

## Power MOSFET



N-Channel MOSFET

### FEATURES

- Dynamic dV/dt rating
- 175 °C operating temperature
- Fast switching
- Ease of paralleling
- Simple drive requirements
- Material categorization: for definitions of compliance please see [www.vishay.com/doc?99912](http://www.vishay.com/doc?99912)



### Note

\* This datasheet provides information about parts that are RoHS-compliant and / or parts that are non RoHS-compliant. For example, parts with lead (Pb) terminations are not RoHS-compliant. Please see the information / tables in this datasheet for details

### DESCRIPTION

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

The TO-220AB package is universally preferred for commercial-industrial applications at power dissipation levels to approximately 50 W. The low thermal resistance and low package cost of the TO-220AB contribute to its wide acceptance throughout the industry.

PRODUCT SUMMARY	
$V_{DS}$ (V)	60
$R_{DS(on)}$ ( $\Omega$ )	$V_{GS} = 10\text{ V}$ 0.028
$Q_g$ (Max.) (nC)	67
$Q_{gs}$ (nC)	18
$Q_{gd}$ (nC)	25
Configuration	Single

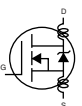
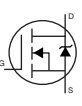
ORDERING INFORMATION	
Package	TO-220AB
Lead (Pb)-free	IRFZ40PbF
Lead (Pb)-free and halogen-free	IRFZ40PbF-BE3

ABSOLUTE MAXIMUM RATINGS ( $T_C = 25\text{ }^\circ\text{C}$ , unless otherwise noted)				
PARAMETER		SYMBOL	LIMIT	UNIT
Drain-source voltage		$V_{DS}$	60	V
Gate-source voltage		$V_{GS}$	$\pm 20$	
Continuous drain current	$V_{GS}$ at 10 V	$I_D$	$T_C = 25\text{ }^\circ\text{C}$	A
			$T_C = 100\text{ }^\circ\text{C}$	
Pulsed drain current <sup>a</sup>		$I_{DM}$	200	
Linear derating factor			1.0	W/ $^\circ\text{C}$
Single pulse avalanche energy <sup>b</sup>		$E_{AS}$	100	mJ
Maximum power dissipation		$P_D$	150	W
Peak diode recovery dV/dt <sup>c</sup>		dV/dt	4.5	V/ns
Operating junction and storage temperature range		$T_J, T_{stg}$	-55 to +175	$^\circ\text{C}$
Soldering recommendations (peak temperature) <sup>d</sup>		For 10 s	300	
Mounting torque	6-32 or M3 screw		10	lbf · in
			1.1	N · m

### Notes

- Repetitive rating; pulse width limited by maximum junction temperature (see fig. 11)
- $V_{DD} = 25\text{ V}$ , starting  $T_J = 25\text{ }^\circ\text{C}$ ,  $L = 44\text{ }\mu\text{H}$ ,  $R_g = 25\text{ }\Omega$ ,  $I_{AS} = 51\text{ A}$  (see fig. 12)
- $I_{SD} \leq 51\text{ A}$ ,  $dI/dt \leq 250\text{ A}/\mu\text{s}$ ,  $V_{DD} \leq V_{DS}$ ,  $T_J \leq 175\text{ }^\circ\text{C}$
- 1.6 mm from case
- Current limited by the package, (die current = 51 A)

THERMAL RESISTANCE RATINGS				
PARAMETER	SYMBOL	TYP.	MAX.	UNIT
Maximum junction-to-ambient	$R_{thJA}$	-	62	°C/W
Case-to-sink, flat, greased surface	$R_{thCS}$	0.50	-	
Maximum junction-to-case (drain)	$R_{thJC}$	-	1.0	

