

# International IR Rectifier

## Benefits

- 200°C Operating Temperature
- Advanced Process Technology
- Ultra Low On-Resistance
- Dynamic dv/dt Rating
- Fast Switching
- Repetitive Avalanche Allowed up to T<sub>j</sub> Max
- Automotive Qualified (Q101)

## Description

Specifically designed for Automotive applications, this HEXFET<sup>®</sup> power MOSFET has a 200°C max operating temperature with a Stripe Planar design that utilizes the latest processing techniques to achieve extremely low on-resistance per silicon area. Additional features of this HEXFET<sup>®</sup> power MOSFET are fast switching speed and improved repetitive avalanche rating.

The continuing technology leadership of International Rectifier provides 200°C operating temperature in a plastic package. At high ambient temperatures, the IRF1704 can carry up to 20% more current than similar 175°C T<sub>j</sub> max devices in the same package outline. This makes this part ideal for existing and emerging under-the-hood automotive applications such as Electric Power Steering (EPS), Fuel / Water Pump Control and wide variety of other applications.

## Absolute Maximum Ratings

	Parameter	Max.	Units
I <sub>D</sub> @ T <sub>C</sub> = 25°C	Continuous Drain Current, V <sub>GS</sub> @ 10V	170 <sup>Ⓒ</sup>	A
I <sub>D</sub> @ T <sub>C</sub> = 100°C	Continuous Drain Current, V <sub>GS</sub> @ 10V	120	
I <sub>DM</sub>	Pulsed Drain Current <sup>Ⓓ</sup>	680	
P <sub>D</sub> @ T <sub>C</sub> = 25°C	Power Dissipation	230	W
	Linear Derating Factor	1.3	W/°C
V <sub>GS</sub>	Gate-to-Source Voltage	± 20	V
E <sub>AS</sub>	Single Pulse Avalanche Energy <sup>Ⓔ</sup>	670	mJ
I <sub>AR</sub>	Avalanche Current <sup>Ⓓ</sup>	100	A
E <sub>AR</sub>	Repetitive Avalanche Energy <sup>Ⓓ</sup>	23	mJ
dv/dt	Peak Diode Recovery dv/dt <sup>Ⓔ</sup>	1.9	V/ns
T <sub>J</sub>	Operating Junction and	-55 to + 200	°C
T <sub>STG</sub>	Storage Temperature Range		
T <sub>LEAD</sub>	Lead Temperature <sup>Ⓔ</sup>		
	Soldering Temperature, for 10 seconds	300 (1.6mm from case )	°C
	Mounting torque, 6-32 or M3 screw	10 lbf•in (1.1N•m)	

## Thermal Resistance

	Parameter	Typ.	Max.	Units
R <sub>θJC</sub>	Junction-to-Case	—	0.75	°C/W
R <sub>θCS</sub>	Case-to-Sink, Flat, Greased Surface	0.50	—	
R <sub>θJA</sub>	Junction-to-Ambient	—	62	

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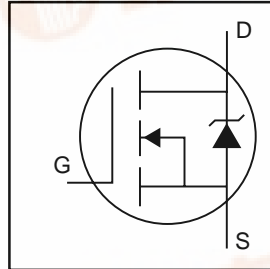
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## AUTOMOTIVE MOSFET

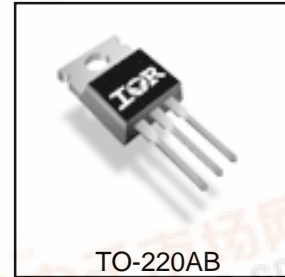
# IRF1704

## HEXFET<sup>®</sup> Power MOSFET

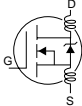
PD -94012B



V <sub>DSS</sub> = 40V
R <sub>DS(on)</sub> = 0.004Ω
I <sub>D</sub> = 170A <sup>Ⓒ</sup>



