta JC}$	16	24	

A: The value of  $R_{\theta JA}$  is measured with the device mounted on 1 in<sup>2</sup> FR-4 board with 2oz. Copper, in a still air environment with  $T_A=25^\circ\text{C}$ . The value in any given application depends on the user's specific board design. The current rating is based on the  $t \leq 10\text{s}$  thermal resistance rating.

B: The  $R_{\theta JA}$  is the sum of the thermal impedance from junction to lead  $R_{\theta JC}$  and lead to ambient.

## N-Channel Electrical Characteristics ( $T_J=25^\circ\text{C}$ unless otherwise noted)

Parameter	Symbol	Condition	Min	Typ	Max	Unit
<b>OFF Characteristics</b>						
Drain-source breakdown voltage	$BV_{DSS}$	$V_{GS}=0\text{V}, I_D=250\mu\text{A}$	20	-	-	V
Zero gate voltage drain current	$I_{DSS}$	$V_{DS}=20\text{V}, V_{GS}=0\text{V}$	-	-	1	$\mu\text{A}$
Gate-body leakage	$I_{GSS}$	$V_{DS}=0\text{V}, V_{GS}=\pm 12\text{V}$	-	-	$\pm 100$	nA
<b>ON Characteristics</b>						
Gate threshold voltage	$V_{GS(th)}$	$V_{DS}=V_{GS}, I_D=250\mu\text{A}$	0.5	0.75	1.2	V
Drain-source on-state resistance	$R_{DS(ON)}$	$V_{GS}=4.5\text{V}, I_D=3\text{A}$	-	31	50	m $\Omega$
		$V_{GS}=2.5\text{V}, I_D=2.8\text{A}$	-	41	80	
Forward transconductance	gfs	$V_{GS}=5\text{V}, I_D=3\text{A}$	-	5	-	S
<b>Dynamic Characteristics</b>						
Input capacitance	$C_{ISS}$	$V_{DS}=10\text{V}, V_{GS}=0\text{V}$ $f=1.0\text{MHz}$	-	240	-	pF
Output capacitance	$C_{OSS}$		-	45	-	
Reverse transfer capacitance	$C_{RSS}$		-	23	-	
Gate resistance	$R_g$	$V_{GS}=0\text{V}, V_{DS}=0\text{V},$ $f=1.0\text{MHz}$	-	3.3	4.9	$\Omega$
<b>Switching Characteristics</b>						
Turn-on delay time	$t_{D(ON)}$	$V_{DD}=10\text{V}$ $R_L=3.3\text{ohm}$ $V_{GEN}=4.5\text{V}$ $R_{GEN}=6\text{ohm}$	-	2.3	-	ns
Rise time	tr		-	3.1	-	
Turn-off delay time	$t_{D(OFF)}$		-	21	-	

Fall time	$t_f$		-	2.6	-	
Total gate charge	$Q_g$	$V_{DS}=10V$ $I_D=3A$ $V_{GS}=4.5V$	-	2.7	-	nC
Gate-source charge	$Q_{gs}$		-	0.4	-	
Gate-drain charge	$Q_{gd}$		-	0.5	-	

