

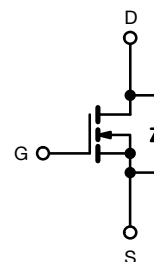
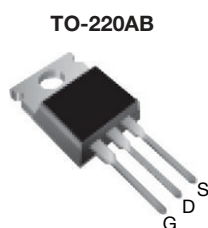
## N-Channel 60 V(D-S) MOSFET


**RoHS**  
 COMPLIANT

PRODUCT SUMMARY		
$V_{DS}$ (V)	60	
$R_{DS(on)}$ ( $\Omega$ )	$V_{GS} = 10\text{ V}$	0.072
$Q_g$ max. (nC)	25	
$Q_{gs}$ (nC)	5.8	
$Q_{gd}$ (nC)	11	
Configuration	Single	

### FEATURES

- Dynamic dV/dt rating
  - Fast switching
  - Ease of paralleling
- Simple drive requirements



N-Channel MOSFET

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	$T_C = 25\text{ }^\circ\text{C}$	20	A
		$T_C = 100\text{ }^\circ\text{C}$	12	
Pulsed Drain Current <sup>a</sup>	$I_{DM}$		68	
Linear Derating Factor			0.40	W/ $^\circ\text{C}$
Single Pulse Avalanche Energy <sup>b</sup>	$E_{AS}$		100	mJ
Maximum Power Dissipation	$T_C = 25\text{ }^\circ\text{C}$		$P_D$	60
Peak Diode Recovery dV/dt <sup>c</sup>			dV/dt	4.5
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  $T_J = 25\text{ }^\circ\text{C}$ ,  $L = 403\text{ }\mu\text{H}$ ,  $R_g = 25\text{ }\Omega$ ,  $I_{AS} = 17\text{ A}$  (see fig. 12).
- $I_{SD} \leq 17\text{ A}$ ,  $dI/dt \leq 140\text{ A}/\mu\text{s}$ ,  $V_{DD} \leq V_{DS}$ ,  $T_J \leq 175\text{ }^\circ\text{C}$ .
- 1.6 mm from case.

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)	$R_{thJC}$	-	2.5	

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 $25\text{ }^\circ\text{C}$ , $I_D = 1\text{ mA}$		-	0.061	-	V/°C
Gate-Source Threshold Voltage	$V_{GS(th)}$	$V_{DS} = V_{GS}, I_D = 250\text{ }\mu\text{A}$		1.0	-	3.0	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	$\mu\text{A}$
		$V_{DS} = 48\text{ V}, V_{GS} = 0\text{ V}, T_J = 150\text{ }^\circ\text{C}$		-	-	250	
Drain-Source On-State Resistance	$R_{DS(on)}$	$V_{GS} = 10\text{ V}$	$I_D = 10\text{ A}^b$	-	0.072	-	$\Omega$
Forward Transconductance	$g_{fs}$	$V_{DS} = 25\text{ V}, I_D = 10\text{ A}$		5.5	-	-	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		-	640	-	pF
Output Capacitance	$C_{oss}$			-	360	-	
Reverse Transfer Capacitance	$C_{rss}$			-	79	-	
Total Gate Charge	$Q_g$	$V_{GS} = 10\text{ V}$	$I_D = 17\text{ A}, V_{DS} = 48\text{ V},$ see fig. 6 and 13 <sup>b</sup>	-	-	25	nC
Gate-Source Charge	$Q_{gs}$			-	-	5.8	
Gate-Drain Charge	$Q_{gd}$			-	-	11	
Turn-On Delay Time	$t_{d(on)}$	$V_{DD} = 30\text{ V}, I_D = 17\text{ A},$ $R_g = 18\text{ }\Omega, R_D = 1.7\text{ }\Omega$ , see fig. 10 <sup>b</sup>		-	13	-	ns
Rise Time	$t_r$			-	58	-	
Turn-Off Delay Time	$t_{d(off)}$			-	25	-	
Fall Time	$t_f$			-	42	-	
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		-	-	20	A
Pulsed Diode Forward Current <sup>a</sup>	$I_{SM}$			-	-	68	
Body Diode Voltage	$V_{SD}$	$T_J = 25\text{ }^\circ\text{C}, I_S = 17\text{ A}, V_{GS} = 0\text{ V}^b$		-	-	1.5	V
Body Diode Reverse Recovery Time	$t_{rr}$	$T_J = 25\text{ }^\circ\text{C}, I_F = 17\text{ A}, di/dt = 100\text{ A}/\mu\text{s}$		-	88	180	ns
Body Diode Reverse Recovery Charge	$Q_{rr}$			-	0.29	0.64	$\mu\text{C}$
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  $\leq 2\text{ }\%$ .