SPECIFICATIONS ( $T_J = 25\text{ }^\circ\text{C}$ , unless otherwise noted)							
PARAMETER	SYMBOL	TEST CONDITIONS		MIN.	TYP.	MAX.	UNIT
<b>Static</b>							
Drain-source breakdown voltage	$V_{DS}$	$V_{GS} = 0\text{ V}, I_D = 250\text{ }\mu\text{A}$		60	-	-	V
$V_{DS}$ temperature coefficient	$\Delta V_{DS}/T_J$	Reference to $25\text{ }^\circ\text{C}$ , $I_D = 1\text{ mA}$		-	0.060	-	V/°C
Gate-source threshold voltage	$V_{GS(th)}$	$V_{DS} = V_{GS}, I_D = 250\text{ }\mu\text{A}$		2.0	-	4.0	V
Gate-source leakage	$I_{GSS}$	$V_{GS} = \pm 20\text{ V}$		-	-	$\pm 100$	nA
Zero gate voltage drain current	$I_{DSS}$	$V_{DS} = 60\text{ V}, V_{GS} = 0\text{ V}$		-	-	25	$\mu\text{A}$
		$V_{DS} = 48\text{ V}, V_{GS} = 0\text{ V}, T_J = 125\text{ }^\circ\text{C}$		-	-	250	
Drain-source on-state resistance	$R_{DS(on)}$	$V_{GS} = 10\text{ V}$	$I_D = 31\text{ A}^b$	-	-	0.028	$\Omega$
Forward transconductance	$g_{fs}$	$V_{DS} = 25\text{ V}, I_D = 31\text{ A}$		15	-	-	S
<b>Dynamic</b>							
Input capacitance	$C_{iss}$	$V_{GS} = 0\text{ V}, V_{DS} = 25\text{ V}, f = 1.0\text{ MHz}$ , see fig. 5		-	1900	-	pF
Output capacitance	$C_{oss}$			-	920	-	
Reverse transfer capacitance	$C_{rss}$			-	170	-	
Total gate charge	$Q_g$	$V_{GS} = 10\text{ V}$	$I_D = 51\text{ A}, V_{DS} = 48\text{ V}$ , see fig. 6 and 13 <sup>b</sup>	-	-	67	nC
Gate-source charge	$Q_{gs}$			-	-	18	
Gate-drain charge	$Q_{gd}$			-	-	25	
Turn-on delay time	$t_{d(on)}$	$V_{DD} = 30\text{ V}, I_D = 51\text{ A}, R_g = 9.1\text{ }\Omega, R_D = 0.55\text{ }\Omega$ , see fig. 10 <sup>b</sup>		-	14	-	ns
Rise time	$t_r$			-	110	-	
Turn-off delay time	$t_{d(off)}$			-	45	-	
Fall time	$t_f$			-	92	-	
Internal drain inductance	$L_D$	Between lead, 6 mm (0.25") from package and center of die contact 		-	4.5	-	nH
Internal source inductance	$L_S$			-	7.5	-	
<b>Drain-Source Body Diode Characteristics</b>							
Continuous source-drain diode current	$I_S$	MOSFET symbol showing the integral reverse p - n junction diode 		-	-	50	A
Pulsed diode forward current <sup>a</sup>	$I_{SM}$			-	-	200	
Body diode voltage	$V_{SD}$	$T_J = 25\text{ }^\circ\text{C}, I_S = 51\text{ A}, V_{GS} = 0\text{ V}^b$		-	-	2.5	V
Body diode reverse recovery time	$t_{rr}$	$T_J = 25\text{ }^\circ\text{C}, I_F = 51\text{ A}, dI/dt = 100\text{ A}/\mu\text{s}$		-	120	180	ns
Body diode reverse recovery charge	$Q_{rr}$			-	0.53	0.80	nC
Forward turn-on time	$t_{on}$	Intrinsic turn-on time is negligible (turn-on is dominated by $L_S$ and $L_D$ )					

**Notes**

- a. Repetitive rating; pulse width limited by maximum junction temperature (see fig. 11)  
 b. Pulse width  $\leq 300\text{ }\mu\text{s}$ ; duty cycle  $\leq 2\%$