## N-Channel: Typical Electrical And Thermal Characteristics

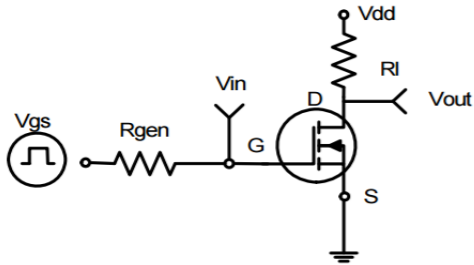


Figure 1: Switching Test Circuit

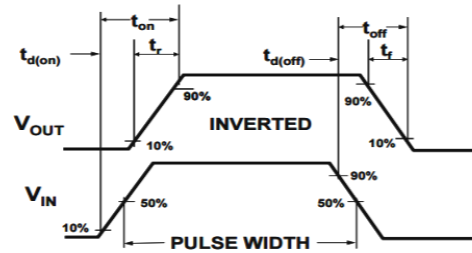


Figure 2: Switching Waveforms

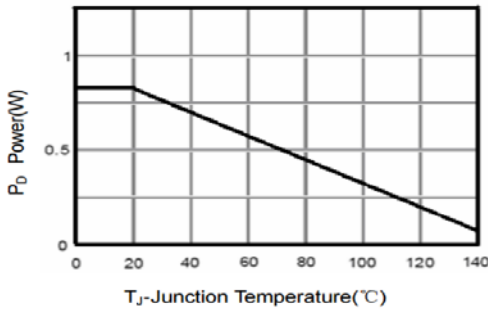


Figure 3 Power Dissipation

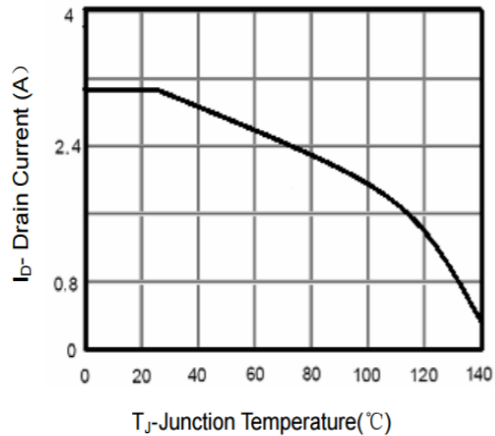


Figure 4 Drain Current

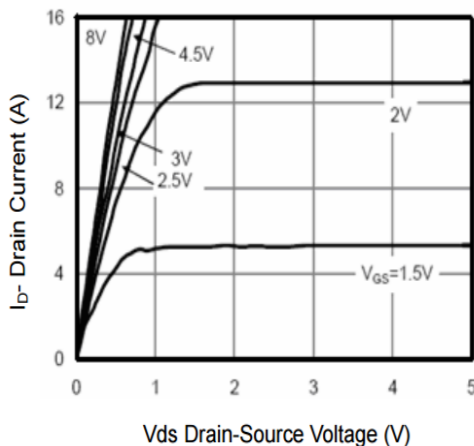


Figure 5 Output Characteristics

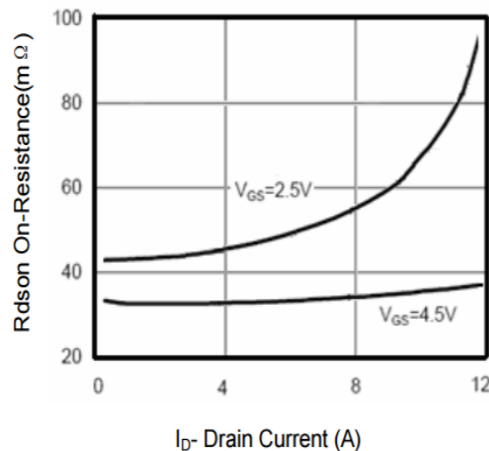


Figure 6 Drain-Source On-Resistance

