International
IOR Rectifier

PD - 93806B

AUTOMOTIVE MOSFET

IRFBA1404P

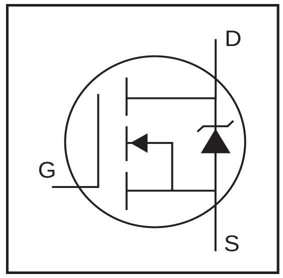
HEXFET® Power MOSFET

Typical Applications

- Anti-lock Braking Systems (ABS)
- Electric Power Steering (EPS)
- Electric Braking
- Radiator Fan Control

Benefits

- Advanced Process Technology
- Ultra Low On-Resistance
- Increase Current Handling Capability
- 175°C Operating Temperature
- Fast Switching
- Dynamic dv/dt Rating
- Repetitive Avalanche Allowed up to Tjmax



V_{DSS} = 40V

$R_{DS(on)}$ = 3.7mΩ

I_D = 206A⑥

Description

Specifically designed for Automotive applications, this Stripe Planar design of HEXFET® Power MOSFETs utilizes the latest processing techniques to achieve extremely low on-resistance per silicon area. Additional features of this MOSFET are a 175°C junction operating temperature, fast switching speed and improved ruggedness in single and repetitive avalanche. The Super-220 ™ is a package that has been designed to have the same mechanical outline and pinout as the industry standard TO-220 but can house a considerably larger silicon die. The result is significantly increased current handling capability over both the TO-220 and the much larger TO-247 package. The combination of extremely low on-resistance silicon and the Super-220 ™ package makes it ideal to reduce the component count in multiparalled TO-220 applications, reduce system power dissipation, upgrade existing designs or have TO-247 performance in a TO-220 outline. This package has been designed to meet automotive, Q101, qualification standard.
These benefits make this design an extremely efficient and reliable device for use in Automotive applications and a wide variety of other applications.

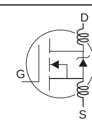
Super-220™

Absolute Maximum Ratings

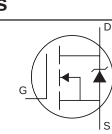
	Parameter	Max.	Units
I_D @ T_C = 25°C	Continuous Drain Current, V_{GS} @ 10V	206⑥	A
I_D @ T_C = 100°C	Continuous Drain Current, V_{GS} @ 10V	145⑥	
I_{DM}	Pulsed Drain Current ①	650	
P_D @T_C = 25°C	Power Dissipation	300	W
	Linear Derating Factor	2.0	W/°C
V_{GS}	Gate-to-Source Voltage	± 20	V
E_{AS}	Single Pulse Avalanche Energy②	480	mJ
I_{AR}	Avalanche Current①	See Fig.12a, 12b, 14, 15	A
E_{AR}	Repetitive Avalanche Energy①		mJ
dv/dt	Peak Diode Recovery dv/dt ③	5.0	V/ns
T_J T_{STG}	Operating Junction and Storage Temperature Range	-40 to + 175 -55 to + 175	°C
	Soldering Temperature, for 10 seconds	300 (1.6mm from case)	
	Recommended clip force	20	N

8/14/02

Electrical Characteristics @ T_J = 25°C (unless otherwise specified)

