


## Power MOSFET, 40 A


**SOT-227**

### FEATURES

- Fully isolated package
- Easy to use and parallel
- Low on-resistance
- Dynamic dV/dt rating
- Fully avalanche rated
- Simple drive requirements
- Low drain to case capacitance
- Low internal inductance
- UL approved file E78996 
- Designed for industrial level
- Material categorization: for definitions of compliance please see [www.vishay.com/doc?99912](http://www.vishay.com/doc?99912)


**RoHS  
COMPLIANT**

PRIMARY CHARACTERISTICS	
$V_{DSS}$	500 V
$R_{DS(on)}$	106 m $\Omega$
$I_D$	40 A
Type	Modules - MOSFET
Package	SOT-227

### DESCRIPTION

Third generation power MOSFETs from Vishay Semiconductors provide the designer with the best combination of fast switching, ruggedized device design, low on-resistance and cost-effectiveness.

The SOT-227 package is universally preferred for all commercial-industrial applications at power dissipation levels to approximately 500 W. The low thermal resistance of the SOT-227 contribute to its wide acceptance throughout the industry.

ABSOLUTE MAXIMUM RATINGS				
PARAMETER	SYMBOL	TEST CONDITIONS	MAX.	UNITS
Continuous drain current at $V_{GS}$ 10 V	$I_D$	$T_C = 25\text{ }^\circ\text{C}$	40	A
		$T_C = 90\text{ }^\circ\text{C}$	29	
Pulsed drain current	$I_{DM}^{(1)}$		150	
Power dissipation	$P_D$	$T_C = 25\text{ }^\circ\text{C}$	543	W
		$T_C = 90\text{ }^\circ\text{C}$	261	
Gate to source voltage	$V_{GS}$		$\pm 20$	V
Single pulse avalanche energy	$E_{AS}^{(2)}$		400	mJ
Repetitive avalanche current	$I_{AR}^{(1)}$		13	A
Repetitive avalanche energy	$E_{AR}^{(1)}$		42	mJ
Peak diode recovery dV/dt	dV/dt <sup>(3)</sup>		10	V/ns
Operating junction and storage temperature range	$T_J, T_{Stg}$		-55 to +150	$^\circ\text{C}$
Insulation withstand voltage (AC-RMS)	$V_{ISO}$		2.5	kV
Mounting torque		M4 screw, on terminals and heatsink	1.3	Nm

#### Notes

- (1) Repetitive rating; pulse width limited by maximum junction temperature (see fig. 18)  
 (2) Starting  $T_J = 25\text{ }^\circ\text{C}$ ,  $L = 500\text{ }\mu\text{H}$ ,  $R_g = 2.4\text{ }\Omega$ ,  $I_{AS} = 40\text{ A}$  (see fig. 18)  
 (3)  $I_{SD} \leq 40\text{ A}$ ,  $dI_F/dt \leq 200\text{ A}/\mu\text{s}$ ,  $V_{DD} \leq V_{(BR)DSS}$ ,  $T_J \leq 150\text{ }^\circ\text{C}$

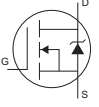


THERMAL - MECHANICAL SPECIFICATIONS						
PARAMETER	SYMBOL	TEST CONDITIONS	MIN.	TYP.	MAX.	UNITS
Junction and storage temperature range	$T_J, T_{Stg}$		-55	-	150	°C
Junction to case	$R_{thJC}$		-	-	0.23	°C/W
Case to heatsink	$R_{thCS}$	Flat, greased surface	-	0.05	-	
Weight			-	30	-	g
Mounting torque		Torque to terminal	-	-	1.1 (9.7)	Nm (lbf.in)
		Torque to heatsink	-	-	1.8 (15.9)	Nm (lbf.in)
Case style			SOT-227			