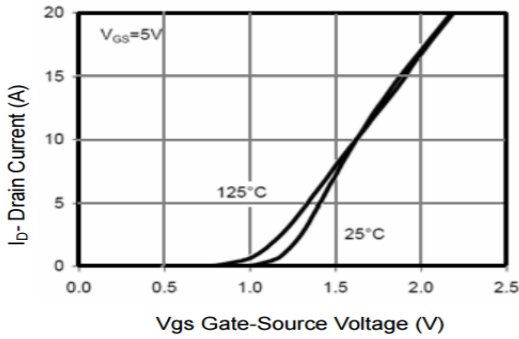


Figure 7 Transfer Characteristics

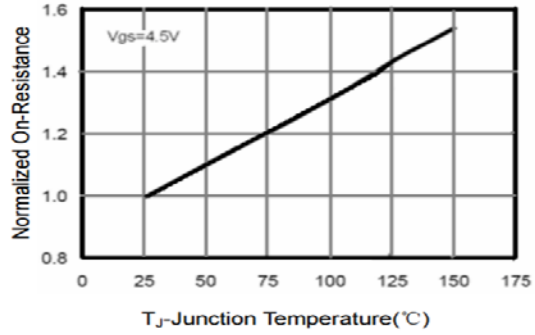


Figure 8 Drain-Source On-Resistance

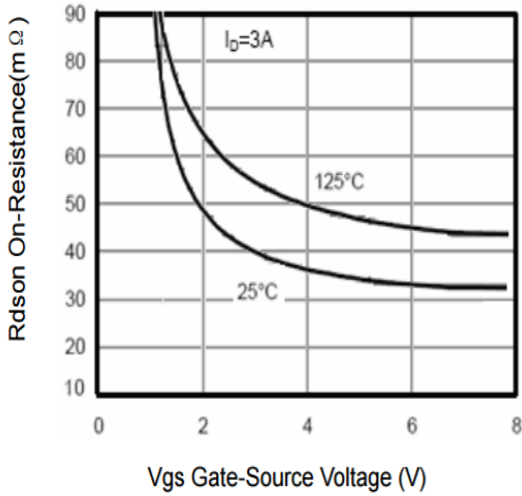


Figure 9 Rdson vs Vgs

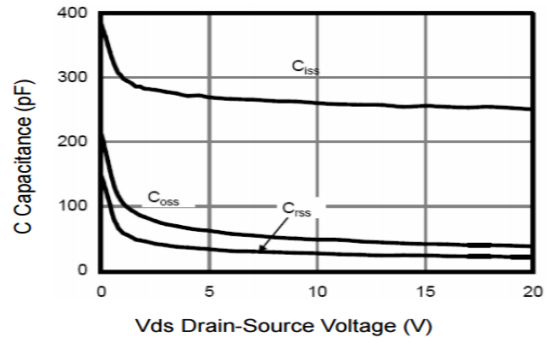


Figure 10 Capacitance vs Vds

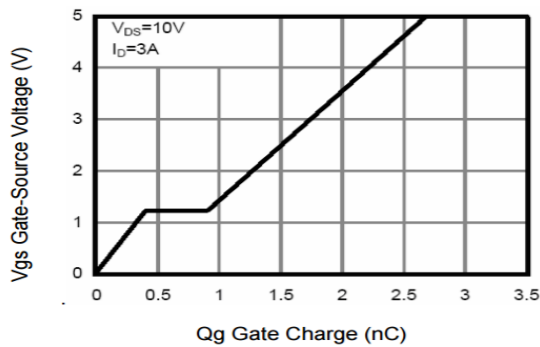


Figure 11 Gate Charge

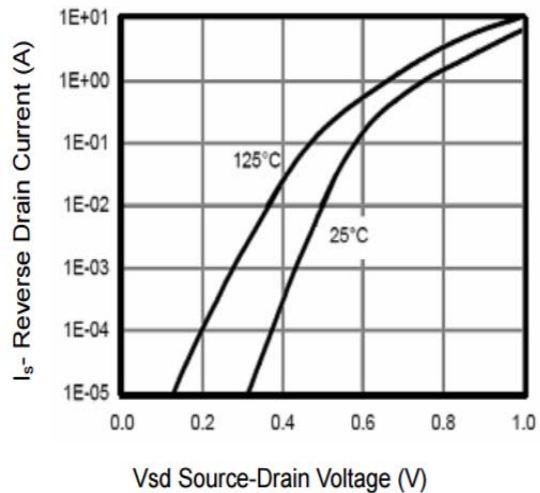
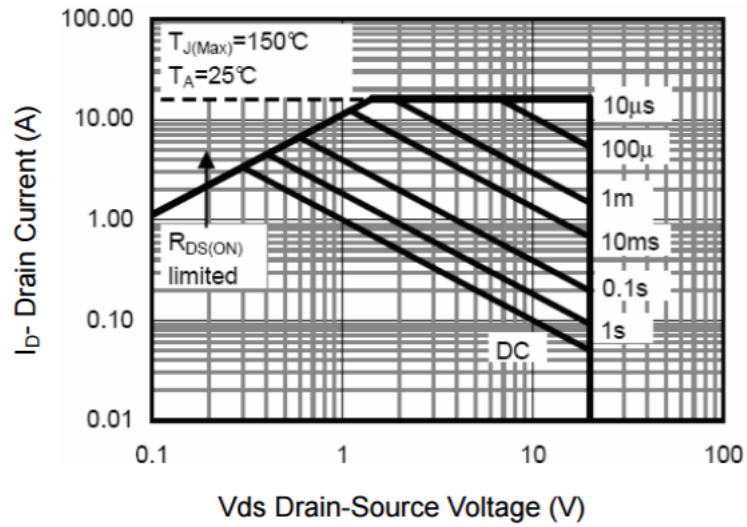
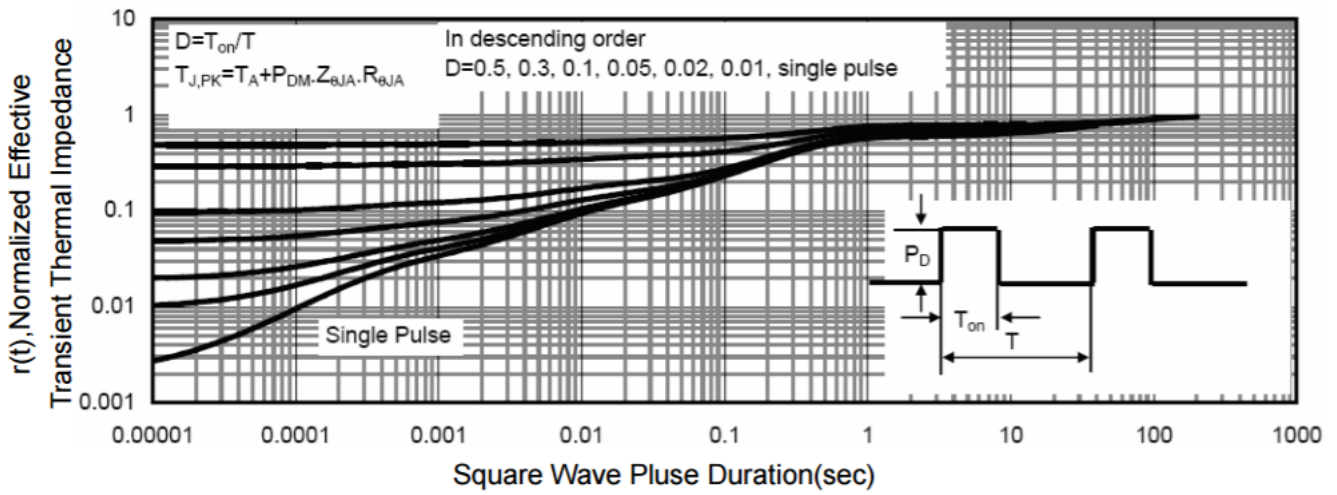


