N-Channel 650 V (D-S)MOSFET

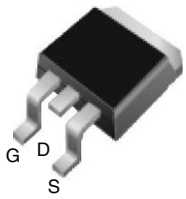
PRODUCT SUMMARY		
V_{DS} (V)	650	
$R_{DS(on)}$ (Ω)	V_{GS} = 10 V	2.1
Q_g (Max.) (nC)	48	
Q_{gs} (nC)	12	
Q_{gd} (nC)	19	
Configuration	Single	

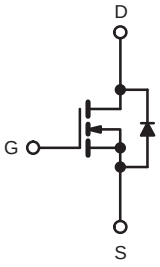
FEATURES

- Low Gate Charge Q_g Results in Simple Drive Requirement
- Improved Gate, Avalanche and Dynamic dV/dt Ruggedness
- Fully Characterized Capacitance and Avalanche Voltage and Current
- Compliant to RoHS directive 2002/95/EC

Available
RoHS

D^2PAK (TO-263)





N-Channel MOSFET

ABSOLUTE MAXIMUM RATINGS T_C = 25 °C, unless otherwise noted					
PARAMETER			SYMBOL	LIMIT	UNIT
Drain-Source Voltage			V_{DS}	650	V
Gate-Source Voltage			V_{GS}	± 30	
Continuous Drain Current[e]	V_{GS} at 10 V	T_C = 25 °C	I_D	4.5	A
Continuous Drain Current		T_C = 100 °C		4.2	
Pulsed Drain Current[a]			I_{DM}	18	
Linear Derating Factor				0.48	W/°C
Single Pulse Avalanche Energy[b]			E_{AS}	325	mJ
Repetitive Avalanche Current[a]			I_{AR}	4	A
Repetitive Avalanche Energy[a]			E_{AR}	6	mJ
Maximum Power Dissipation	T_C = 25 °C		P_D	60	W
Peak Diode Recovery dV/dt[c]			dV/dt	2.8	V/ns
Operating Junction and Storage Temperature Range			T_J, T_{stg}	- 55 to + 150	°C
Soldering Recommendations (Peak Temperature)[d]	for 10 s			300	
Mounting Torque	6-32 or M3 screw			10	lbf · in
				1.1	N · m

Notes

a. Repetitive rating; pulse width limited by maximum junction temperature (see fig. 11).
b. Starting T_J = 25 °C, L = 24 mH, R_G = 25 Ω, I_{AS} = 3.2 A (see fig. 12).
c. $I_{SD} \leq$ 3.2 A, dI/dt ≤ 90 A/µs, $V_{DD} \leq V_{DS}$, $T_J \leq$ 150 °C.
d. 1.6 mm from case.
e. Drain current limited by maximum junction temperature.

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THERMAL RESISTANCE RATINGS				
PARAMETER	**SYMBOL**	**TYP.**	**MAX.**	**UNIT**
Maximum Junction-to-Ambient	R_{thJA}	-	65	°C/W
Maximum Junction-to-Case (Drain)	R_{thJC}	-	2.1	