	Parameter	Min.	Typ.	Max.	Units	Conditions
$V_{(BR)DSS}$	Drain-to-Source Breakdown Voltage	40	–––	–––	V	V_{GS} = 0V, I_D = 250µA
$\Delta V_{(BR)DSS}/\Delta T_J$	Breakdown Voltage Temp. Coefficient	–––	0.036	–––	V/°C	Reference to 25°C, I_D = 1mA
$R_{DS(on)}$	Static Drain-to-Source On-Resistance	–––	–––	3.7	mΩ	V_{GS} = 10V, I_D = 95A ④
$V_{GS(th)}$	Gate Threshold Voltage	2.0	–––	4.0	V	V_{DS} = 10V, I_D = 250µA
g_{fs}	Forward Transconductance	106	–––	–––	S	V_{DS} = 25V, I_D = 60A
I_{DSS}	Drain-to-Source Leakage Current	–––	–––	20	µA	V_{DS} = 40V, V_{GS} = 0V
		–––	–––	250		V_{DS} = 32V, V_{GS} = 0V, T_J = 150°C
I_{GSS}	Gate-to-Source Forward Leakage	–––	–––	200	nA	V_{GS} = 20V
	Gate-to-Source Reverse Leakage	–––	–––	-200		V_{GS} = -20V
Q_g	Total Gate Charge	–––	160	200	nC	I_D = 95A
Q_{gs}	Gate-to-Source Charge	–––	35	–––		V_{DS} = 32V
Q_{gd}	Gate-to-Drain ("Miller") Charge	–––	42	60		V_{GS} = 10V
$t_{d(on)}$	Turn-On Delay Time	–––	17	–––	ns	V_{DD} = 20V
t_r	Rise Time	–––	140	–––		I_D = 95A
$t_{d(off)}$	Turn-Off Delay Time	–––	72	–––		R_G = 2.5Ω
t_f	Fall Time	–––	26	–––		R_D = 0.21Ω ④
L_D	Internal Drain Inductance	–––	2.0	–––	nH	Between lead, 6mm (0.25in.) 
L_S	Internal Source Inductance	–––	5.0	–––		from package and center of die contact
C_{iss}	Input Capacitance	–––	7360	–––	pF	V_{GS} = 0V
C_{oss}	Output Capacitance	–––	1680	–––		V_{DS} = 25V
C_{rss}	Reverse Transfer Capacitance	–––	240	–––		f = 1.0MHz, See Fig. 5
C_{oss}	Output Capacitance	–––	6630	–––		V_{GS} = 0V, V_{DS} = 1.0V, f = 1.0MHz
C_{oss}	Output Capacitance	–––	1490	–––		V_{GS} = 0V, V_{DS} = 32V, f = 1.0MHz
C_{oss} eff.	Effective Output Capacitance ⑤	–––	1540	–––		V_{GS} = 0V, V_{DS} = 0V to 32V

Source-Drain Ratings and Characteristics

	Parameter	Min.	Typ.	Max.	Units	Conditions
I_S	Continuous Source Current (Body Diode)	–––	–––	206⑥	A	MOSFET symbol showing the integral reverse p-n junction diode. 
I_{SM}	Pulsed Source Current (Body Diode) ①	–––	–––	650		
V_{SD}	Diode Forward Voltage	–––	–––	1.3	V	T_J = 25°C, I_S = 95A, V_{GS} = 0V ④
t_{rr}	Reverse Recovery Time	–––	71	110	ns	T_J = 25°C, I_F = 95A
Q_{rr}	Reverse Recovery Charge	–––	180	270	nC	di/dt = 100A/µs ④
t_{on}	Forward Turn-On Time	Intrinsic turn-on time is negligible (turn-on is dominated by L_S+L_D)				

Thermal Resistance

	Parameter	Typ.	Max.	Units
$R_{\theta JC}$	Junction-to-Case	–––	0.50	°C/W
$R_{\theta CS}$	Case-to-Sink, Flat, Greased Surface	0.5	–––	
$R_{\theta JA}$	Junction-to-Ambient	–––	58	