Figure 12 Source- Drain Diode Forward



**Figure 13 Safe Operation Area**

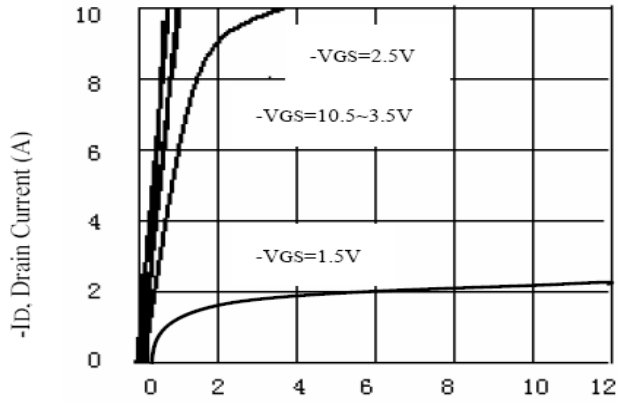


**Figure 14 Normalized Maximum Transient Thermal Impedance**

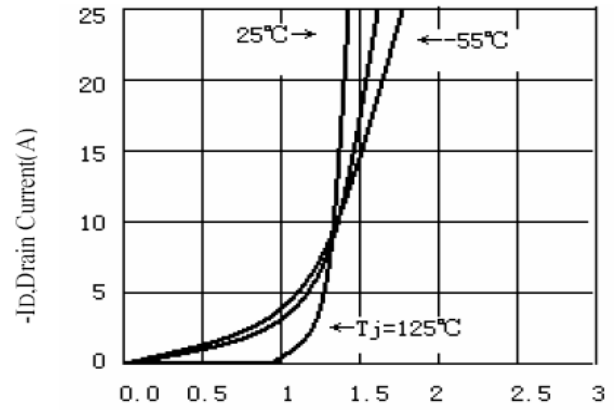
**P-Channel Electrical Characteristics** ( $T_J=25^{\circ}\text{C}$  unless otherwise noted)

Parameter	Symbol	Condition	Min	Typ	Max	Unit
<b>OFF Characteristics</b>						
Drain-source breakdown voltage	$BV_{DSS}$	$V_{GS}=0V, I_D=-250\mu A$	-20	-	-	V
Zero gate voltage drain current	$I_{DSS}$	$V_{DS}=-20V, V_{GS}=0V$	-	-	-1	$\mu A$
Gate-body leakage	$I_{GSS}$	$V_{DS}=0V, V_{GS}=\pm 12V$	-	-	$\pm 100$	nA
<b>ON Characteristics</b>						
Gate threshold voltage	$V_{GS(th)}$	$V_{DS}=V_{GS}, I_D=-250\mu A$	-0.4	-0.65	-1.2	V
Drain-source on-state resistance	$R_{DS(ON)}$	$V_{GS}=-4.5V, I_D=-2.8A$	-	60	90	m $\Omega$
		$V_{GS}=-2.5V, I_D=-2.8A$	-	75	120	
Forward transconductance	gfs	$V_{GS}=-5V, I_D=-5A$	-	5	-	S
<b>Dynamic Characteristics</b>						
Input capacitance	$C_{ISS}$	$V_{DS}=-10V, V_{GS}=0V$ $f=1.0\text{MHz}$	-	561	-	pF
Output capacitance	$C_{OSS}$		-	61	-	
Reverse transfer capacitance	$C_{RSS}$		-	52	-	
<b>Switching Characteristics</b>						
Turn-on delay time	$t_{D(ON)}$	$V_{DD}=-10V$ $I_D=-2.8A$ $V_{GEN}=-4.5V$ $R_L=10\text{ohm}$ $R_{GEN}=-60\text{ohm}$	-	12.5	-	ns
Rise time	$t_r$		-	6.6	-	
Turn-off delay time	$t_{D(OFF)}$		-	113	-	
Fall time	$t_f$		-	46.6	-	
Total gate charge	Qg	$V_{DS}=-10V, I_D=-3A$ $V_{GS}=-4.5V$	-	6.1	-	nC
Gate-source charge	Qgs		-	1.7	-	
Gate-drain charge	Qgd		-	1.2	-	

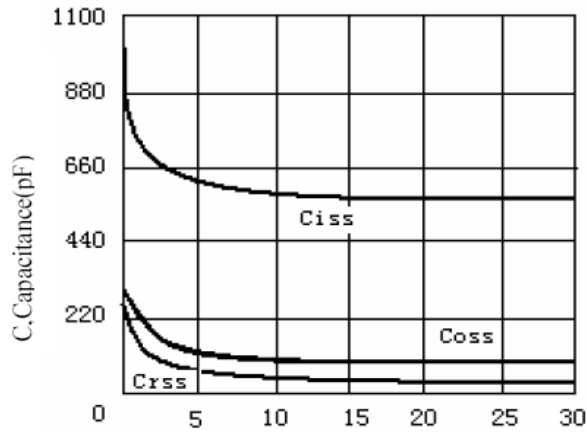
## P-Channel: Typical Electrical And Thermal Characteristics