ELECTRICAL CHARACTERISTICS ( $T_J = 25\text{ °C}$ unless otherwise noted)						
PARAMETER	SYMBOL	TEST CONDITIONS	MIN.	TYP.	MAX.	UNITS
Drain to source breakdown voltage	$V_{(BR)DSS}$	$V_{GS} = 0\text{ V}, I_D = 1.0\text{ mA}$	500	-	-	V
Breakdown voltage temperature coefficient	$\Delta V_{(BR)DSS}/\Delta T_J$	Reference to $25\text{ °C}, I_D = 1\text{ mA}$	-	0.65	-	V/°C
Static drain to source on-resistance	$R_{DS(on)}^{(1)}$	$V_{GS} = 10\text{ V}, I_D = 23\text{ A}$	-	106	130	mΩ
Gate threshold voltage	$V_{GS(th)}$	$V_{DS} = V_{GS}, I_D = 250\text{ }\mu\text{A}$	2	3	4	V
		$V_{DS} = V_{GS}, I_D = 250\text{ }\mu\text{A}, T_J = 125\text{ °C}$	-	1.9	-	
Forward transconductance	$g_{fs}$	$V_{DS} = 50\text{ V}, I_D = 23\text{ A}$	-	29	-	S
Drain to source leakage current	$I_{DSS}$	$V_{DS} = 500\text{ V}, V_{GS} = 0\text{ V}$	-	0.5	50	μA
		$V_{DS} = 500\text{ V}, V_{GS} = 0\text{ V}, T_J = 125\text{ °C}$	-	30	500	
		$V_{DS} = 500\text{ V}, V_{GS} = 0\text{ V}, T_J = 150\text{ °C}$	-	0.2	3	mA
Gate to source forward leakage	$I_{GSS}$	$V_{GS} = 20\text{ V}$	-	-	200	nA
Gate to source reverse leakage		$V_{GS} = -20\text{ V}$	-	-	-200	
Total gate charge	$Q_g$	$I_D = 38\text{ A}$	-	280	420	nC
Gate to source charge	$Q_{gs}$	$V_{DS} = 400\text{ V}$	-	37	55	
Gate to drain ("Miller") charge	$Q_{gd}$	$V_{GS} = 10\text{ V}$ ; see fig. 15 and 19 <sup>(1)</sup>	-	150	220	
Turn-on delay time	$t_{d(on)}$	$V_{DD} = 250\text{ V}, I_D = 40\text{ A}, R_g = 2.4\text{ }\Omega,$ $L = 500\text{ }\mu\text{H},$ diode used: 60APH06	-	143	-	ns
Rise time	$t_r$		-	33	-	
Turn-off delay time	$t_{d(off)}$		-	107	-	
Fall time	$t_f$		-	36	-	
Turn-on delay time	$t_{d(on)}$	$V_{DD} = 250\text{ V}, I_D = 40\text{ A}, R_g = 2.4\text{ }\Omega,$ $L = 500\text{ }\mu\text{H}, T_J = 125\text{ °C},$ diode used: 60APH06	-	145	-	ns
Rise time	$t_r$		-	35	-	
Turn-off delay time	$t_{d(off)}$		-	110	-	
Fall time	$t_f$		-	40	-	
Internal source inductance	$L_S$	Between lead, and center of die contact	-	5	-	nH
Input capacitance	$C_{iss}$	$V_{GS} = 0\text{ V}$	-	6900	-	pF
Output capacitance	$C_{oss}$	$V_{DS} = 25\text{ V}$	-	1600	-	
Reverse transfer capacitance	$C_{rss}$	$f = 1.0\text{ MHz}$ , see fig. 14	-	580	-	

**Note**

<sup>(1)</sup> Pulse width  $\leq 300\text{ }\mu\text{s}$ , duty cycle  $\leq 2\%$

SOURCE-DRAIN RATINGS AND CHARACTERISTICS						
PARAMETER	SYMBOL	TEST CONDITIONS	MIN.	TYP.	MAX.	UNITS
Continuous source current (body diode)	$I_S$	MOSFET symbol showing the integral reverse p-n junction diode. 	-	-	38	A
Pulsed source current (body diode)	$I_{SM}^{(1)}$		-	-	150	
Diode forward voltage	$V_{SD}^{(2)}$	$T_J = 25\text{ }^\circ\text{C}$ , $I_S = 38\text{ A}$ , $V_{GS} = 0\text{ V}$	-	0.9	1.31	V
		$T_J = 125\text{ }^\circ\text{C}$ , $I_S = 38\text{ A}$ , $V_{GS} = 0\text{ V}$	-	0.75	-	
Reverse recovery time	$t_{rr}$	$T_J = 25\text{ }^\circ\text{C}$ , $I_F = 40\text{ A}$ ; $dI_F/dt = 100\text{ A}/\mu\text{s}^{(2)}$	-	560	-	ns
Reverse recovery current	$I_{rr}$		-	40	-	A
Reverse recovery charge	$Q_{rr}$		-	11	-	$\mu\text{C}$
Reverse recovery time	$t_{rr}$	$T_J = 25\text{ }^\circ\text{C}$ , $I_F = 40\text{ A}$ ; $dI_F/dt = 100\text{ A}/\mu\text{s}^{(2)}$	-	680	-	ns
Reverse recovery current	$I_{rr}$		-	47	-	A
Reverse recovery charge	$Q_{rr}$		-	16	-	$\mu\text{C}$
Forward turn-on time	$t_{on}$	Intrinsic turn-on time is negligible (turn-on is dominated by $L_S + L_D$ )				