**TYPICAL CHARACTERISTICS** (25 °C, unless otherwise noted)

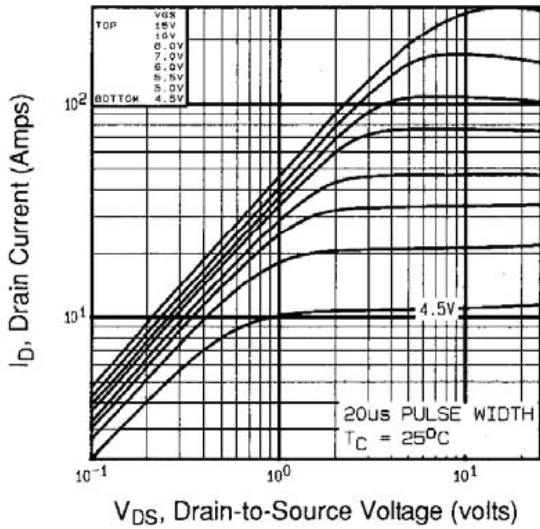


Fig. 1 - Typical Output Characteristics,  $T_C = 25\text{ }^\circ\text{C}$

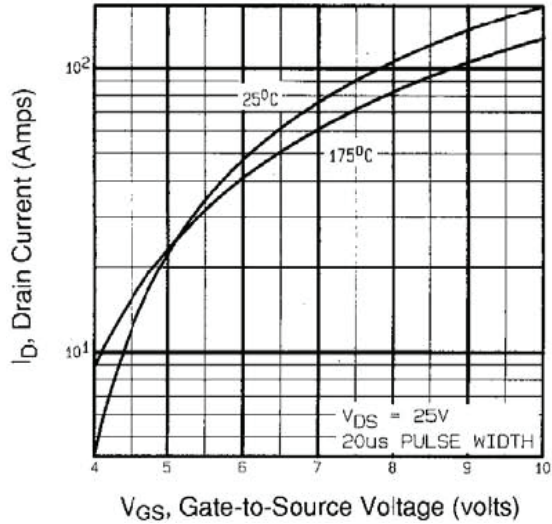


Fig. 3 - Typical Transfer Characteristics

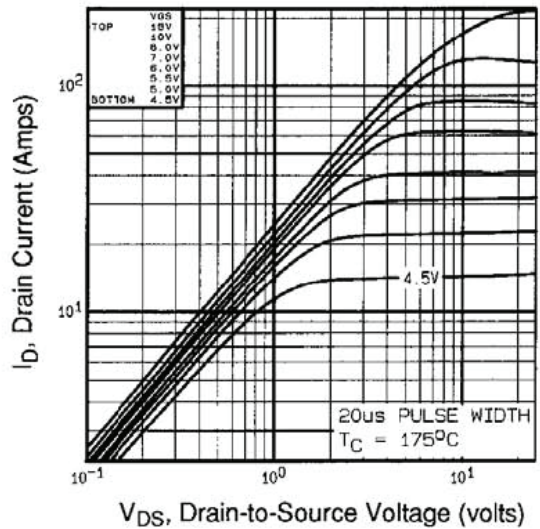


Fig. 2 - Typical Output Characteristics,  $T_C = 175\text{ }^\circ\text{C}$

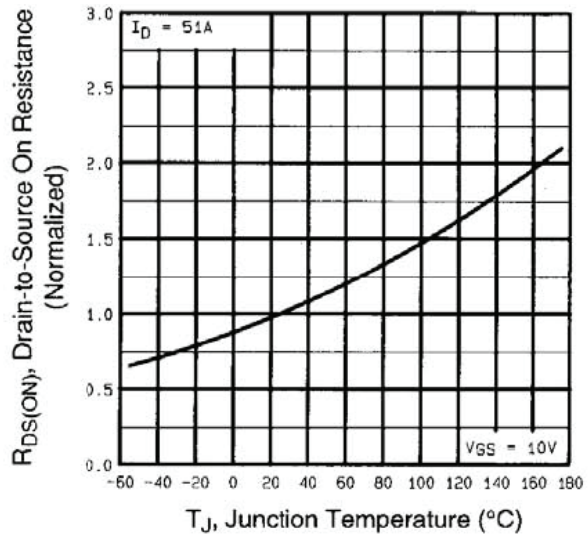


Fig. 4 - Normalized On-Resistance vs. Temperature