-  $V_{DS}$ , Drain-to-Source Voltage (V)  
Figure 1. Output Characteristics



-  $V_{GS}$ , Gate-to-source Voltage (V)  
Figure 2. Transfer Characteristics



-  $V_{GS}$ , Drain-to-Source Voltage  
Figure 3. Capacitance

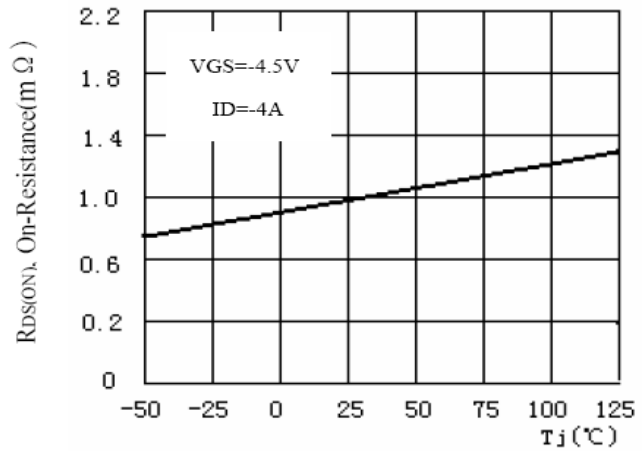
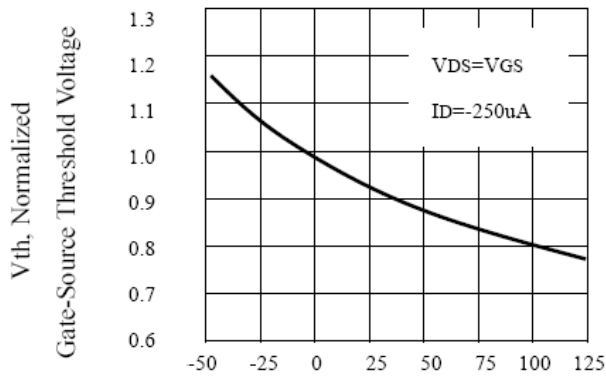
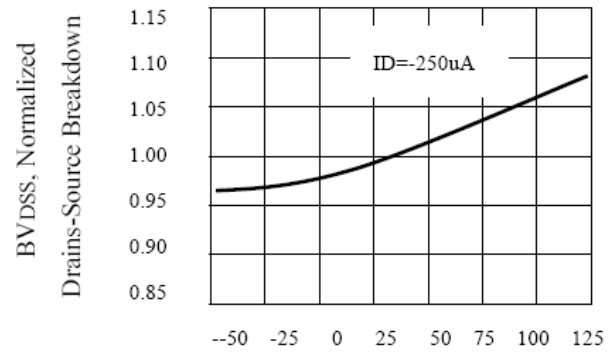


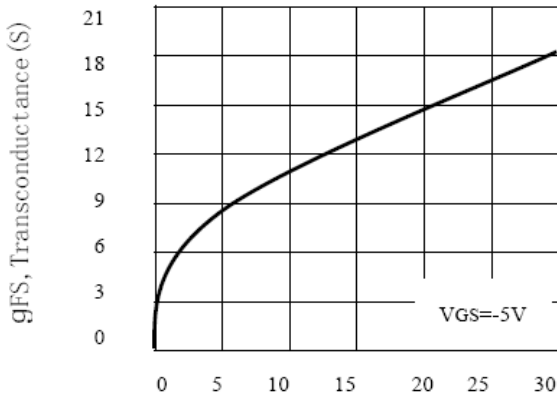
Figure 4. On-Resistance Variation with Temperature



$T_j$ , Junction Temperature ( $^{\circ}C$ )  
Figure 5. Gate Threshold Variation With Temperature

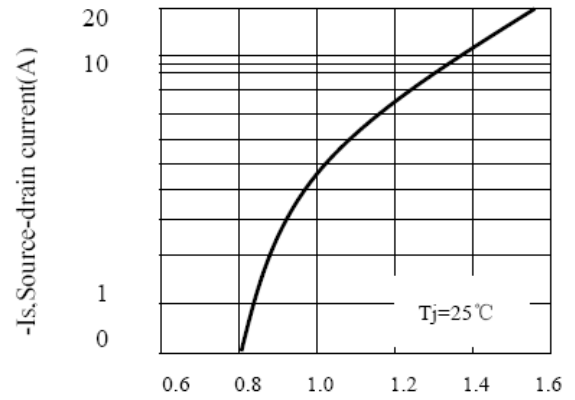


$T_j$ , Junction Temperature ( $^{\circ}C$ )  
Figure 6. Breakdown Voltage Variation With Temperature



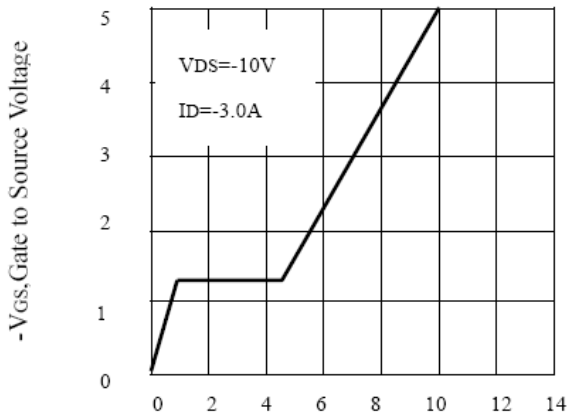
-IDS, Drain-Source Current (A)

