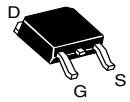
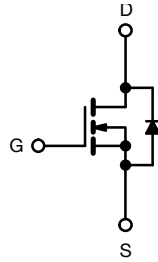
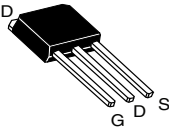


## Power MOSFET

**DKPAK (TO-252)**

**IPAK (TO-251)**


N-Channel MOSFET

### FEATURES

- Dynamic dV/dt rating
- Repetitive avalanche rated
- Surface-mount (IRFR210, SiHFR210)
- Straight lead (IRFU210, SiHFU210)
- Available in tape and reel
- Fast switching
- Ease of paralleling
- Material categorization: for definitions of compliance please see [www.vishay.com/doc?99912](http://www.vishay.com/doc?99912)



**RoHS**  
COMPLIANT  
HALOGEN  
**FREE**  
Available

### PRODUCT SUMMARY

$V_{DS}$ (V)	200	
$R_{DS(on)}$ ( $\Omega$ )	$V_{GS} = 10\text{ V}$	1.5
$Q_g$ max. (nC)	8.2	
$Q_{gs}$ (nC)	1.8	
$Q_{gd}$ (nC)	4.5	
Configuration	Single	

### 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 DPAK is designed for surface mounting using vapor phase, infrared, or wave soldering techniques. The straight lead version (IRFU, SiHFU series) is for through-hole mounting applications. Power dissipation levels up to 1.5 W are possible in typical surface mount applications.

### ORDERING INFORMATION

PACKAGE	DKPAK (TO-252)	DKPAK (TO-252)	DKPAK (TO-252)	DKPAK (TO-252)	IPAK (TO-251)
Lead (Pb)-free and halogen-free	SiHFR210-GE3	SiHFR210TRL-GE3 <sup>a</sup>	-	SiHFR210TRR-GE3 <sup>a</sup>	SiHFU210-GE3
Lead (Pb)-free	IRFR210PbF	IRFR210TRLPbF <sup>a</sup>	IRFR210TRPbF <sup>a</sup>	IRFR210TRRPbF	IRFU210PbF
Lead (Pb)-free and halogen-free	IRFR210PbF-BE3 <sup>ab</sup>	IRFR210TRLPbF-BE3 <sup>ab</sup>	IRFR210TRPbF-BE3 <sup>ab</sup>	-	-

#### Notes

- See device orientation
- “-BE3” denotes alternate manufacturing location

### ABSOLUTE MAXIMUM RATINGS ( $T_C = 25\text{ }^\circ\text{C}$ , unless otherwise noted)

PARAMETER	SYMBOL	LIMIT	UNIT
Drain-source voltage	$V_{DS}$	200	V
Gate-source voltage	$V_{GS}$	$\pm 20$	
Continuous drain current	$V_{GS}$ at 10 V	$T_C = 25\text{ }^\circ\text{C}$	2.6
		$T_C = 100\text{ }^\circ\text{C}$	1.7
Pulsed drain current <sup>a</sup>	$I_{DM}$	10	A
Linear derating factor		0.20	W/ $^\circ\text{C}$
Linear derating factor (PCB mount) <sup>e</sup>		0.020	
Single pulse avalanche Energy <sup>b</sup>	$E_{AS}$	95	mJ
Avalanche current <sup>a</sup>	$I_{AR}$	2.7	A
Repetitive avalanche energy <sup>a</sup>	$E_{AR}$	2.5	mJ
Maximum power dissipation	$P_D$	$T_C = 25\text{ }^\circ\text{C}$	25
Maximum power dissipation (PCB mount) <sup>e</sup>		$T_A = 25\text{ }^\circ\text{C}$	2.5
Peak diode recovery dV/dt <sup>c</sup>	dV/dt	5.0	V/ns
Operating junction and storage temperature range	$T_J, T_{stg}$	-55 to +150	$^\circ\text{C}$
Soldering recommendations (peak temperature) <sup>d</sup>	for 10 s	260	