**Notes**

- (1) Repetitive rating; pulse width limited by maximum junction temperature (see fig. 18)
- (2) Pulse width  $\leq 300\text{ }\mu\text{s}$ , duty cycle  $\leq 2\%$

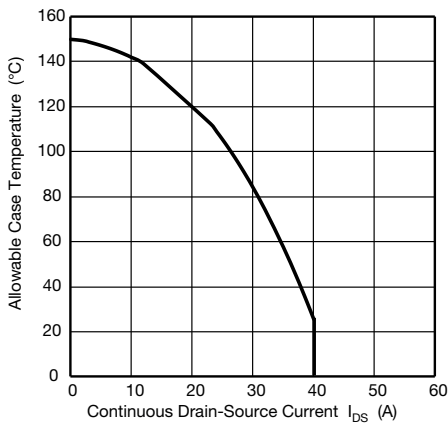


Fig. 1 - Maximum DC MOSFET Drain-Source Current vs. Case Temperature

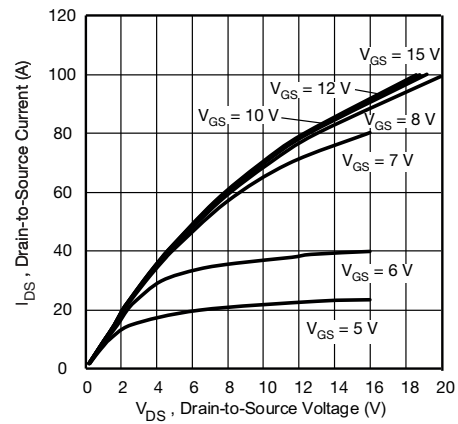


Fig. 3 - Typical Drain-to-Source Current Output Characteristics at  $T_J = 25\text{ }^\circ\text{C}$

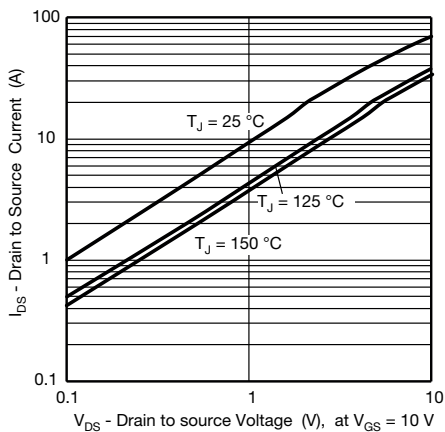


Fig. 2 - Typical Drain-to-Source Current Output Characteristics;  $V_{GS} = 10\text{ V}$

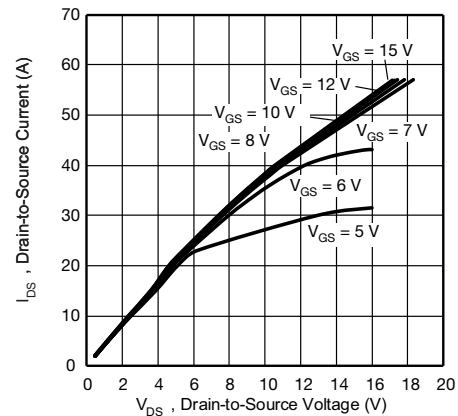


Fig. 4 - Typical Drain-to-Source Current Output Characteristics at  $T_J = 125\text{ }^\circ\text{C}$