Figure7. Transconductance Variation With Drain Current



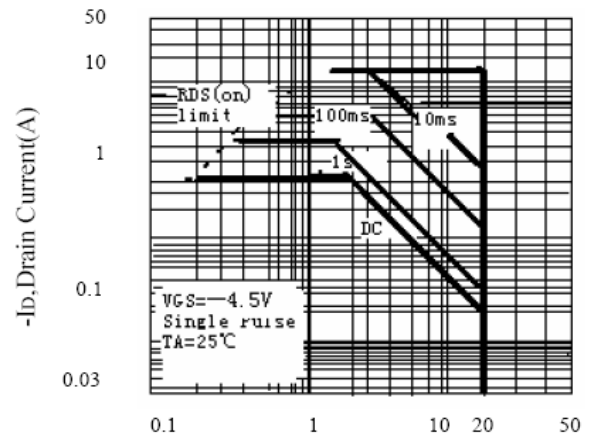
-VSD, Body Diode Forward Voltage

Figure8. Body Diode Forward Voltage Variation with Source Current



Qg, Total Gate Charge (nC)

Figure9. Gate Charge

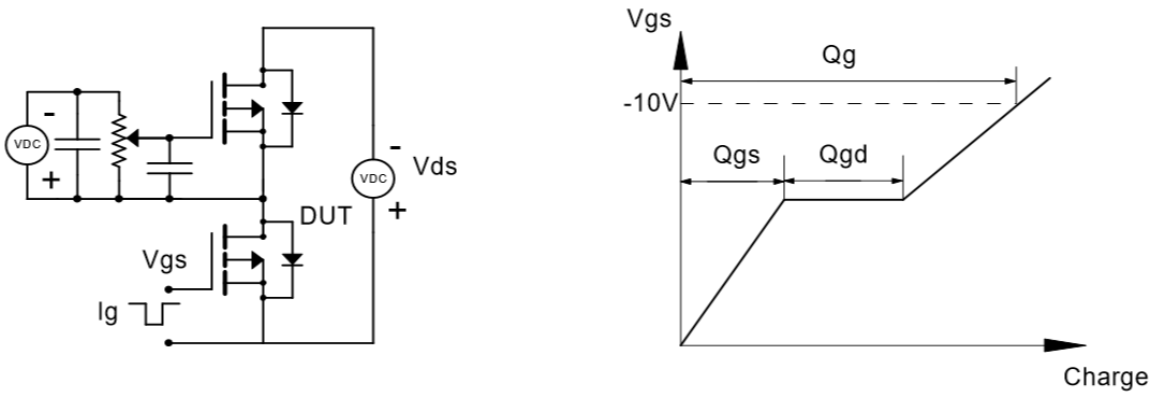


-VDS, Drain-Source Voltage(V)