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



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



Fig. 4 - Normalized On-Resistance vs. Temperature



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

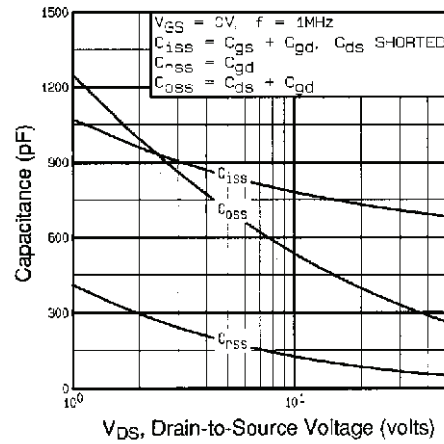


Fig. 5 - Typical Capacitance vs. Drain-to-Source Voltage



Fig. 3 - Typical Transfer Characteristics

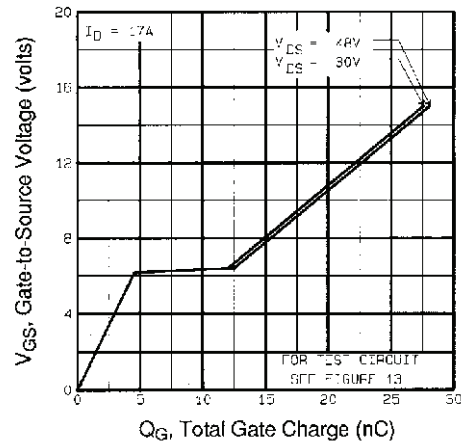


Fig. 6 - Typical Gate Charge vs. Gate-to-Source Voltage

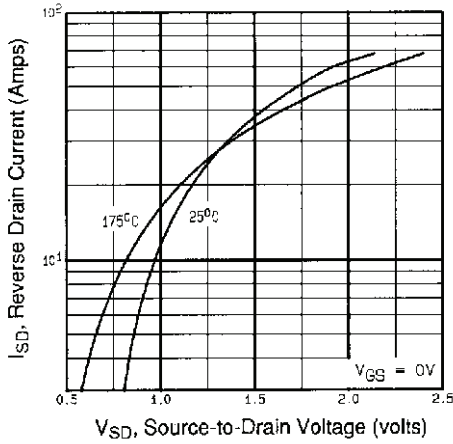


Fig. 7 - Typical Source-Drain Diode Forward Voltage

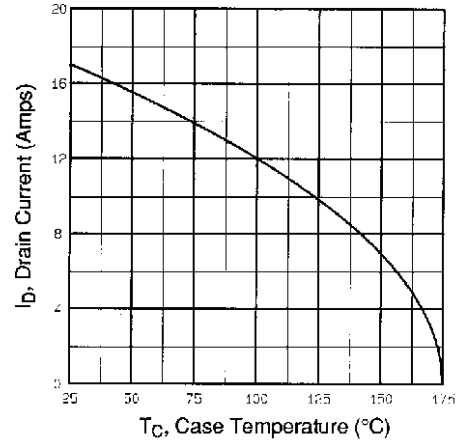


Fig. 9 - Maximum Drain Current vs. Case Temperature