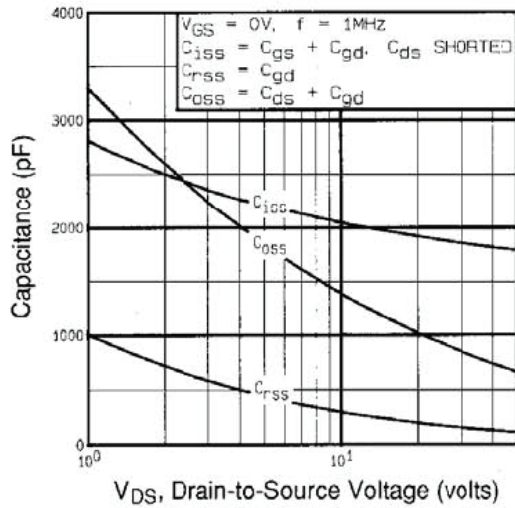


Fig. 5 - Typical Capacitance vs. Drain-to-Source Voltage

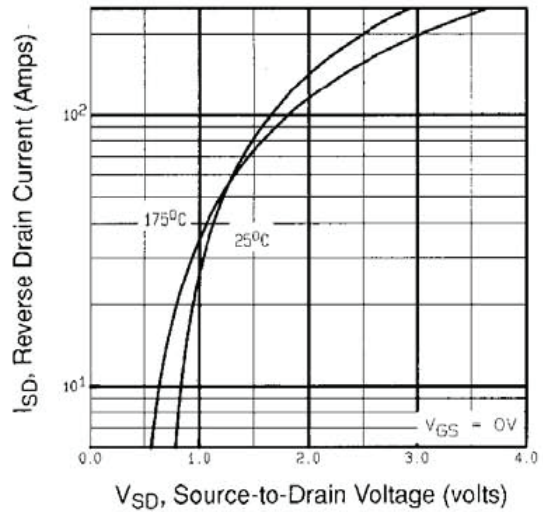


Fig. 7 - Typical Source-Drain Diode Forward Voltage

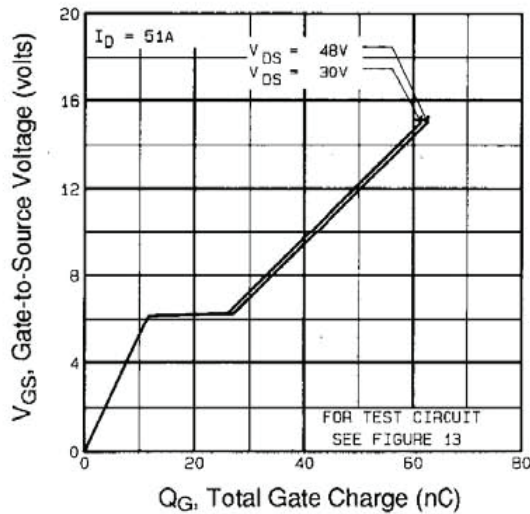


Fig. 6 - Typical Gate Charge vs. Gate-to-Source Voltage

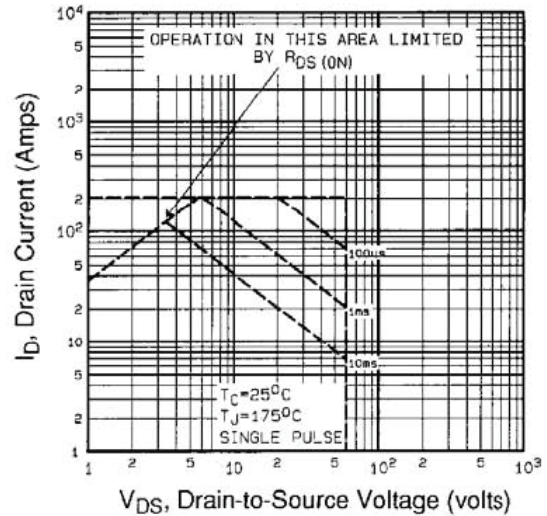


Fig. 8 - Maximum Safe Operating Area

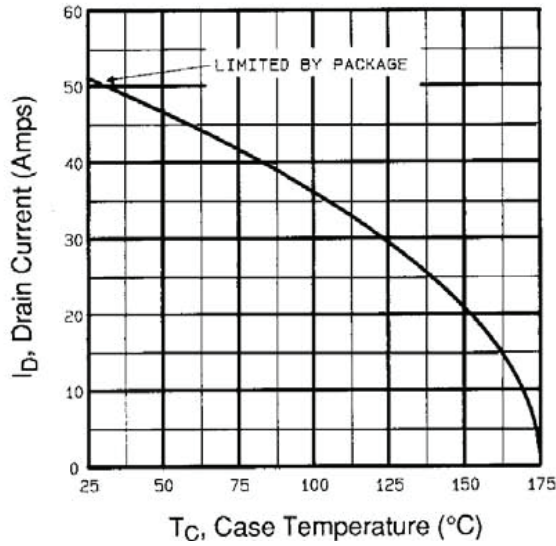