#### Notes

- Repetitive rating; pulse width limited by maximum junction temperature (see fig. 11)
- $V_{DD} = 50\text{ V}$ , starting  $T_J = 25\text{ }^\circ\text{C}$ ,  $L = 28\text{ mH}$ ,  $R_g = 25\text{ }\Omega$ ,  $I_{AS} = 2.6\text{ A}$  (see fig. 12)
- $I_{SD} \leq 2.6\text{ A}$ ,  $dI/dt \leq 70\text{ A}/\mu\text{s}$ ,  $V_{DD} \leq V_{DS}$ ,  $T_J \leq 150\text{ }^\circ\text{C}$
- 1.6 mm from case
- When mounted on 1" square PCB (FR-4 or G-10 material)



THERMAL RESISTANCE RATINGS						
PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNIT	
Maximum junction-to-ambient	$R_{thJA}$	-	-	110	°C/W	
Maximum junction-to-ambient (PCB mount) <sup>a</sup>	$R_{thJA}$	-	-	50		
Maximum junction-to-case (drain)	$R_{thJC}$	-	-	5.0		

**Note**

a. When mounted on 1" square PCB (FR-4 or G-10 material)

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	$V_{DS}$	$V_{GS} = 0\text{ V}, I_D = 250\text{ }\mu\text{A}$		200	-	-	V
$V_{DS}$ temperature coefficient	$\Delta V_{DS}/T_J$	Reference to $25\text{ }^\circ\text{C}$ , $I_D = 1\text{ mA}$		-	0.30	-	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	$I_{DSS}$	$V_{DS} = 200\text{ V}, V_{GS} = 0\text{ V}$		-	-	25	$\mu\text{A}$
		$V_{DS} = 160\text{ V}, V_{GS} = 0\text{ V}, T_J = 125\text{ }^\circ\text{C}$		-	-	250	
Drain-source on-state resistance	$R_{DS(on)}$	$V_{GS} = 10\text{ V}$	$I_D = 1.6\text{ A}^b$	-	-	1.5	$\Omega$
Forward transconductance	$g_{fs}$	$V_{DS} = 50\text{ V}, I_D = 1.6\text{ A}^b$		0.80	-	-	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		-	140	-	$\mu\text{F}$
Output capacitance	$C_{oss}$			-	53	-	
Reverse transfer capacitance	$C_{rss}$			-	15	-	
Total gate charge	$Q_g$	$V_{GS} = 10\text{ V}$	$I_D = 3.3\text{ A}, V_{DS} = 160\text{ V},$ see fig. 6 and 13 <sup>b</sup>	-	-	8.2	nC
Gate-source charge	$Q_{gs}$			-	-	1.8	
Gate-drain charge	$Q_{gd}$			-	-	4.5	
Turn-on delay time	$t_{d(on)}$	$V_{DD} = 100\text{ V}, I_D = 3.3\text{ A},$ $R_g = 24\text{ }\Omega, R_D = 30\text{ }\Omega$ , see fig. 10 <sup>b</sup>		-	8.2	-	ns
Rise time	$t_r$			-	17	-	
Turn-off delay time	$t_{d(off)}$			-	14	-	
Fall time	$t_f$			-	8.9	-	
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		-	-	2.6	A
Pulsed diode forward current <sup>a</sup>	$I_{SM}$			-	-	10	
Body diode voltage	$V_{SD}$	$T_J = 25\text{ }^\circ\text{C}, I_S = 2.6\text{ A}, V_{GS} = 0\text{ V}^b$		-	-	2.0	V
Body diode reverse recovery time	$t_{rr}$	$T_J = 25\text{ }^\circ\text{C}, I_F = 3.3\text{ A}, dI/dt = 100\text{ A}/\mu\text{s}^b$		-	150	310	ns
Body diode reverse recovery charge	$Q_{rr}$			-	0.60	1.4	$\mu\text{C}$
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)