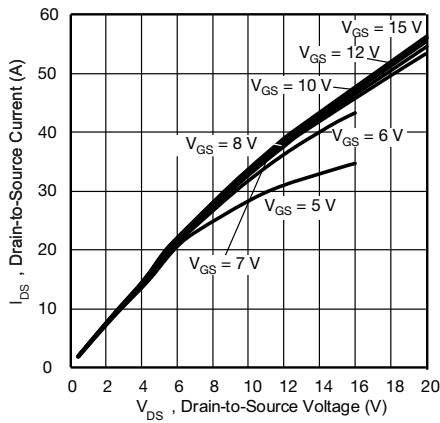


Fig. 5 - Typical Drain-to-Source Current Output Characteristics at  $T_J = 150\text{ }^\circ\text{C}$

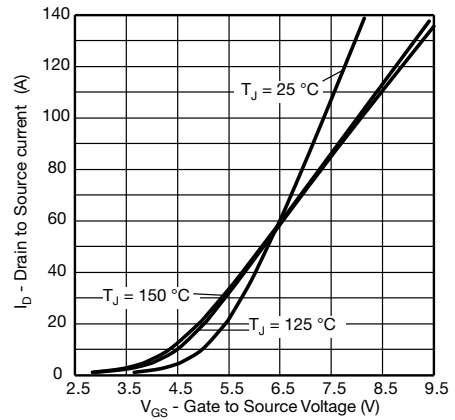


Fig. 8 - Typical MOSFET Transfer Characteristics

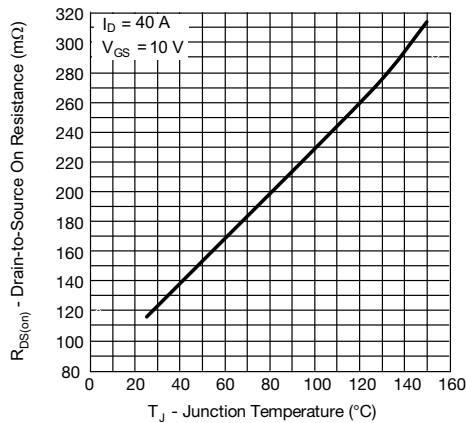


Fig. 6 - Normalized On-Resistance vs. Temperature

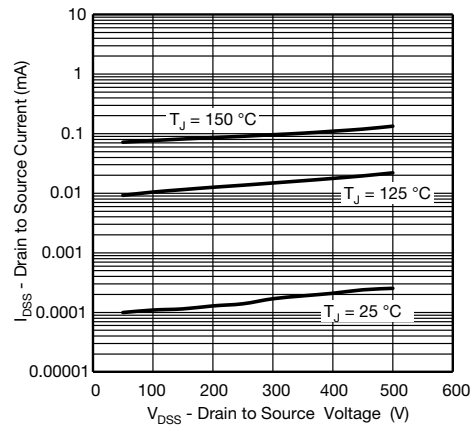


Fig. 9 - Typical MOSFET Zero Gate Voltage Drain Current

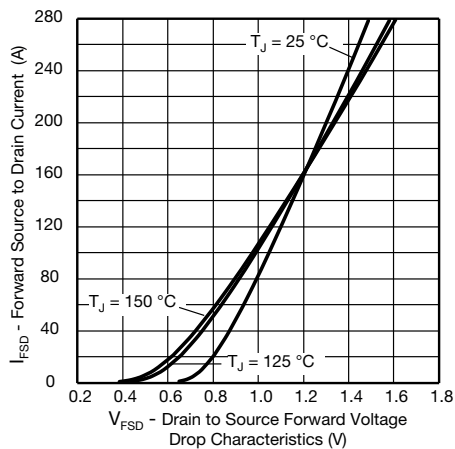


Fig. 7 - Typical Body Diode Forward Voltage Drop Characteristics

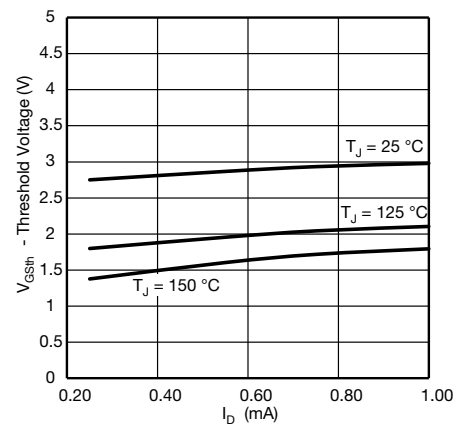