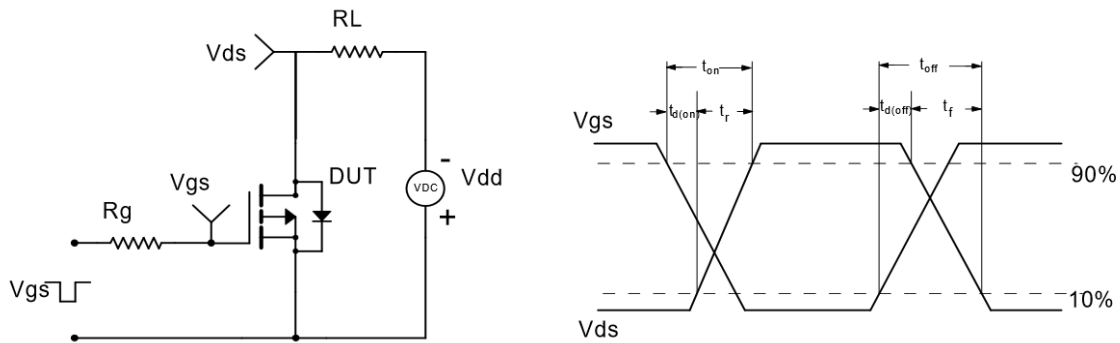
Figure10. Maximum Safe Operating Area



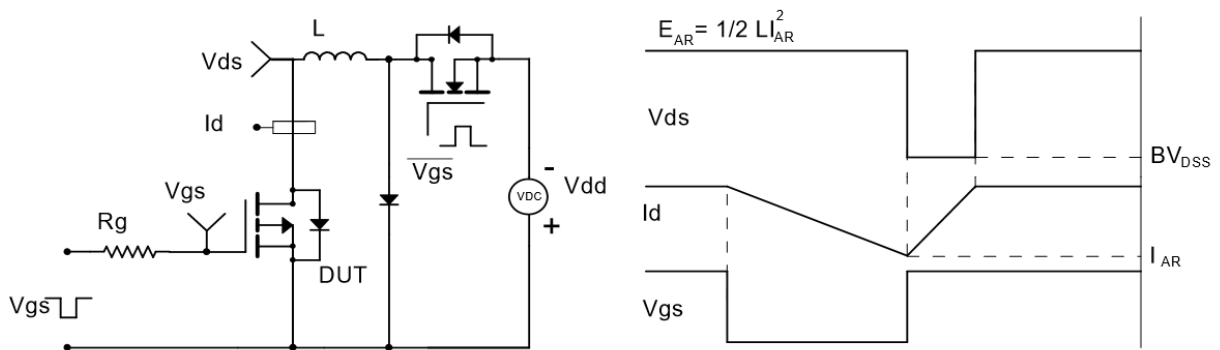
Gate Charge Test Circuit & Waveform



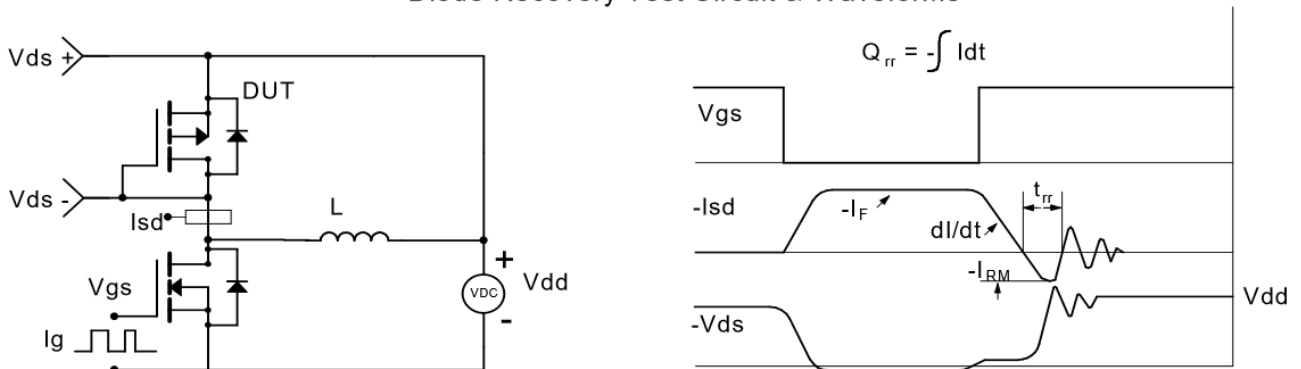
Resistive Switching Test Circuit & Waveforms