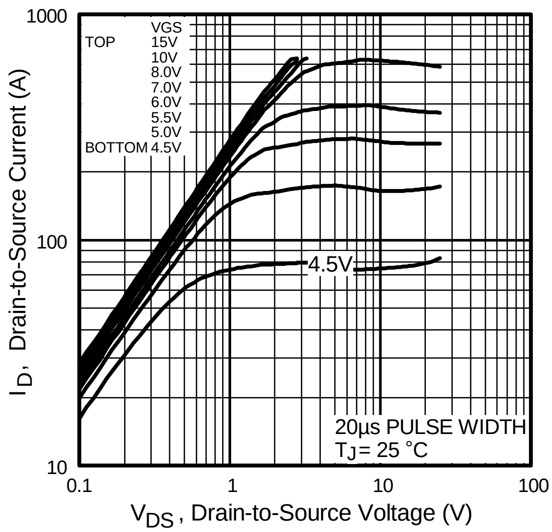


Fig 1. Typical Output Characteristics

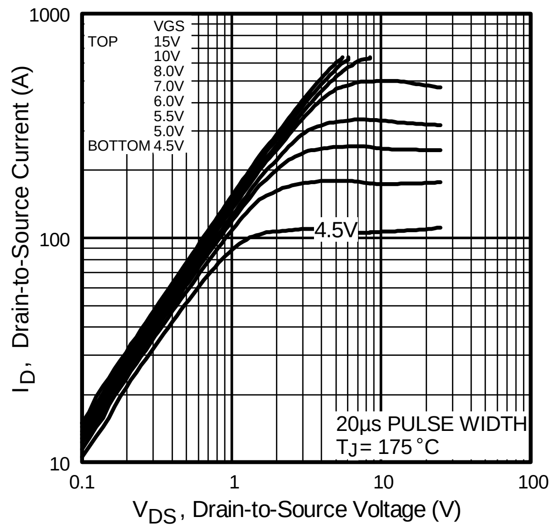


Fig 2. Typical Output Characteristics

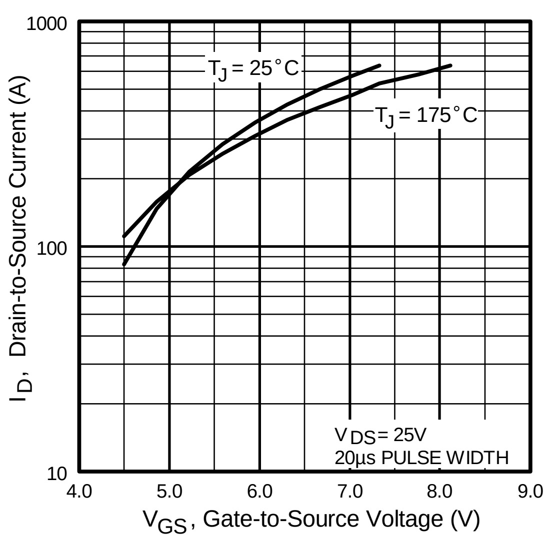


Fig 3. Typical Transfer Characteristics

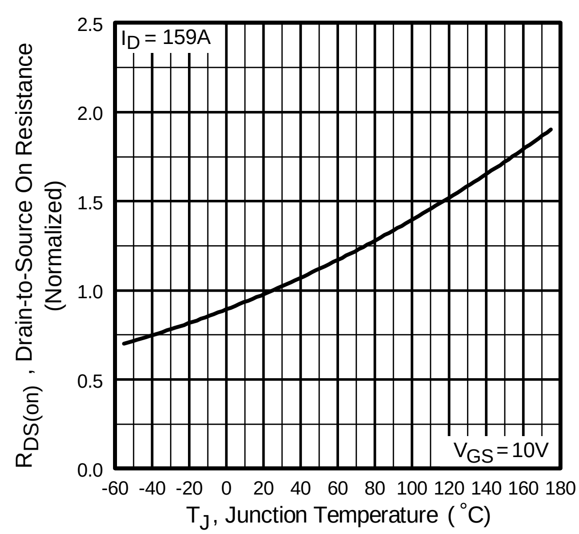


Fig 4. Normalized On-Resistance
Vs. Temperature

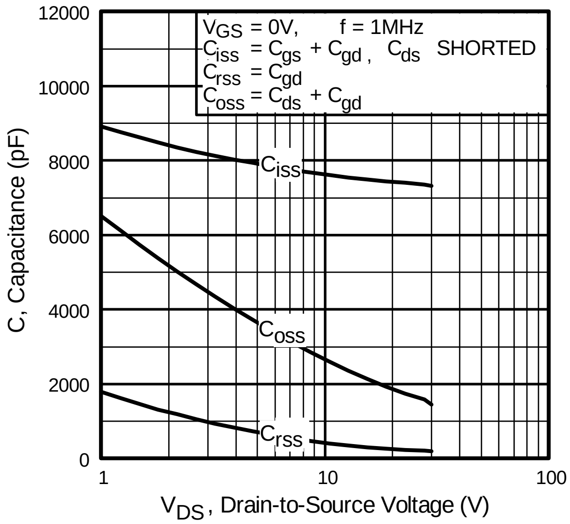


Fig 5. Typical Capacitance Vs. Drain-to-Source Voltage

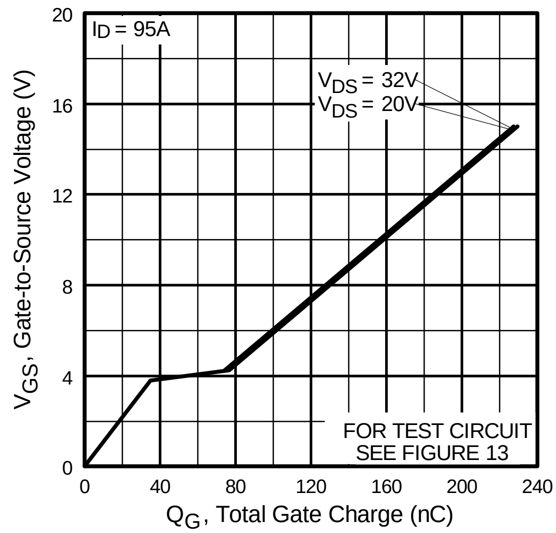


Fig 6. Typical Gate Charge Vs. Gate-to-Source Voltage

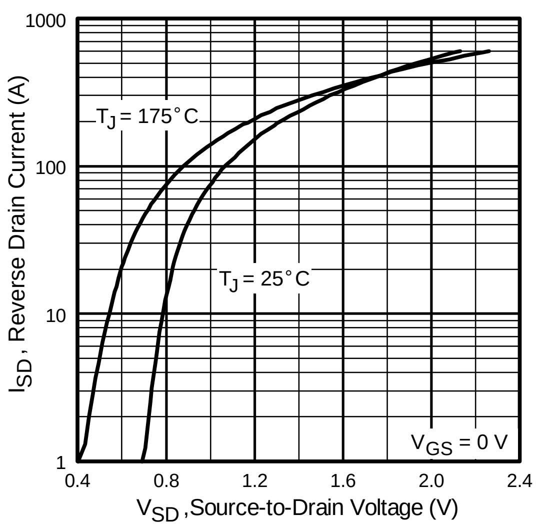