Fig. 10 - Typical MOSFET Threshold Voltage

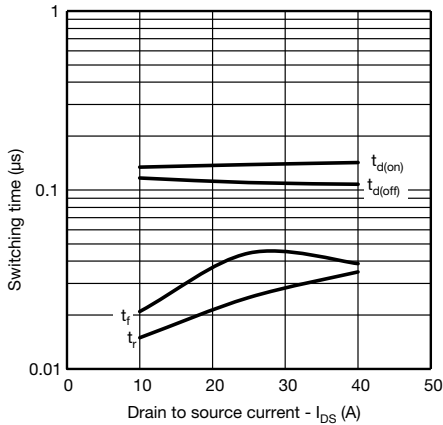


Fig. 11 - Typical MOSFET Switching Time vs.  $I_{DS}$ ,  $T_J = 125^\circ\text{C}$ ,  $V_{DD} = 250\text{ V}$ ,  $V_{GS} = 10\text{ V}$ ,  $L = 500\ \mu\text{H}$ ,  $R_G = 2.4\ \Omega$   
Diode used 60APH06

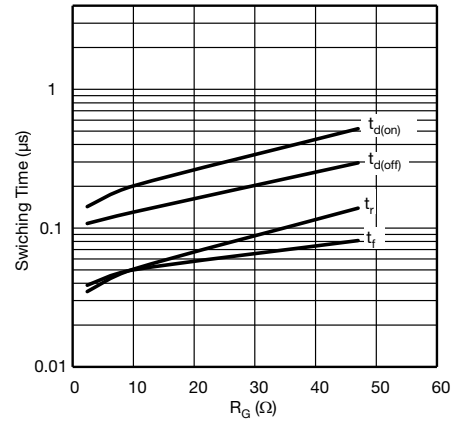


Fig. 12 - Typical MOSFET Switching Time vs.  $R_G$ ,  $T_J = 125^\circ\text{C}$ ,  $I_{DS} = 40\text{ A}$ ,  $V_{DD} = 250\text{ V}$ ,  $V_{GS} = 10\text{ V}$ ,  $L = 500\ \mu\text{H}$   
Diode used 60APH06