Unclamped Inductive Switching (UIS) Test Circuit & Waveforms

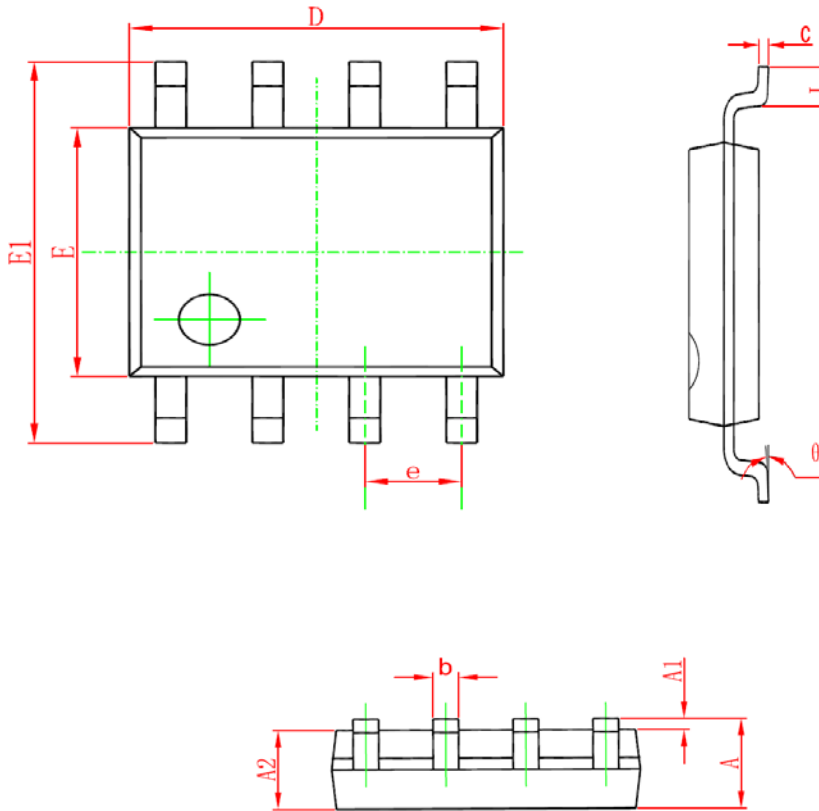


Diode Recovery Test Circuit & Waveforms



## Package Information

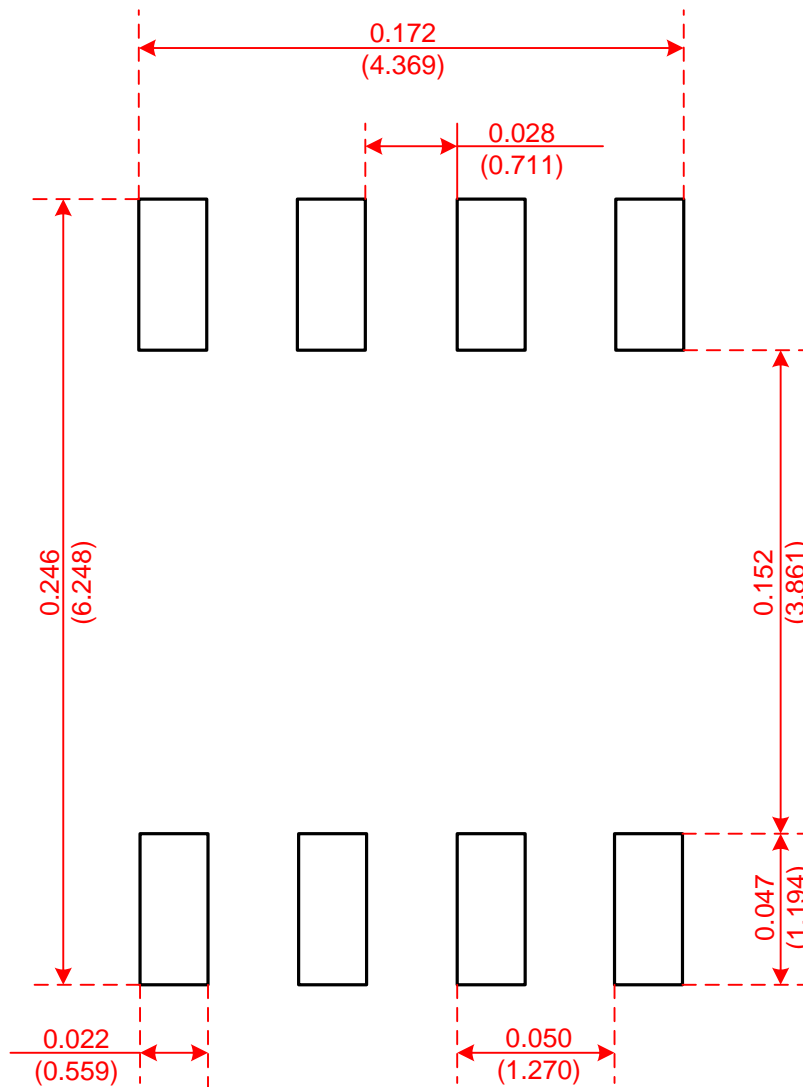
- SOP-8



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	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
c	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°

## Recommended Minimum Pads

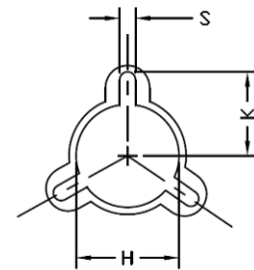
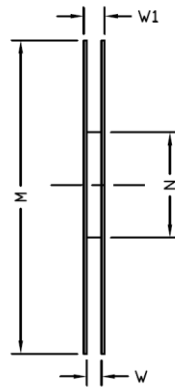
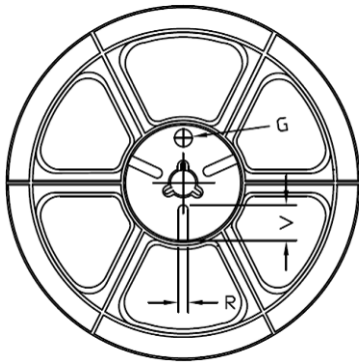
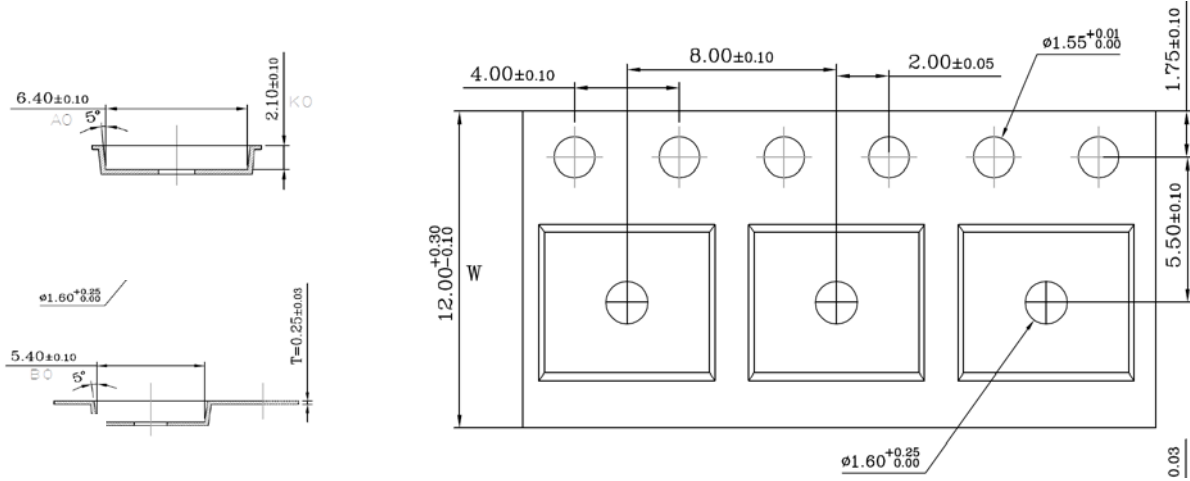
- SOP-8



Recommended Minimum Pads  
Dimensions in Inches/(mm)

## Tape and Reel

- SOP-8



Tape Size	Reel Size	M	N	W	W1	H	K	S	G	R	V
12mm	Φ330	Φ330.00 ±0.50	Φ97.00 ±0.30	13.00 ±0.30	17.40 ±1.00	Φ13.00 ±0.5	10.6	2.00 ±0.50	—	—	—

Unit Per Reel:  
4000pcs