Fig 7. Typical Source-Drain Diode Forward Voltage

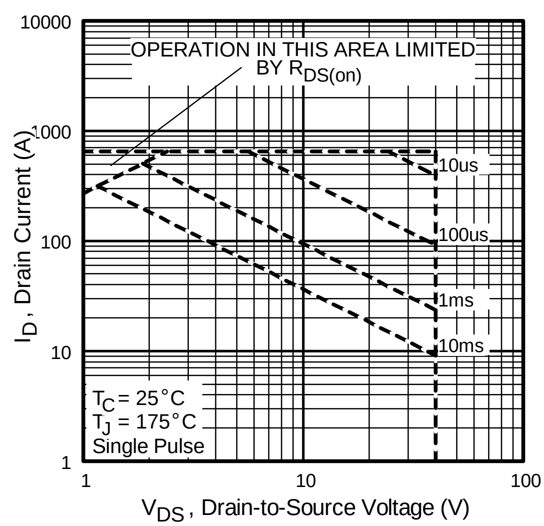


Fig 8. Maximum Safe Operating Area

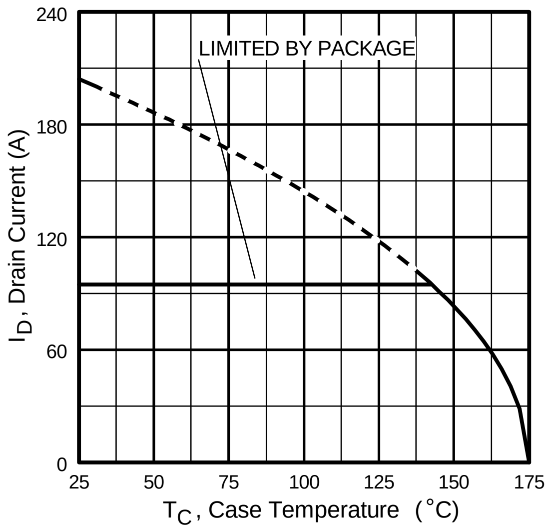


Fig 9. Maximum Drain Current Vs. Case Temperature

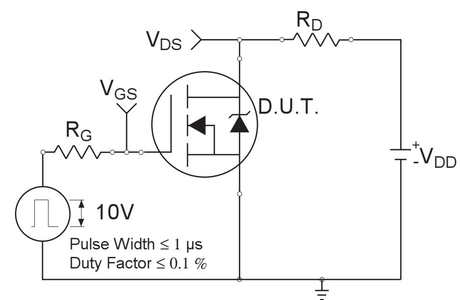


Fig 10a. Switching Time Test Circuit

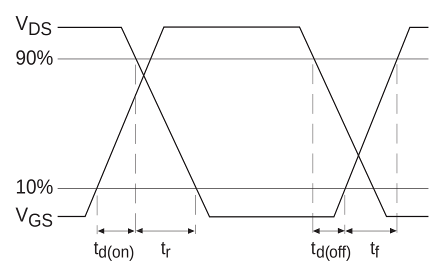


Fig 10b. Switching Time Waveforms

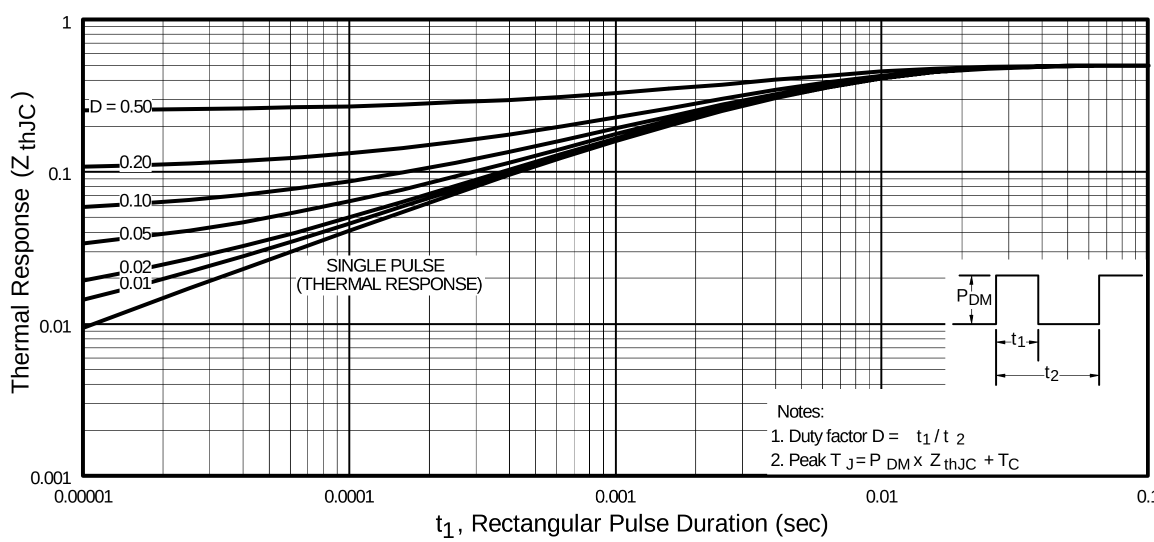


Fig 11. Maximum Effective Transient Thermal Impedance, Junction-to-Case

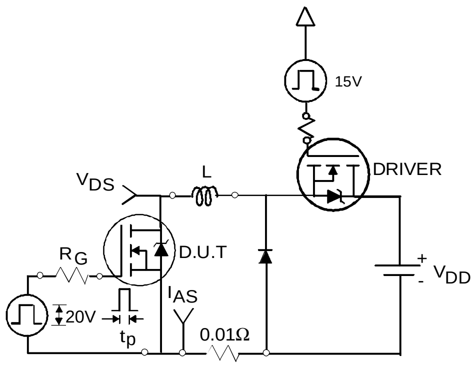


Fig 12a. Unclamped Inductive Test Circuit