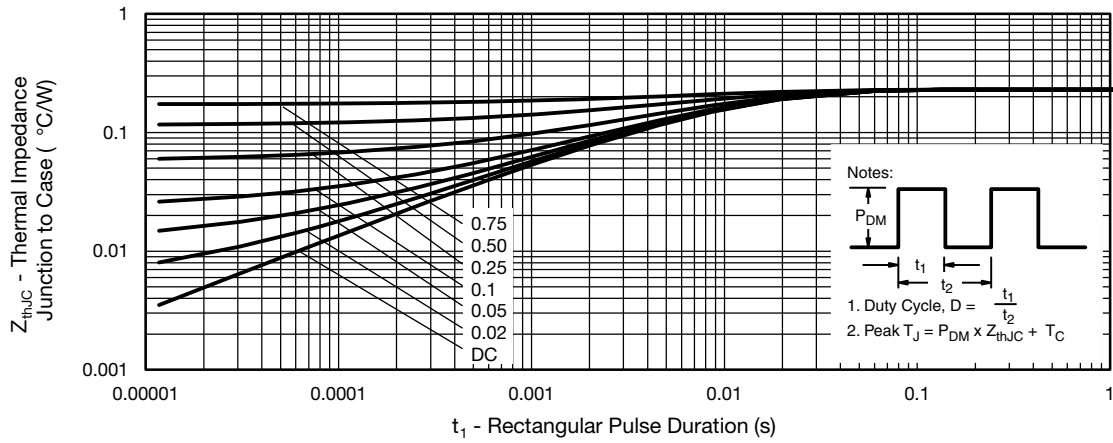


Fig. 13 - Maximum Thermal Impedance  $Z_{thJC}$  Characteristics, MOSFET

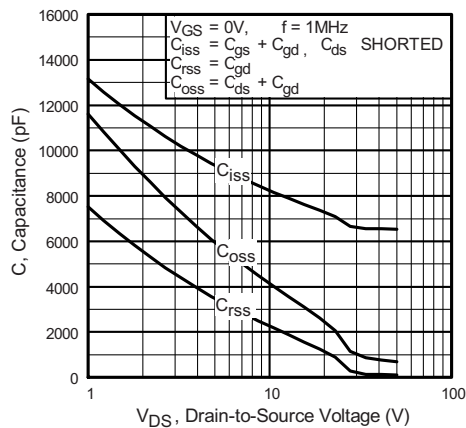


Fig. 14 - Typical Capacitance vs. Drain to Source Voltage

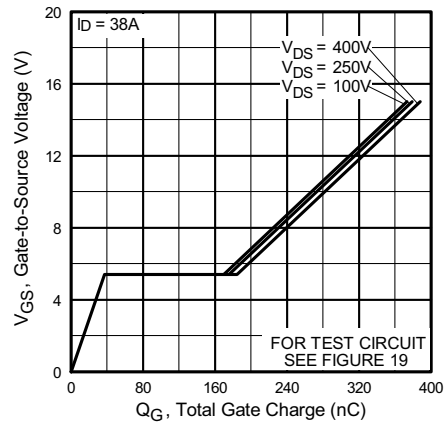


Fig. 15 - Typical Gate Charge vs. Gate to Source Voltage

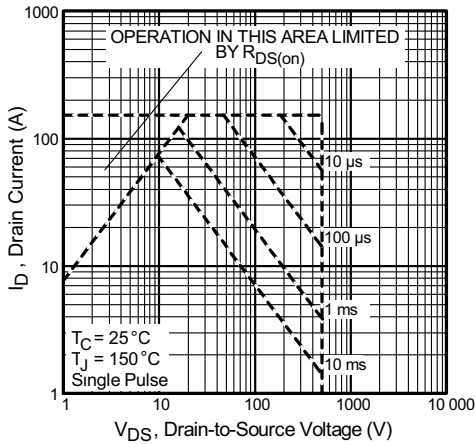


Fig. 16 - Maximum Safe Operating Area

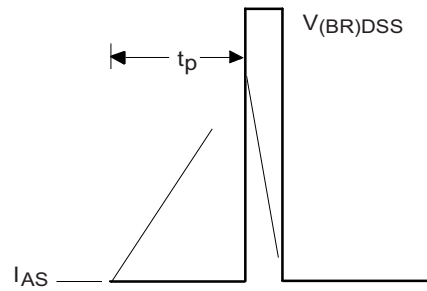


Fig. 20 - Unclamped Inductive Waveforms

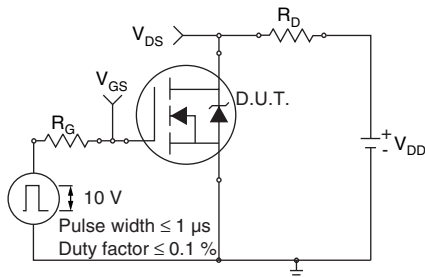


Fig. 17 - Switching Time Test Circuit

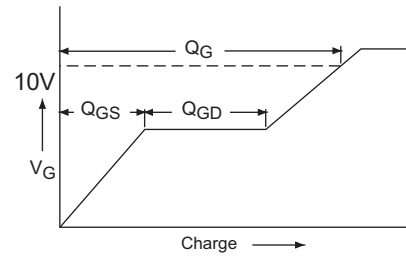