SPECIFICATIONS T_J = 25 °C, unless otherwise noted							
PARAMETER	**SYMBOL**	**TEST CONDITIONS**		**MIN.**	**TYP.**	**MAX.**	**UNIT**
Static							
Drain-Source Breakdown Voltage	V_{DS}	V_{GS} = 0 V, I_D = 250 µA		650	-	-	V
V_{DS} Temperature Coefficient	$\Delta V_{DS}/T_J$	Reference to 25 °C, I_D = 1 mA[d]		-	670	-	mV/°C
Gate-Source Threshold Voltage	$V_{GS(th)}$	V_{DS} = V_{GS}, I_D = 250 µA		2.0	-	4.0	V
Gate-Source Leakage	I_{GSS}	V_{GS} = ± 30 V		-	-	± 100	nA
Zero Gate Voltage Drain Current	I_{DSS}	V_{DS} = 650 V, V_{GS} = 0 V		-	-	25	µA
		V_{DS} = 520 V, V_{GS} = 0 V, T_J = 125 °C		-	-	250	
Drain-Source On-State Resistance	$R_{DS(on)}$	V_{GS} = 10 V	I_D = 3.1 A[b]	-	2.1	-	Ω
Forward Transconductance	g_{fs}	V_{DS} = 50 V, I_D = 3.1 A		3.9	-	-	S
Dynamic							
Input Capacitance	C_{iss}	V_{GS} = 0 V, V_{DS} = 25 V, f = 1.0 MHz, see fig. 5		-	1417	-	pF
Output Capacitance	C_{oss}			-	177	-	
Reverse Transfer Capacitance	C_{rss}			-	7.0	-	
Output Capacitance	C_{oss}	V_{GS} = 0 V	V_{DS} = 1.0 V, f = 1.0 MHz	-	1912	-	
			V_{DS} = 520 V, f = 1.0 MHz	-	48	-	
Effective Output Capacitance	C_{oss} eff.		V_{DS} = 0 V to 520 V[c]	-	84	-	
Total Gate Charge	Q_g	V_{GS} = 10 V	I_D = 3.2 A, V_{DS} = 400 V see fig. 6 and 13[b]	-	-	48	nC
Gate-Source Charge	Q_{gs}			-	-	12	
Gate-Drain Charge	Q_{gd}			-	-	19	
Turn-On Delay Time	$t_{d(on)}$	V_{DD} = 325 V, I_D = 3.2 A, R_G = 9.1 Ω, R_D = 62 Ω, see fig. 10[b]		-	14	-	ns
Rise Time	t_r			-	20	-	
Turn-Off Delay Time	$t_{d(off)}$			-	34	-	
Fall Time	t_f			-	18	-	
Drain-Source Body Diode Characteristics							
Continuous Source-Drain Diode Current	I_S	MOSFET symbol showing the integral reverse p - n junction diode 		-	-	4	A
Pulsed Diode Forward Current[a]	I_{SM}			-	-	21	
Body Diode Voltage	V_{SD}	T_J = 25 °C, I_S = 3.2 A, V_{GS} = 0 V[b]		-	-	1.5	V
Body Diode Reverse Recovery Time	t_{rr}	T_J = 25 °C, I_F = 3.2 A, dI/dt = 100 A/µs[b]		-	493	739	ns
Body Diode Reverse Recovery Charge	Q_{rr}			-	2.1	3.2	µC
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 ≤ 300 µs; duty cycle ≤ 2 %.
c. C_{oss} eff. is a fixed capacitance that gives the same charging time as C_{oss} while V_{DS} is rising from 0 % to 80 % V_{DS}.
d. t = 60 s, f = 60 Hz.

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TYPICAL CHARACTERISTICS 25 °C, unless otherwise noted