Fig. 9 - Maximum Drain Current vs. Case Temperature

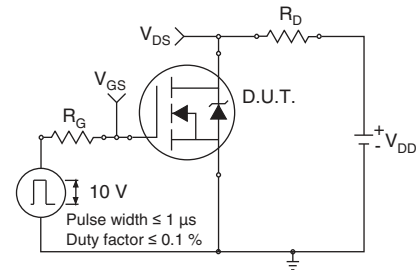


Fig. 10a - Switching Time Test Circuit



Fig. 10b - Switching Time Waveforms

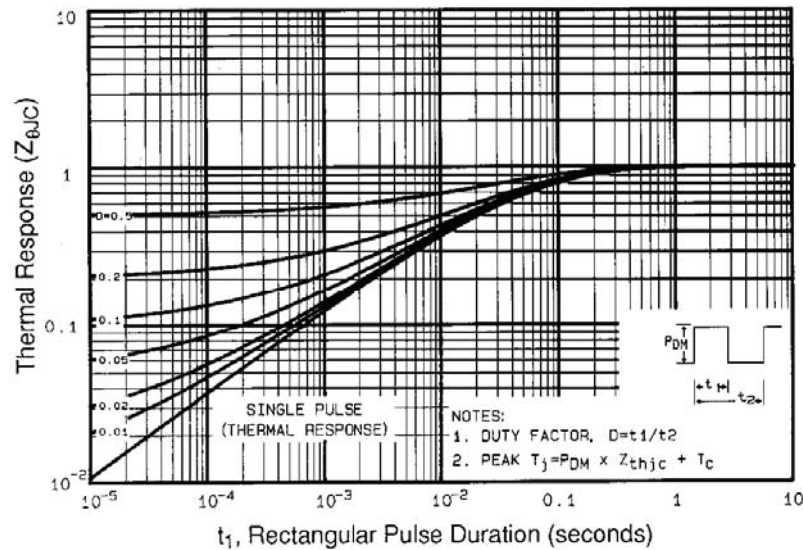


Fig. 11 - Maximum Effective Transient Thermal Impedance, Junction-to-Case

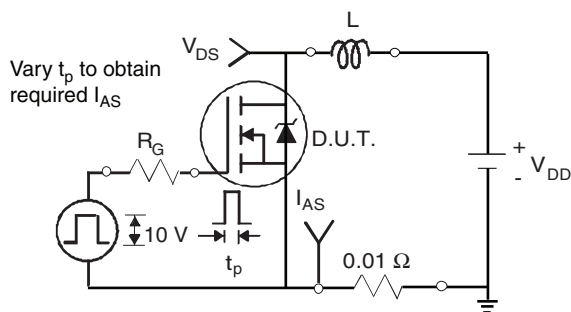


Fig. 12a - Unclamped Inductive Test Circuit

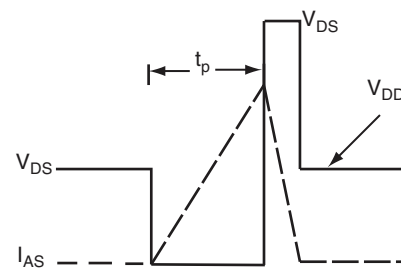


Fig. 12b - Unclamped Inductive Waveforms