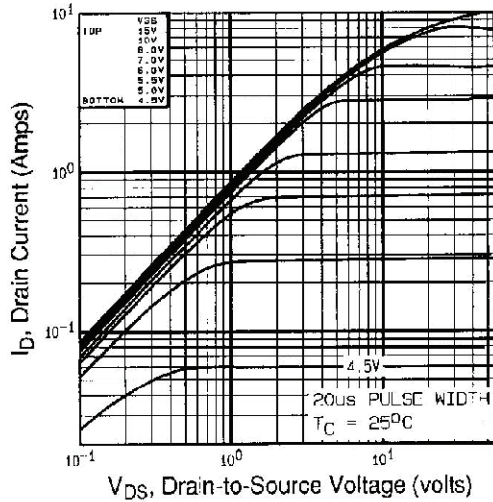


Fig. 1 - Typical Output Characteristics,  $T_C = 25\text{ }^\circ\text{C}$

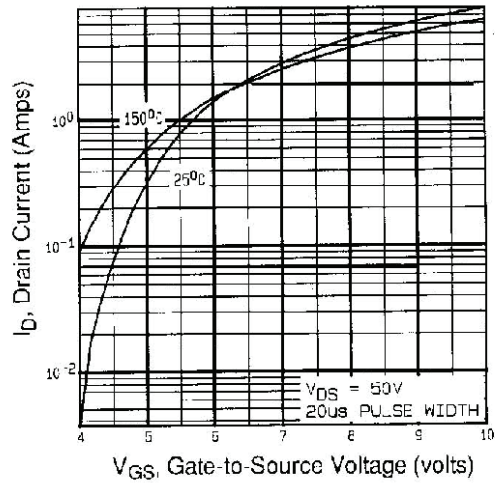


Fig. 2 - Typical Transfer Characteristics

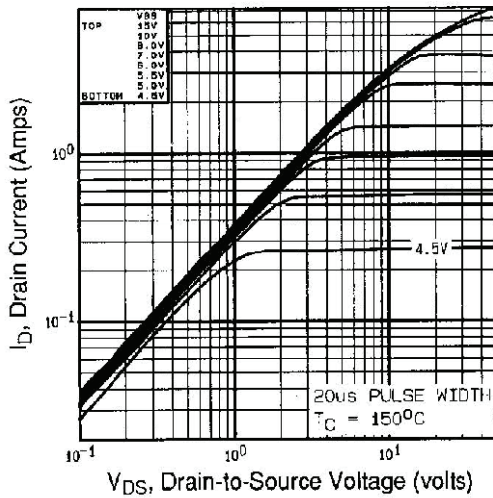


Fig. 1 - Typical Output Characteristics,  $T_C = 150\text{ }^\circ\text{C}$

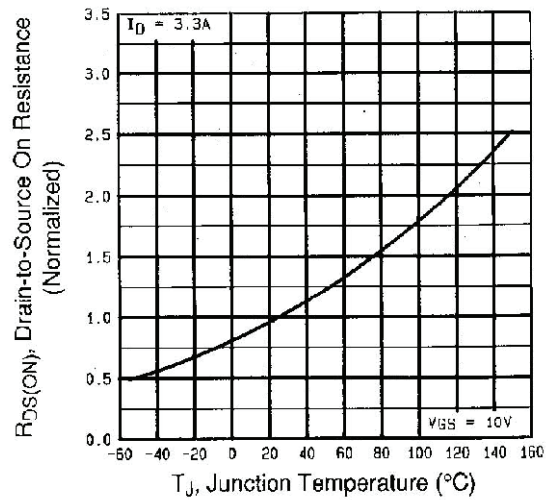


Fig. 3 - Normalized On-Resistance vs. Temperature

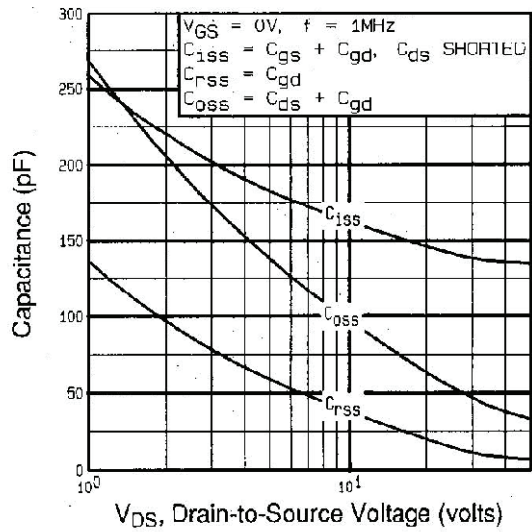


Fig. 4 - Typical Capacitance vs. Drain-to-Source Voltage

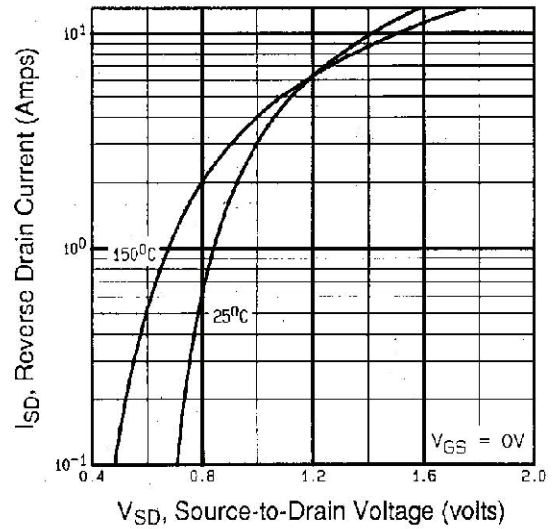


Fig. 6 - Typical Source-Drain Diode Forward Voltage