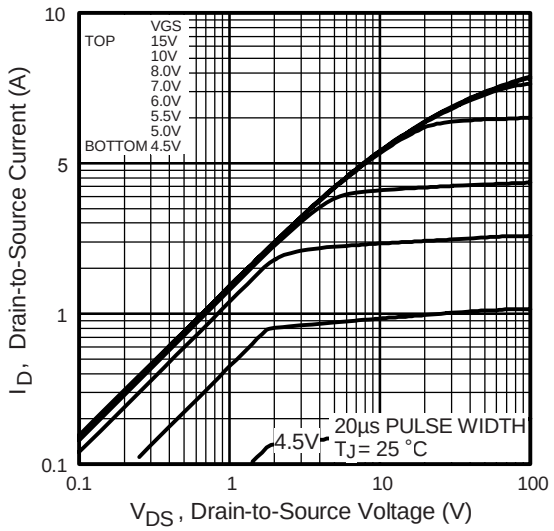


Fig. 1 - Typical Output Characteristics

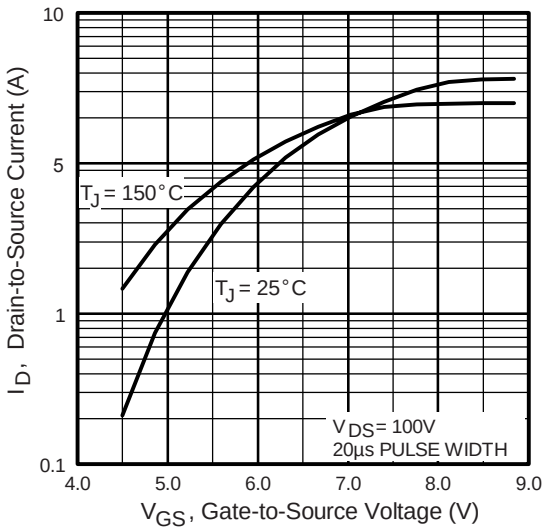


Fig. 3 - Typical Transfer Characteristics

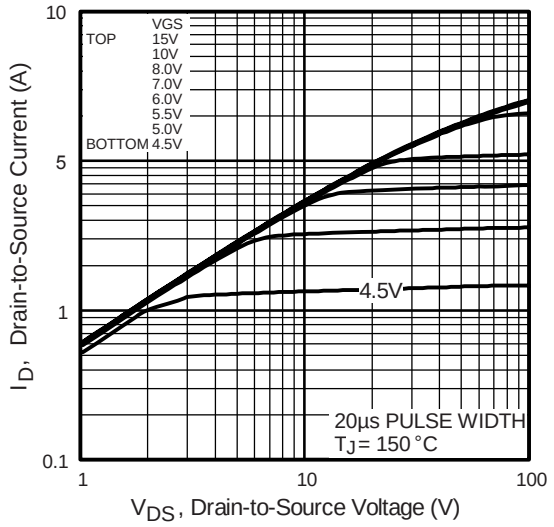


Fig. 2 - Typical Output Characteristics

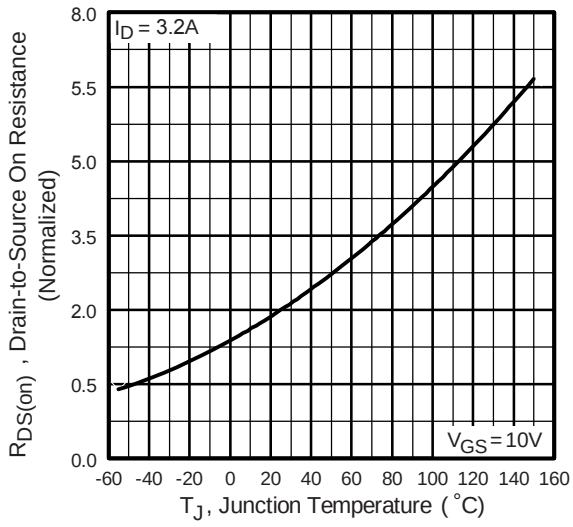


Fig. 4 - Normalized On-Resistance vs. Temperature

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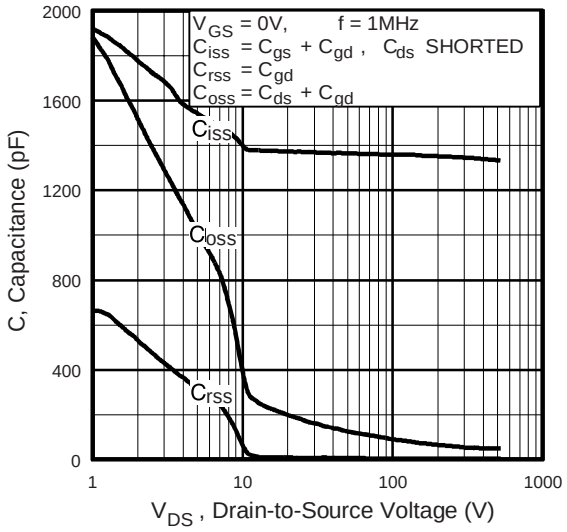