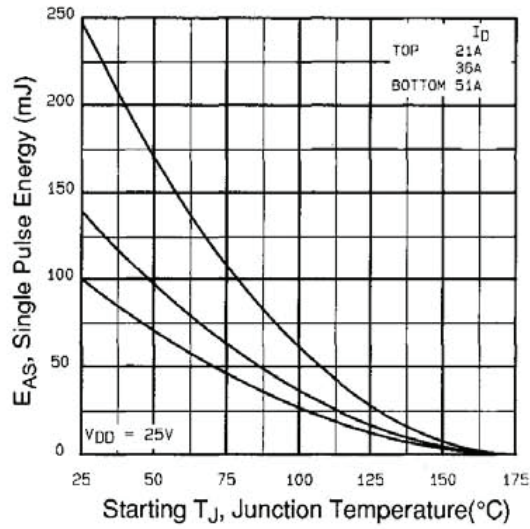


Fig. 12c - Maximum Avalanche Energy vs. Drain Current

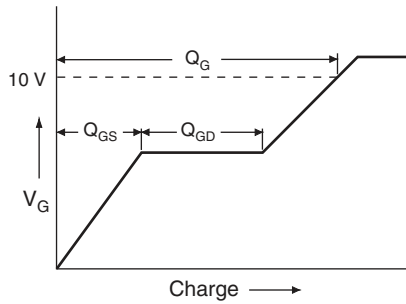


Fig. 13a - Basic Gate Charge Waveform

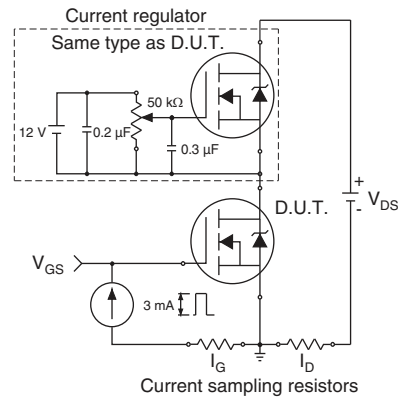
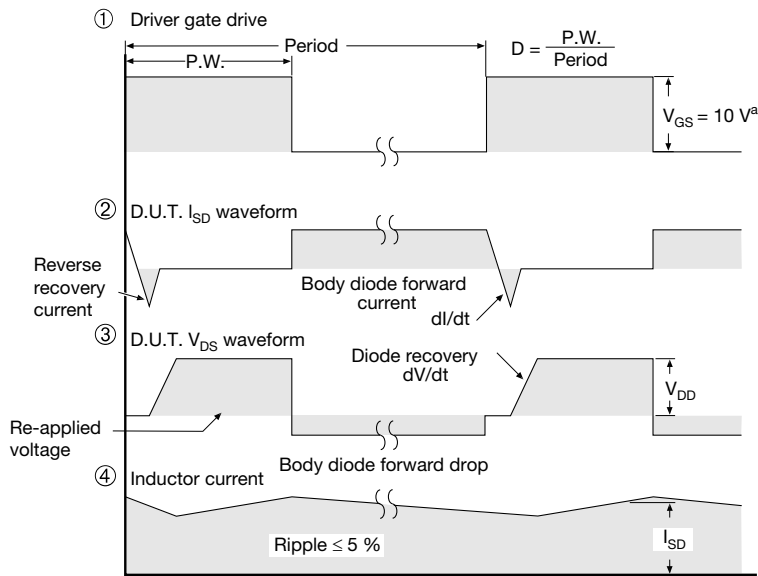
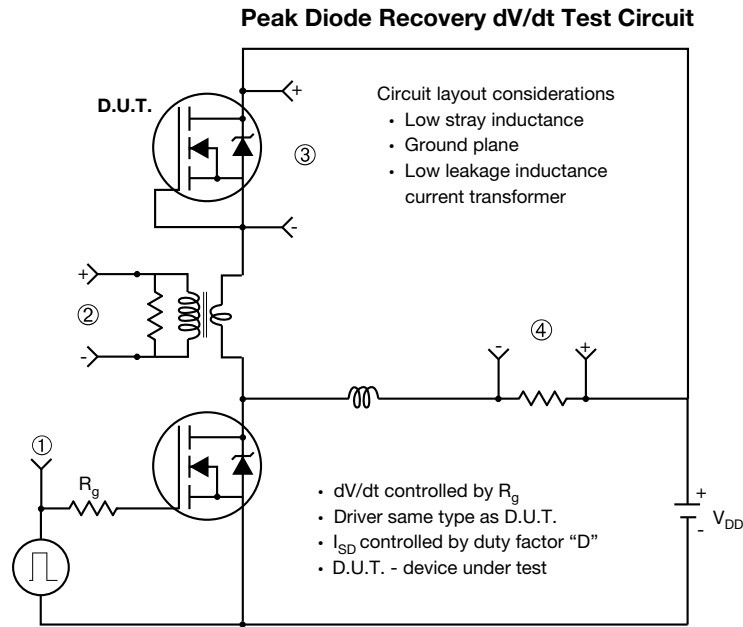


Fig. 13b - Gate Charge Test



**Note**

a.  $V_{GS} = 5 V$  for logic level devices

**Fig. 14 - For N-Channel**

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