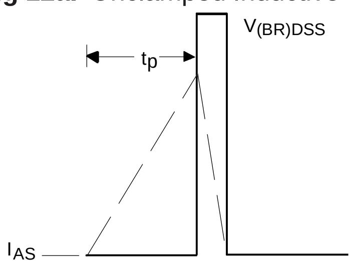


Fig 12b. Unclamped Inductive Waveforms

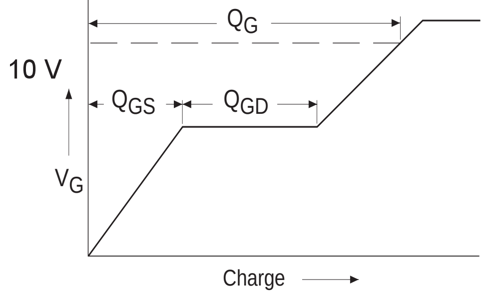


Fig 13a. Basic Gate Charge Waveform

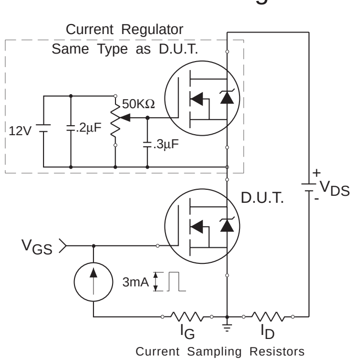


Fig 13b. Gate Charge Test Circuit

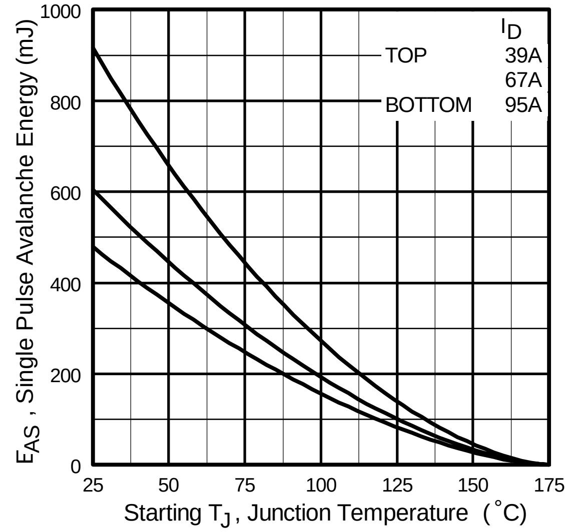


Fig 12c. Maximum Avalanche Energy Vs. Drain Current

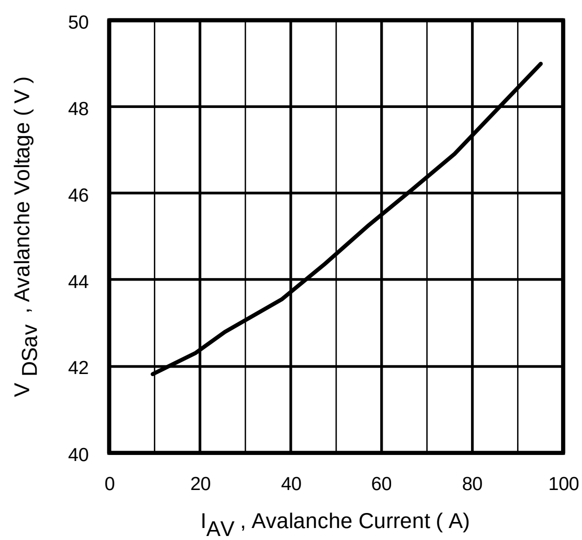


Fig 12d. Typical Drain-to-Source Voltage Vs. Avalanche Current

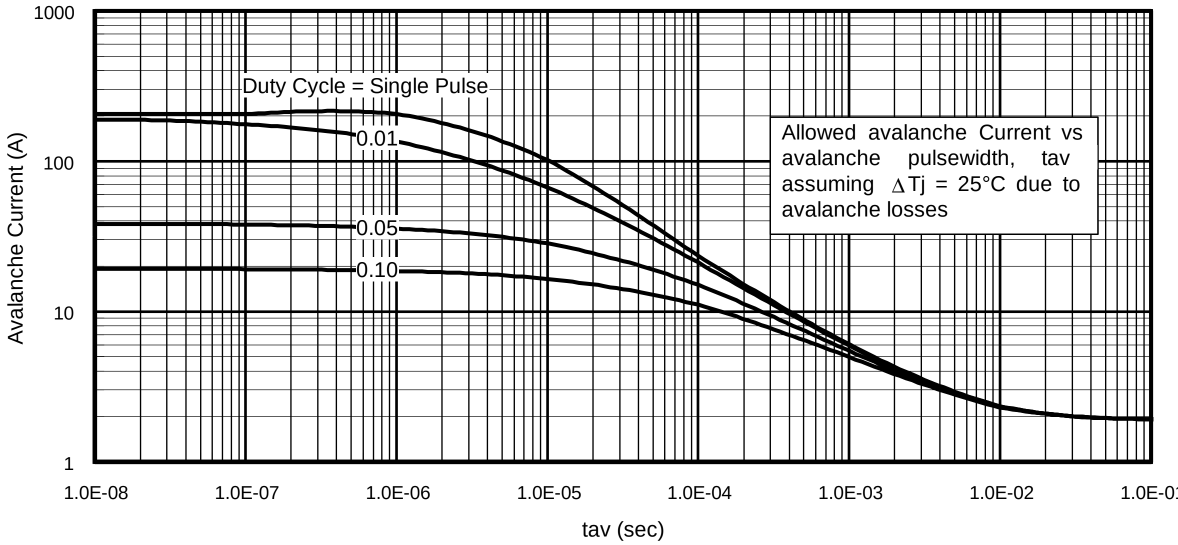


Fig 14. Typical Avalanche Current Vs.Pulsewidth