Fig. 5 - Typical Capacitance vs. Drain-to-Source Voltage

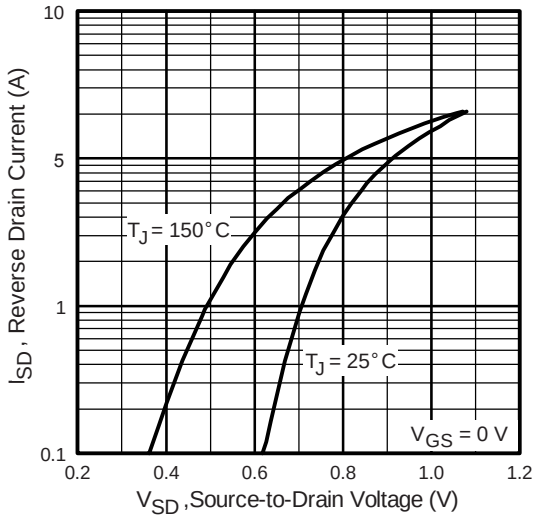


Fig. 7 - Typical Source-Drain Diode Forward Voltage

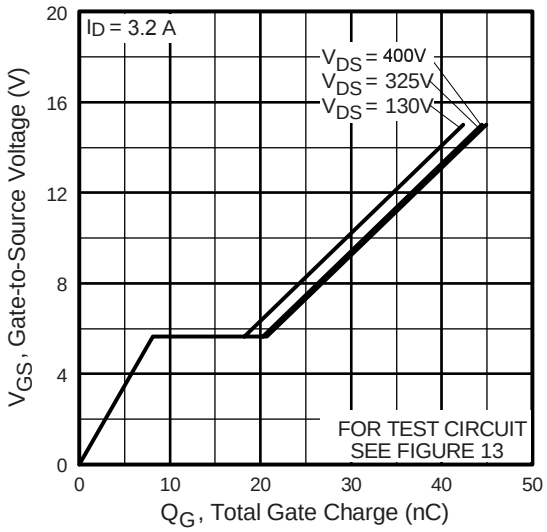


Fig. 6 - Typical Gate Charge vs. Gate-to-Source Voltage

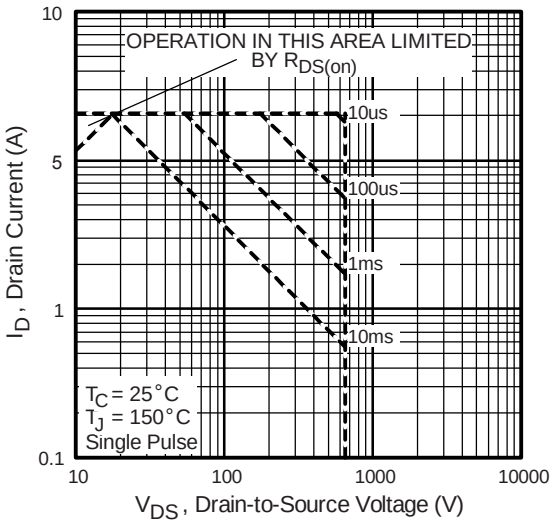


Fig. 8 - Maximum Safe Operating Area

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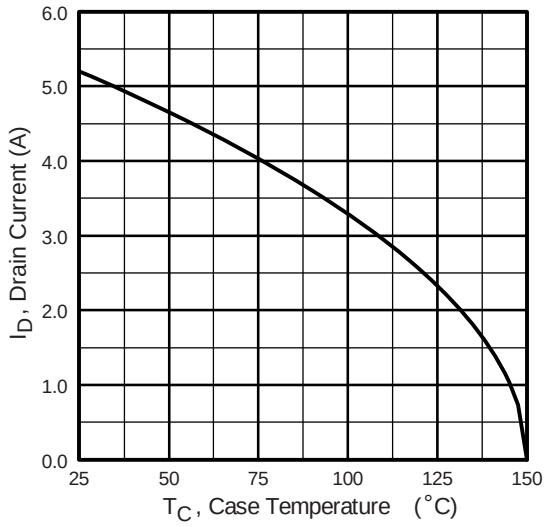