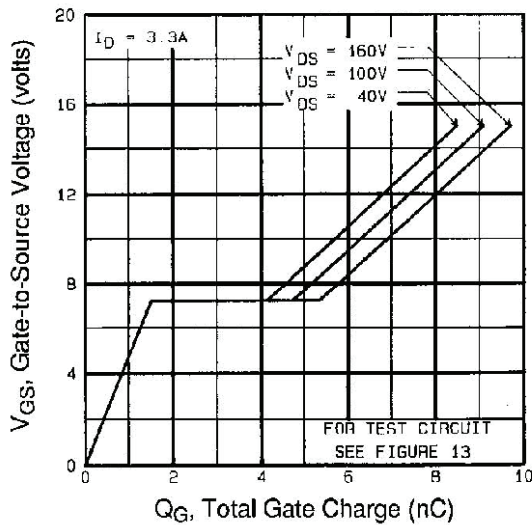


Fig. 5 - Typical Gate Charge vs. Gate-to-Source Voltage

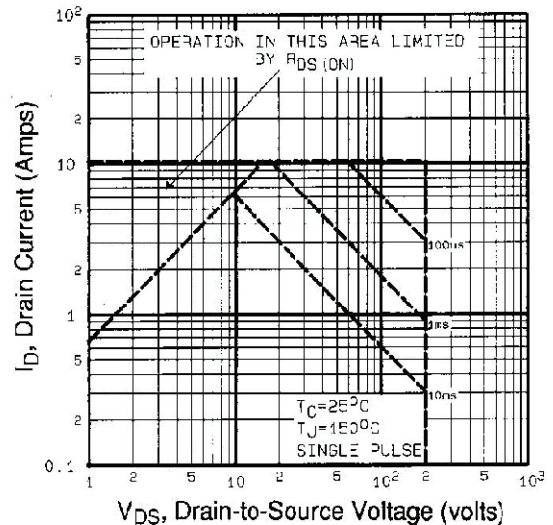


Fig. 7 - Maximum Safe Operating Area

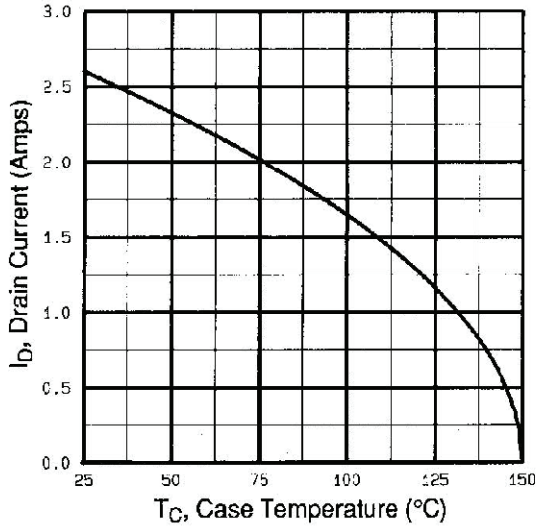


Fig. 8 - Maximum Drain Current vs. Case Temperature

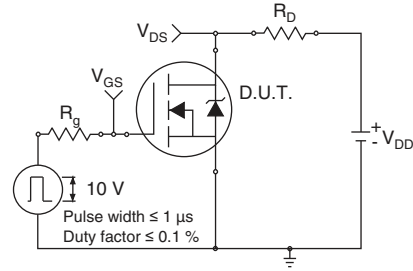


Fig. 10a - Switching Time Test Circuit

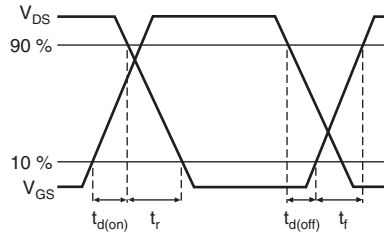


Fig. 10b - Switching Time Waveforms

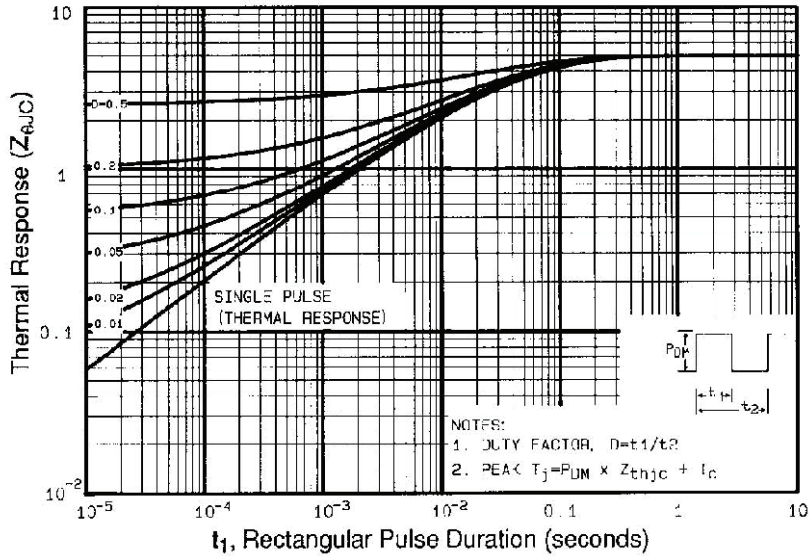


Fig. 9 - Maximum Effective Transient Thermal Impedance, Junction-to-Case

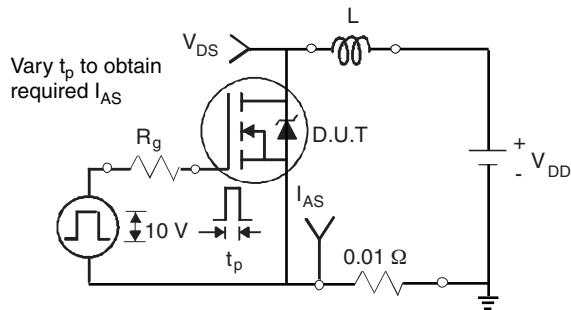