## Electrical Characteristics @ $T_J = 25^\circ\text{C}$ (unless otherwise specified)

	Parameter	Min.	Typ.	Max.	Units	Conditions
$V_{(BR)DSS}$	Drain-to-Source Breakdown Voltage	40	—	—	V	$V_{GS} = 0V, I_D = 250\mu A$
$\Delta V_{(BR)DSS}/\Delta T_J$	Breakdown Voltage Temp. Coefficient	—	0.036	—	V/°C	Reference to $25^\circ\text{C}, I_D = 1\text{mA}$
$R_{DS(on)}$	Static Drain-to-Source On-Resistance	—	—	0.004	$\Omega$	$V_{GS} = 10V, I_D = 100A$ ④
$V_{GS(th)}$	Gate Threshold Voltage	2.0	—	4.0	V	$V_{DS} = V_{GS}, I_D = 250\mu A$
$g_{fs}$	Forward Transconductance	110	—	—	S	$V_{DS} = 25V, I_D = 100A$
$I_{DSS}$	Drain-to-Source Leakage Current	—	—	20	$\mu A$	$V_{DS} = 40V, V_{GS} = 0V$
		—	—	250		$V_{DS} = 32V, V_{GS} = 0V, T_J = 175^\circ\text{C}$
$I_{GSS}$	Gate-to-Source Forward Leakage	—	—	200	nA	$V_{GS} = 20V$
	Gate-to-Source Reverse Leakage	—	—	-200		$V_{GS} = -20V$
$Q_g$	Total Gate Charge	—	170	260	nC	$I_D = 100A$
$Q_{gs}$	Gate-to-Source Charge	—	42	63		$V_{DS} = 32V$
$Q_{gd}$	Gate-to-Drain ("Miller") Charge	—	39	59		$V_{GS} = 10V$ , See Fig. 6 and 13 ④
$t_{d(on)}$	Turn-On Delay Time	—	16	—	ns	$V_{DD} = 20V$
$t_r$	Rise Time	—	120	—		$I_D = 100A$
$t_{d(off)}$	Turn-Off Delay Time	—	73	—		$R_G = 2.5\Omega$
$t_f$	Fall Time	—	37	—		$V_{GS} = 10V$ , See Fig. 10 ④
$L_D$	Internal Drain Inductance	—	4.5	—	nH	Between lead, 6mm (0.25in.) from package and center of die contact
$L_S$	Internal Source Inductance	—	7.5	—		
$C_{iss}$	Input Capacitance	—	6950	—	pF	$V_{GS} = 0V$
$C_{oss}$	Output Capacitance	—	1660	—		$V_{DS} = 25V$
$C_{rss}$	Reverse Transfer Capacitance	—	200	—		$f = 1.0\text{MHz}$ , See Fig. 5
$C_{oss}$	Output Capacitance	—	6250	—		$V_{GS} = 0V, V_{DS} = 1.0V, f = 1.0\text{MHz}$
$C_{oss}$	Output Capacitance	—	1470	—		$V_{GS} = 0V, V_{DS} = 32V, f = 1.0\text{MHz}$
$C_{oss \text{ eff.}}$	Effective Output Capacitance ⑤	—	2320	—		$V_{GS} = 0V, V_{DS} = 0V \text{ to } 32V$

## Source-Drain Ratings and Characteristics

	Parameter	Min.	Typ.	Max.	Units	Conditions
$I_S$	Continuous Source Current (Body Diode)	—	—	170⑥	A	MOSFET symbol showing the integral reverse p-n junction diode.
$I_{SM}$	Pulsed Source Current (Body Diode) ①	—	—	680		
$V_{SD}$	Diode Forward Voltage	—	—	1.3	V	$T_J = 25^\circ\text{C}, I_S = 100A, V_{GS} = 0V$ ④
$t_{rr}$	Reverse Recovery Time	—	73	110	ns	$T_J = 25^\circ\text{C}, I_F = 100A$
$Q_{rr}$	Reverse Recovery Charge	—	200	300	nC	$di/dt = 100A/\mu s$ ④
$t_{on}$	Forward Turn-On Time	Intrinsic turn-on time is negligible (turn-on is dominated by $L_S + L_D$ )				