Fig. 9 - Maximum Drain Current vs. Case Temperature

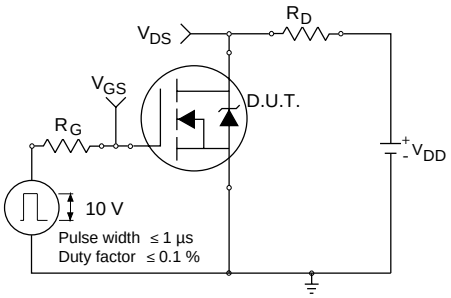


Fig. 10a - Switching Time Test Circuit

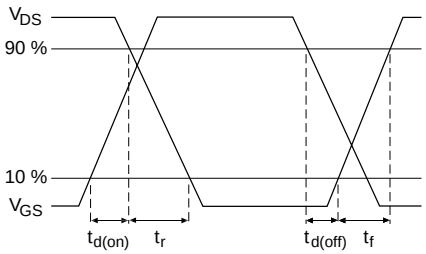


Fig. 10b - Switching Time Waveforms

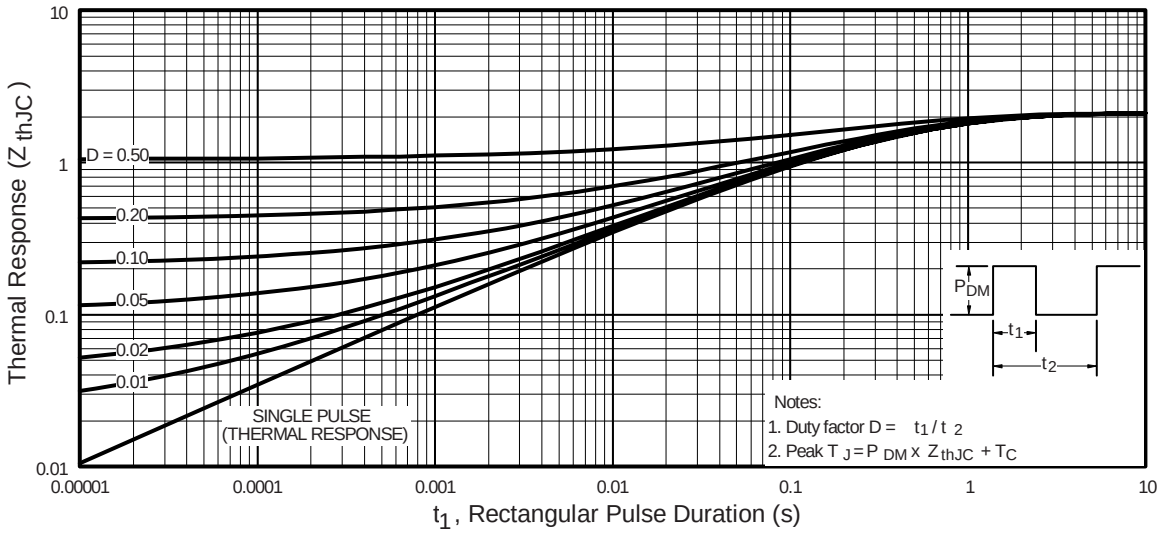


Fig. 11 - Maximum Effective Transient Thermal Impedance, Junction-to-Case