Fig. 12a - Unclamped Inductive Test Circuit

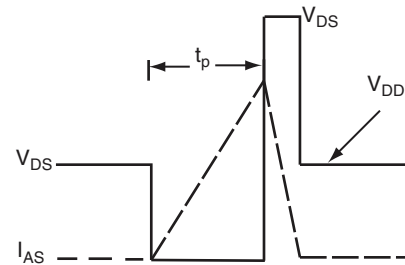


Fig. 12b - Unclamped Inductive Waveforms

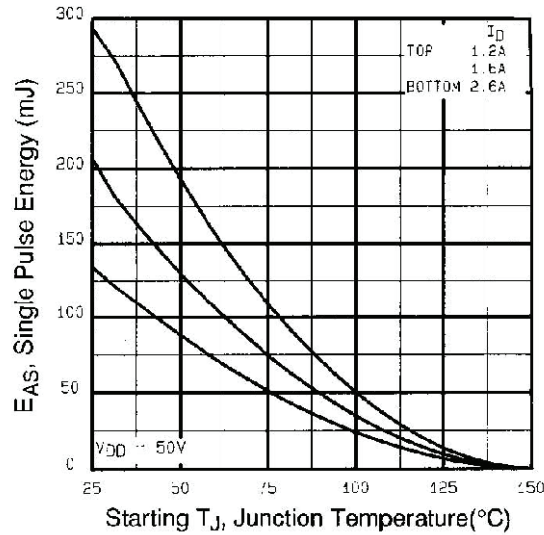


Fig. 12c - Maximum Avalanche Energy vs. Drain Current

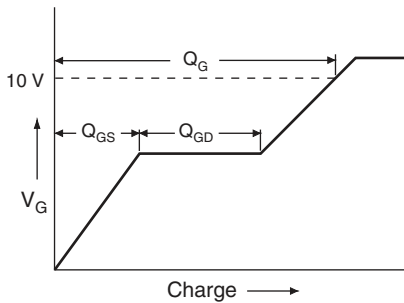


Fig. 13a - Basic Gate Charge Waveform

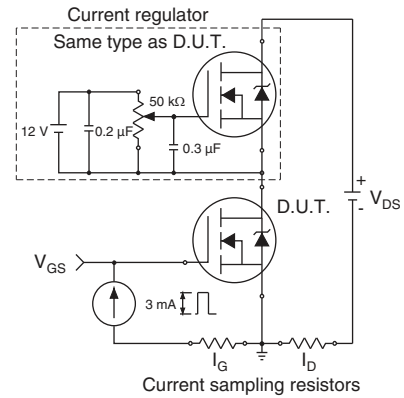
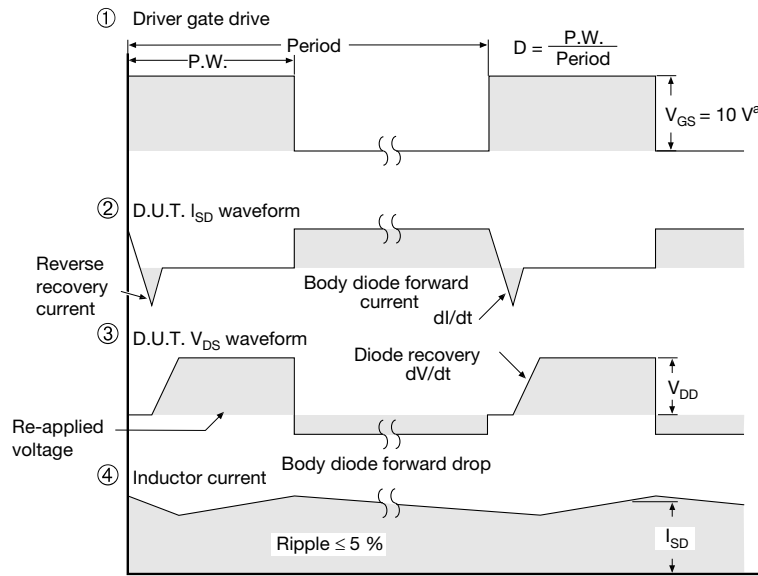
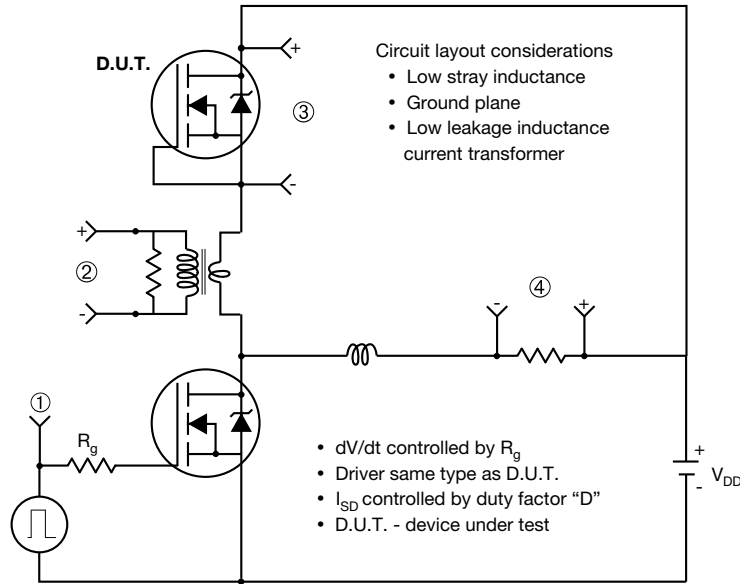


Fig. 13b - Gate Charge Test Circuit

## Peak Diode Recovery dV/dt Test Circuit



**Note**

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