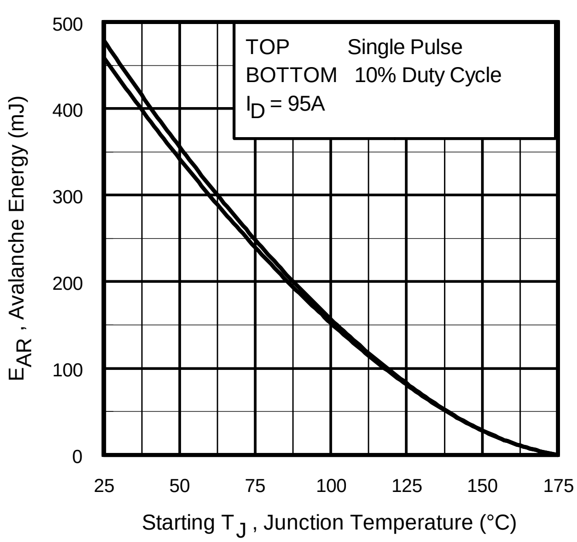


Fig 15. Maximum Avalanche Energy Vs. Temperature

Notes on Repetitive Avalanche Curves , Figures 15, 16:
(For further info, see AN-1005 at www.irf.com)

1. Avalanche failures assumption:
   Purely a thermal phenomenon and failure occurs at a temperature far in excess of T_{jmax}. This is validated for every part type.
2. Safe operation in Avalanche is allowed as long as T_{jmax} is not exceeded.
3. Equation below based on circuit and waveforms shown in Figures 12a, 12b.
4. $P_{D\ (ave)}$ = Average power dissipation per single avalanche pulse.
5. BV = Rated breakdown voltage (1.3 factor accounts for voltage increase during avalanche).
6. I_{av} = Allowable avalanche current.
7. ΔT = Allowable rise in junction temperature, not to exceed T_{jmax} (assumed as 25°C in Figure 15, 16).
   t_{av} = Average time in avalanche.
   D = Duty cycle in avalanche = $t_{av} \cdot f$
   $Z_{thJC}(D, t_{av})$ = Transient thermal resistance, see figure 11)

$$P_{D\ (ave)} = 1/2\ (1.3 \cdot BV \cdot I_{av}) = \Delta T / Z_{thJC}$$
$$I_{av} = 2\Delta T / [1.3 \cdot BV \cdot Z_{th}]$$
$$E_{AS\ (AR)} = P_{D\ (ave)} \cdot t_{av}$$