Fig. 8 - Maximum Safe Operating Area

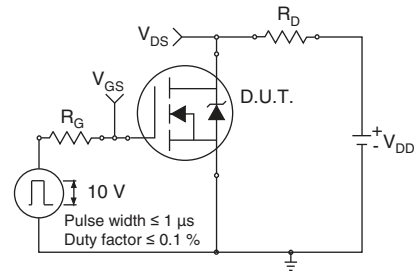


Fig. 10a - Switching Time Test Circuit

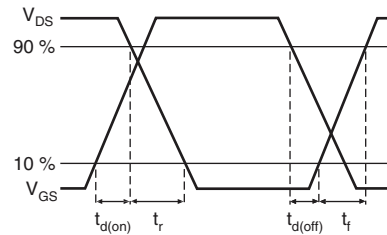


Fig. 10b - Switching Time Waveforms



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

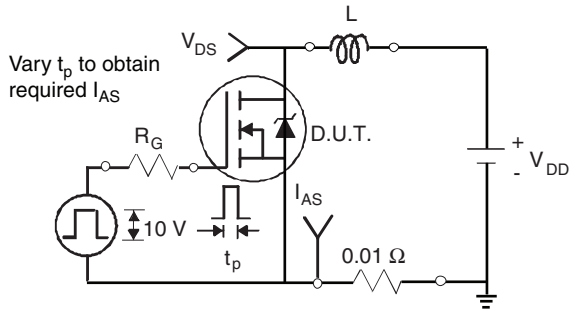


Fig. 12a - Unclamped Inductive Test Circuit

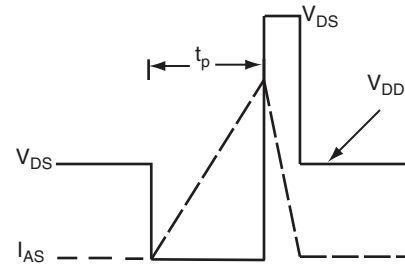


Fig. 12b - Unclamped Inductive Waveforms



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



Fig. 13a - Basic Gate Charge Waveform

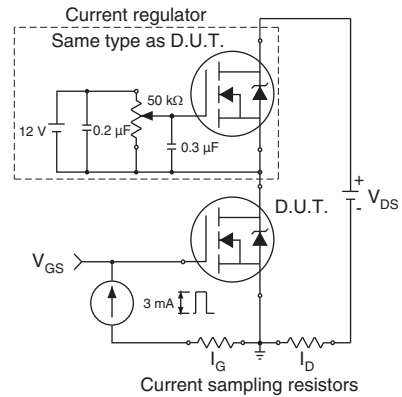
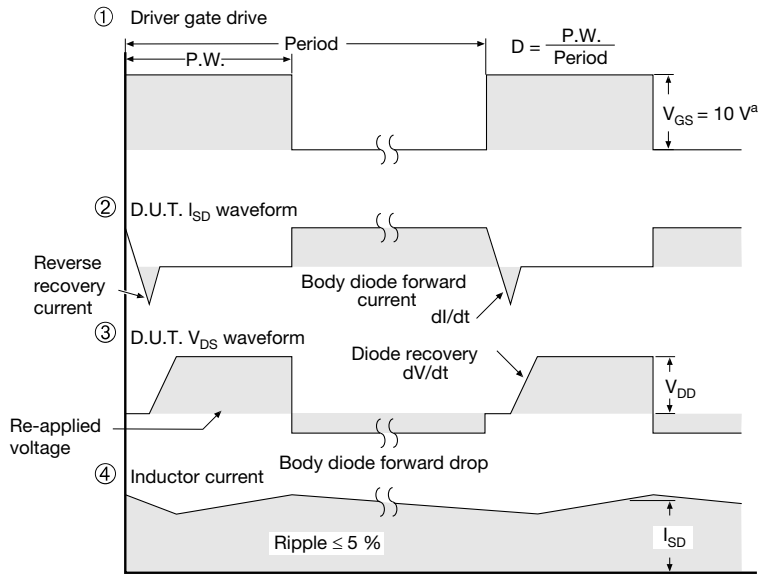
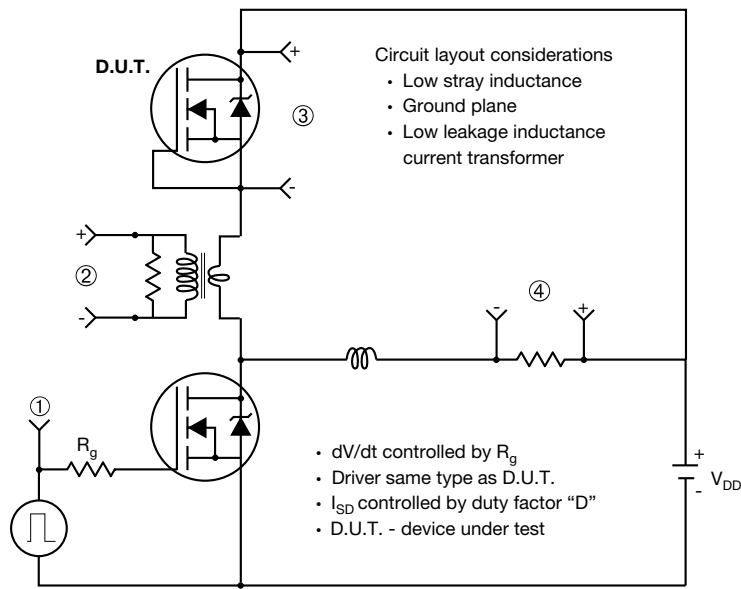