**Fig. 10 - For N-Channel**

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# TO-252AA Case Outline

## VERSION 1: FACILITY CODE = Y



DIM.	MILLIMETERS	
	MIN.	MAX.
A	2.18	2.38
A1	-	0.127
b	0.64	0.88
b2	0.76	1.14
b3	4.95	5.46
C	0.46	0.61
C2	0.46	0.89
D	5.97	6.22
D1	4.10	-
E	6.35	6.73
E1	4.32	-
H	9.40	10.41
e	2.28 BSC	
e1	4.56 BSC	
L	1.40	1.78
L3	0.89	1.27
L4	-	1.02
L5	1.01	1.52

### Note

- Dimension L3 is for reference only





VERSION 2: FACILITY CODE = N



MILLIMETERS		
DIM.	MIN.	MAX.
A	2.18	2.39
A1	-	0.13
b	0.65	0.89
b1	0.64	0.79
b2	0.76	1.13
b3	4.95	5.46
c	0.46	0.61
c1	0.41	0.56
c2	0.46	0.60
D	5.97	6.22
D1	5.21	-
E	6.35	6.73
E1	4.32	-
e	2.29 BSC	
H	9.94	10.34

MILLIMETERS		
DIM.	MIN.	MAX.
L	1.50	1.78
L1	2.74 ref.	
L2	0.51 BSC	
L3	0.89	1.27
L4	-	1.02
L5	1.14	1.49
L6	0.65	0.85
θ	0°	10°
θ1	0°	15°
θ2	25°	35°

Notes

- Dimensioning and tolerance confirm to ASME Y14.5M-1994
- All dimensions are in millimeters. Angles are in degrees
- Heat sink side flash is max. 0.8 mm
- Radius on terminal is optional

ECN: E22-0399-Rev. R, 03-Oct-2022  
 DWG: 5347

## RECOMMENDED MINIMUM PADS FOR DPAK (TO-252)



Recommended Minimum Pads  
Dimensions in Inches/(mm)

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