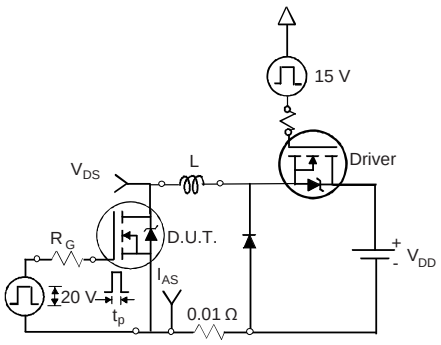


Fig. 12a - Unclamped Inductive Test Circuit

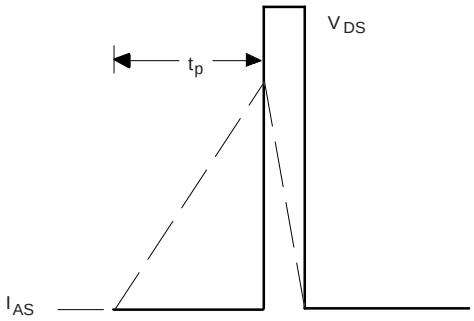


Fig. 12b - Unclamped Inductive Waveforms

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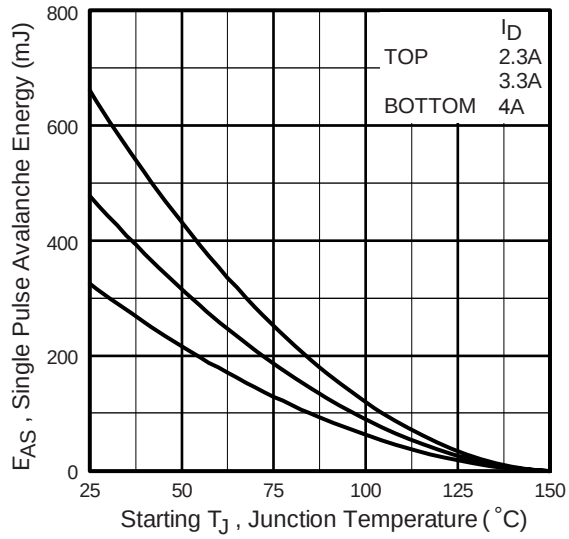