Fig. 13b - Gate Charge Test

**Peak Diode Recovery dV/dt Test Circuit**

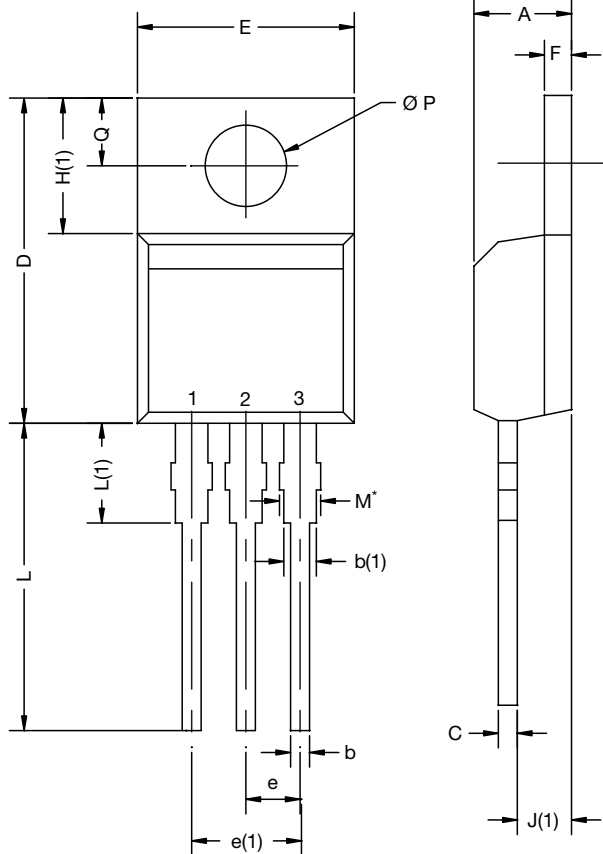


**Note**

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

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

TO-220



DIM.	MILLIMETERS		INCHES	
	MIN.	MAX.	MIN.	MAX.
A	4.24	4.65	0.167	0.183
b	0.69	1.02	0.027	0.040
b(1)	1.14	1.78	0.045	0.070
c	0.36	0.61	0.014	0.024
D	14.33	15.85	0.564	0.624
E	9.96	10.52	0.392	0.414
e	2.41	2.67	0.095	0.105
e(1)	4.88	5.28	0.192	0.208
F	1.14	1.40	0.045	0.055
H(1)	6.10	6.71	0.240	0.264
J(1)	2.41	2.92	0.095	0.115
L	13.36	14.40	0.526	0.567
L(1)	3.33	4.04	0.131	0.159
Ø P	3.53	3.94	0.139	0.155
Q	2.54	3.00	0.100	0.118

ECN: X15-0364-Rev. C, 14-Dec-15  
DWG: 6031

**Note**

- $M^*$  = 0.052 inches to 0.064 inches (dimension including protrusion), heatsink hole for HVM

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