Fig. 21 - Basic Gate Charge Waveform

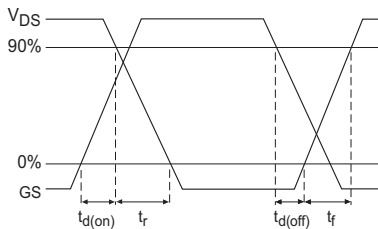


Fig. 18 - Switching Time Waveforms

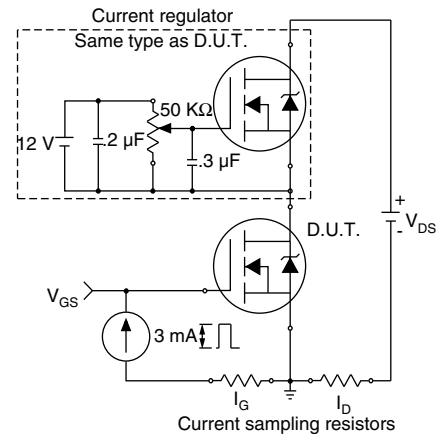


Fig. 22 - Gate Charge Test Circuit

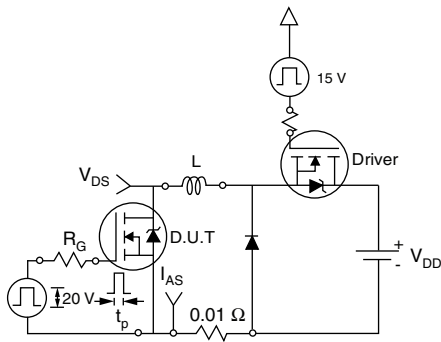


Fig. 19 - Unclamped Inductive Test Circuit

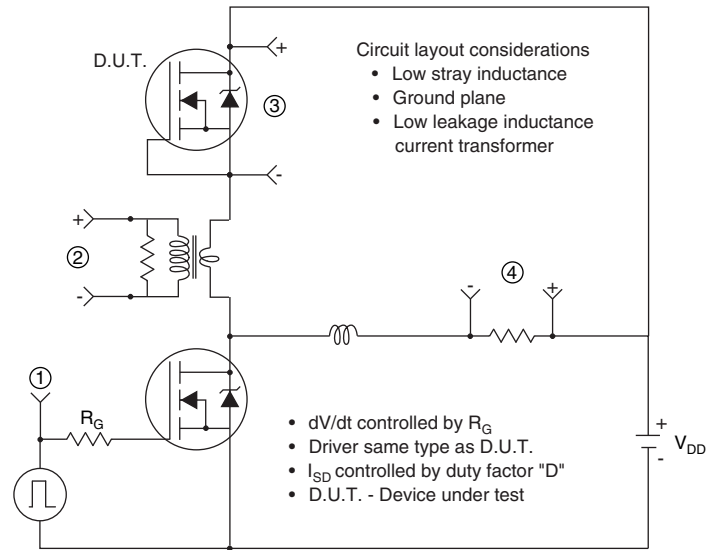
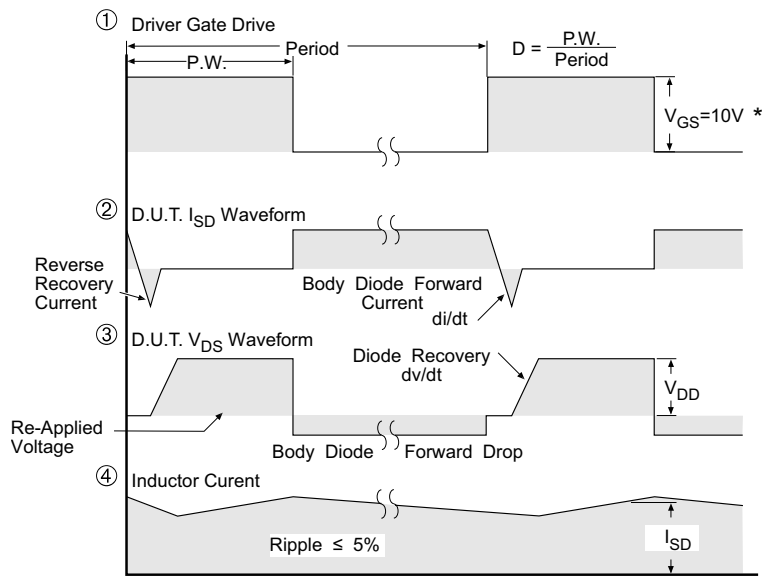


Fig. 23 - Peak Diode Recovery  $dv/dt$  Test Circuit



\*  $V_{GS} = 5V$  for Logic Level Devices

Fig. 24 - For N-Channel Power MOSFETs

## ORDERING INFORMATION TABLE

Device code	<b>VS-</b>	<b>F</b>	<b>A</b>	<b>40</b>	<b>S</b>	<b>A</b>	<b>50</b>	<b>LC</b>
	1	2	3	4	5	6	7	8