Fig. 12c - Maximum Avalanche Energy vs. Drain Current

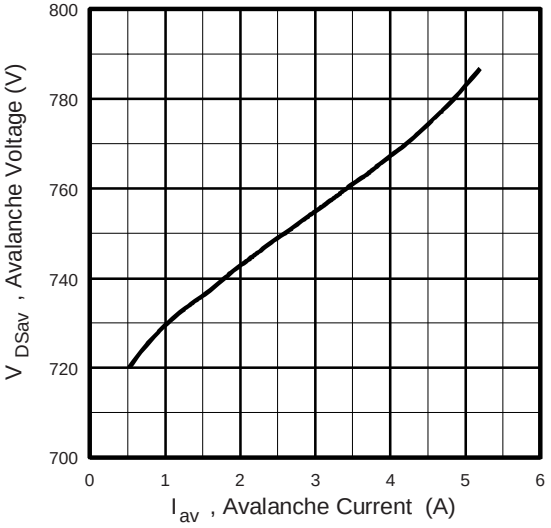


Fig. 12d - Typical Drain-to Source Voltage vs. Avalanche Current

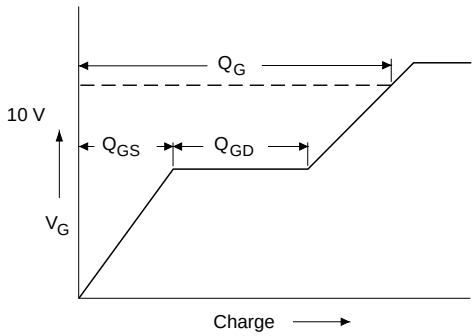


Fig. 13a - Basic Gate Charge Waveform

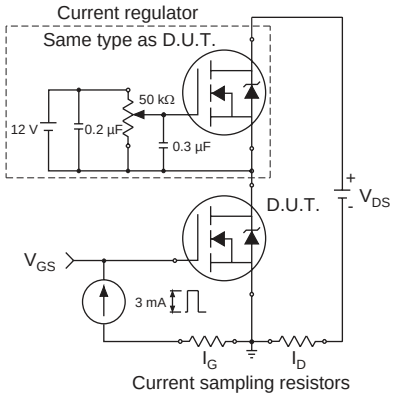
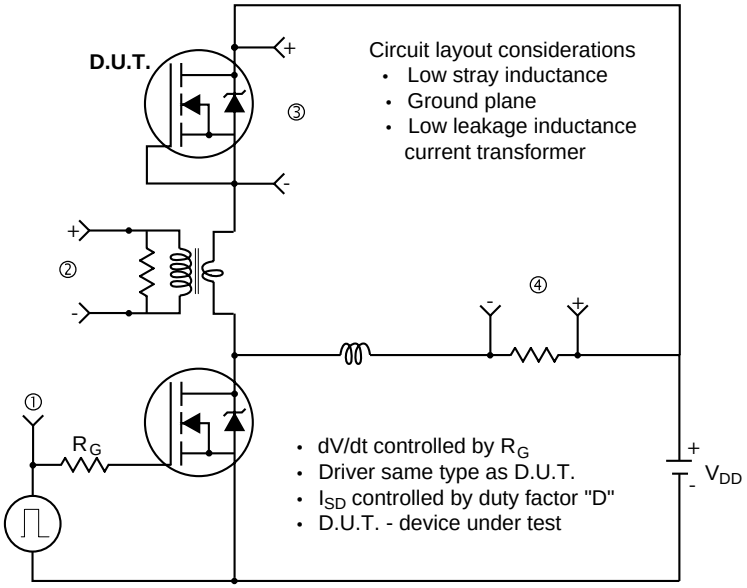
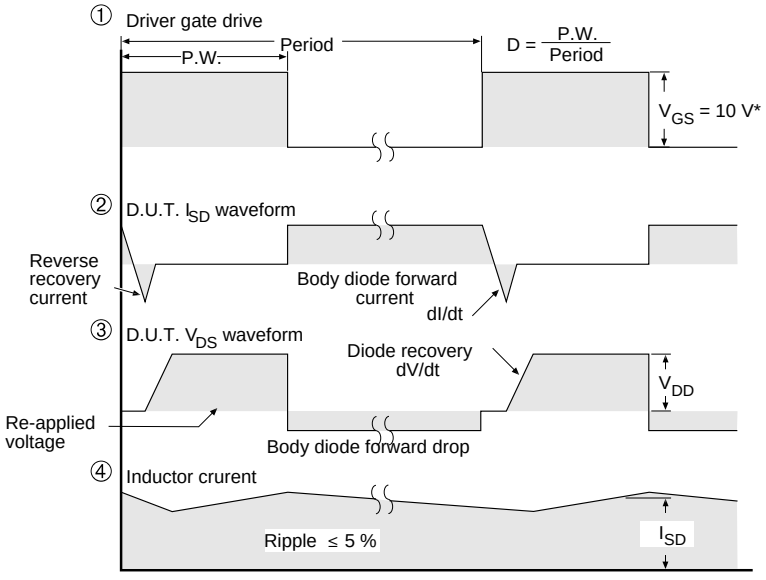


Fig. 13b - Gate Charge Test Circuit

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Peak Diode Recovery dV/dt Test Circuit