Peak Diode Recovery dv/dt Test Circuit

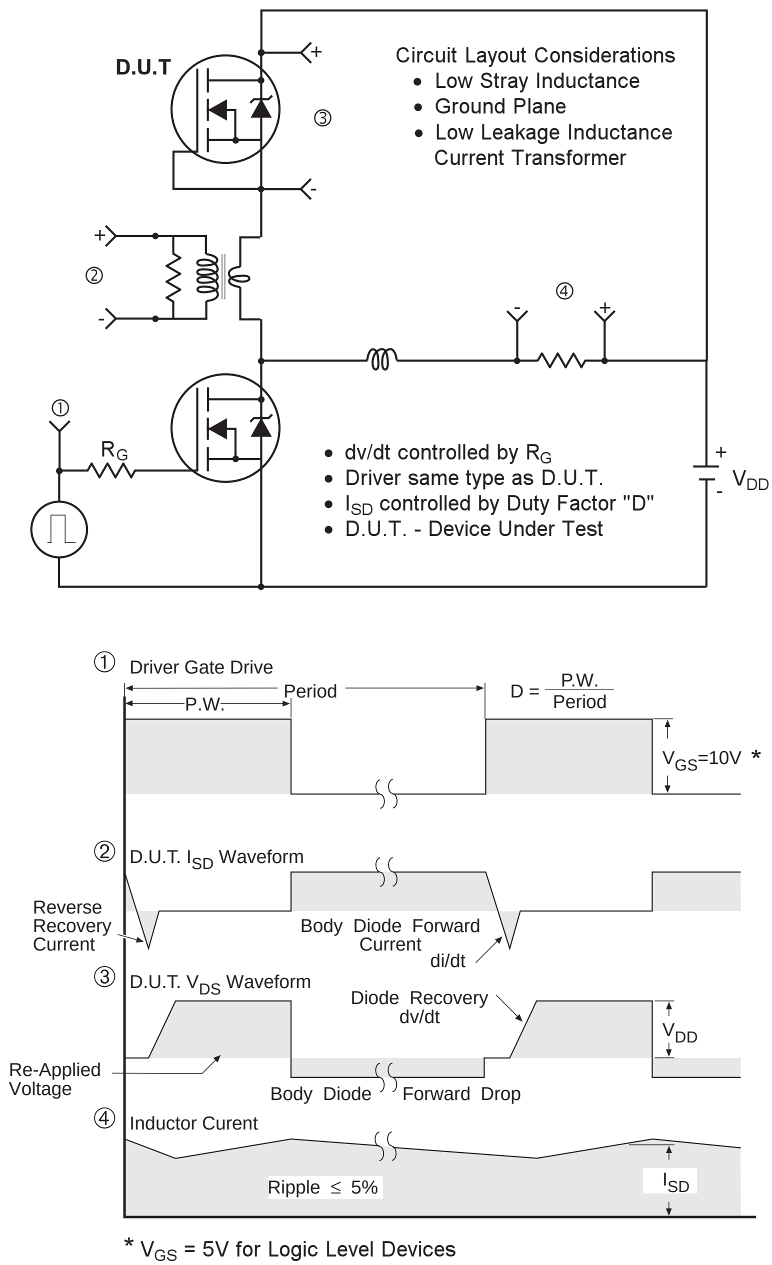
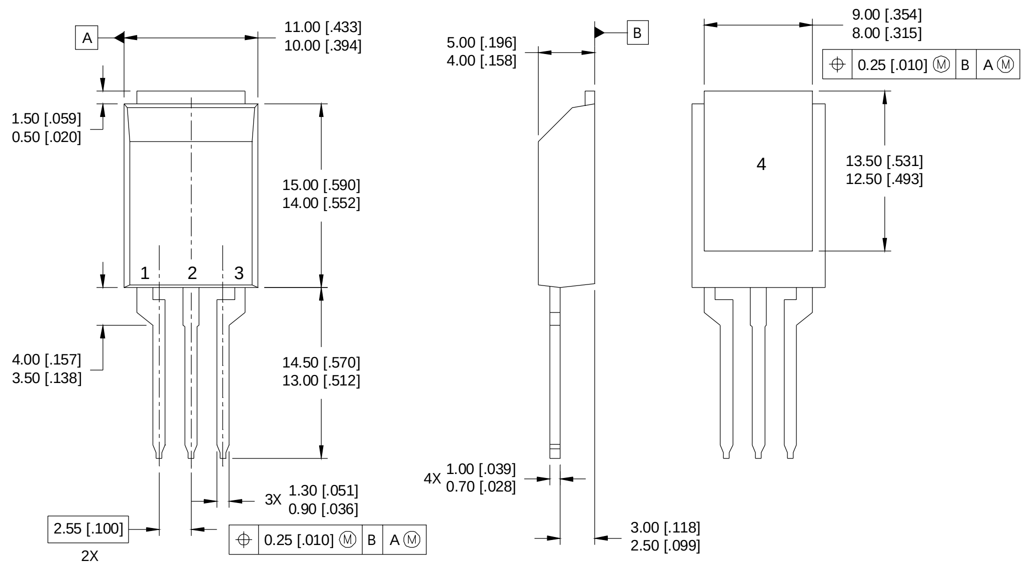


Fig 16. For N-Channel HEXFET® Power MOSFETs

Super-220™ Package Outline



NOTES:

1. DIMENSIONING & TOLERANCING PER ASME Y14.5M-1994.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSIONS ARE SHOWN IN MILLIMETERS [INCHES].
4. OUTLINE CONFORMS TO JEDEC OUTLINE TO-273AA.

LEAD ASSIGNMENTS

MOSFET	IGBT
1 - GATE	1 - GATE
2 - DRAIN	2 - COLLECTOR
3 - SOURCE	3 - EMITTER
4 - DRAIN	4 - COLLECTOR

Notes:

① Repetitive rating; pulse width limited by max. junction temperature.

② Starting $T_J = 25°C$, L = 0.11mH $R_G = 25\Omega$, $I_{AS} = 95A$.

③ $I_{SD} \leq 95A$, $di/dt \leq 150A/\mu s$, $V_{DD} \leq V_{(BR)DSS}$, $T_J \leq 175°C$

④ Pulse width ≤ 400µs; duty cycle ≤ 2%.

⑤ 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_{DSS} . Refer to AN-1001

⑥ Calculated continuous current based on maximum allowable junction temperature. Package limitation current is 95A.

Super-220™ not recommended for surface mount application

Data and specifications subject to change without notice.
This product has been designed and qualified for the Automotive [Q101] market.
Qualification Standards can be found on IR's Web site.

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