- 1** - Vishay Semiconductors product
- 2** - Power MOSFET
- 3** - A = generation 3, MOSFET silicon die
- 4** - Current rating (40 = 40 A)
- 5** - Single switch
- 6** - Package indicator (SOT-227)
- 7** - Voltage rating (50 = 500 V)
- 8** - LC = low charge

CIRCUIT CONFIGURATION		
CIRCUIT	CIRCUIT CONFIGURATION CODE	CIRCUIT DRAWING
Single switch	S	

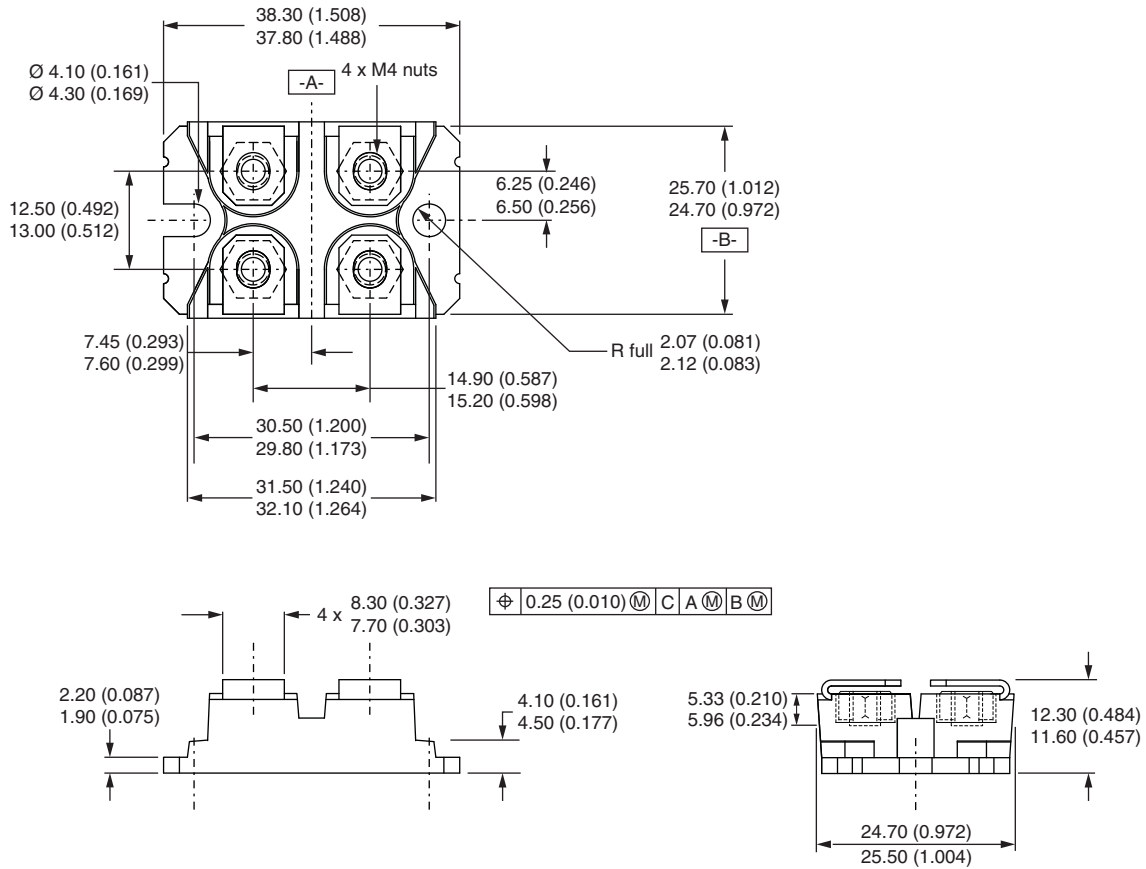
LINKS TO RELATED DOCUMENTS	
Dimensions	<a href="http://www.vishay.com/doc?95423">www.vishay.com/doc?95423</a>
Packaging information	<a href="http://www.vishay.com/doc?95425">www.vishay.com/doc?95425</a>





## SOT-227 Generation 2

**DIMENSIONS** in millimeters (inches)



**Note**

- Controlling dimension: millimeter



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