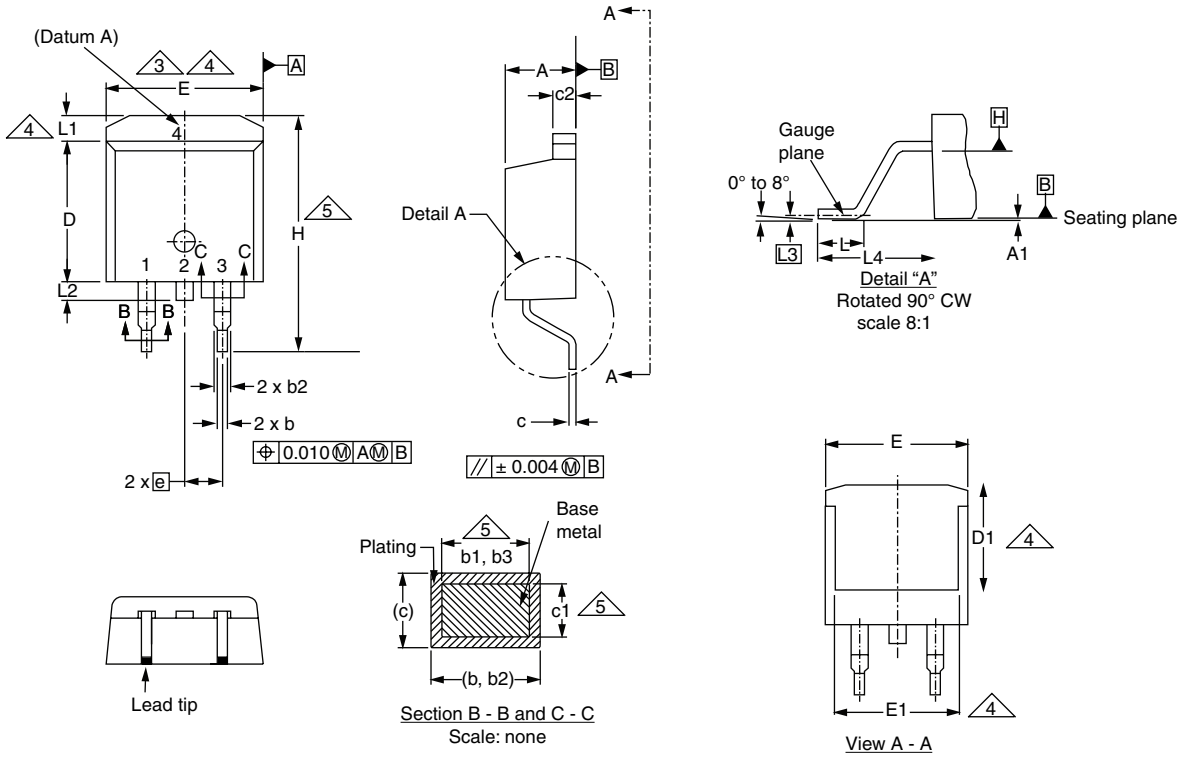


* V_{GS} = 5 V for logic level devices

Fig. 14 - For N-Channel

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TO-263AB (HIGH VOLTAGE)



	MILLIMETERS		INCHES	
DIM.	MIN.	MAX.	MIN.	MAX.
A	4.06	4.83	0.160	0.190
A1	0.00	0.25	0.000	0.010
b	0.51	0.99	0.020	0.039
b1	0.51	0.89	0.020	0.035
b2	1.14	1.78	0.045	0.070
b3	1.14	1.73	0.045	0.068
c	0.38	0.74	0.015	0.029
c1	0.38	0.58	0.015	0.023
c2	1.14	1.65	0.045	0.065
D	8.38	9.65	0.330	0.380

	MILLIMETERS		INCHES	
DIM.	MIN.	MAX.	MIN.	MAX.
D1	6.86	-	0.270	-
E	9.65	10.67	0.380	0.420
E1	6.22	-	0.245	-
e	2.54 BSC		0.100 BSC	
H	14.61	15.88	0.575	0.625
L	1.78	2.79	0.070	0.110
L1	-	1.65	-	0.066
L2	-	1.78	-	0.070
L3	0.25 BSC		0.010 BSC	
L4	4.78	5.28	0.188	0.208

ECN: S-82110-Rev. A, 15-Sep-08
DWG: 5970

Notes

1. Dimensioning and tolerancing per ASME Y14.5M-1994.
2. Dimensions are shown in millimeters (inches).
3. Dimension D and E do not include mold flash. Mold flash shall not exceed 0.127 mm (0.005") per side. These dimensions are measured at the outmost extremes of the plastic body at datum A.
4. Thermal PAD contour optional within dimension E, L1, D1 and E1.
5. Dimension b1 and c1 apply to base metal only.
6. Datum A and B to be determined at datum plane H.
7. Outline conforms to JEDEC outline to TO-263AB.

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