### Notes:

- ① Repetitive rating; pulse width limited by max. junction temperature. (See Fig. 11)
- ② Starting  $T_J = 25^\circ\text{C}$ ,  $L = 0.13\text{mH}$ ,  $V_{GS} = 10V$ ,  $R_G = 25\Omega$ ,  $I_{AS} = 100A$ . (See Figure 12)
- ③  $I_{SD} \leq 100A$ ,  $di/dt \leq 150A/\mu s$ ,  $V_{DD} \leq V_{(BR)DSS}$ ,  $T_J \leq 200^\circ\text{C}$
- ④ Pulse width  $\leq 400\mu s$ ; duty cycle  $\leq 2\%$ .
- ⑤  $C_{oss \text{ eff.}}$  is a fixed capacitance that gives the same charging time as  $C_{oss}$  while  $V_{DS}$  is rising from 0 to 80%  $V_{DSS}$
- ⑥ Calculated continuous current based on maximum allowable junction temperature. Package limitation current is 75A
- ⑦ At the point of termination of the leads at the PCB, the temp. should be limited to  $175^\circ\text{C}$ . The device case temperature is allowed to be higher

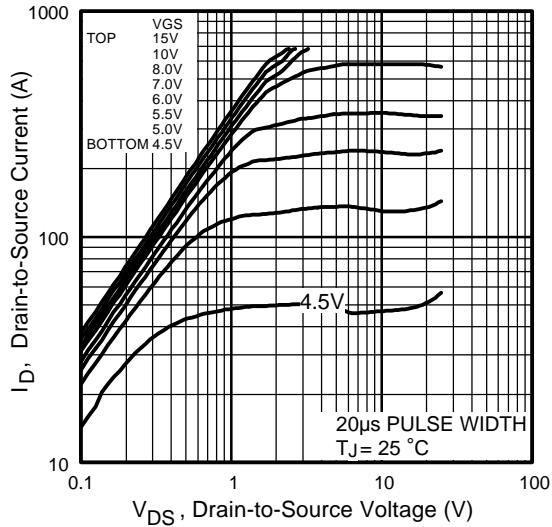


Fig 1. Typical Output Characteristics

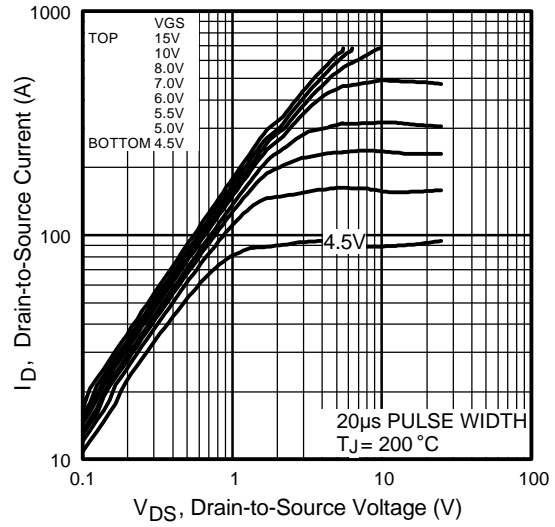


Fig 2. Typical Output Characteristics

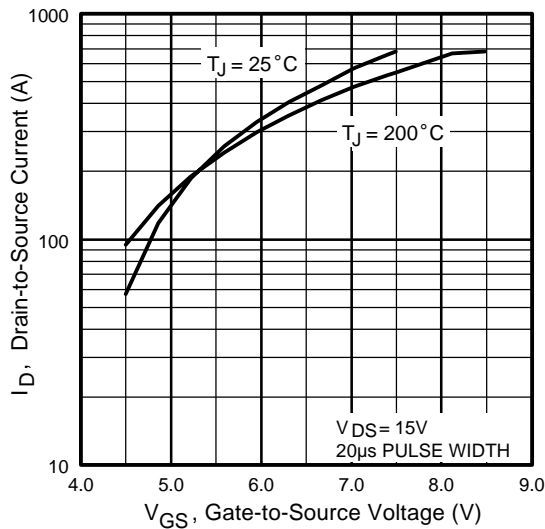


Fig 3. Typical Transfer Characteristics

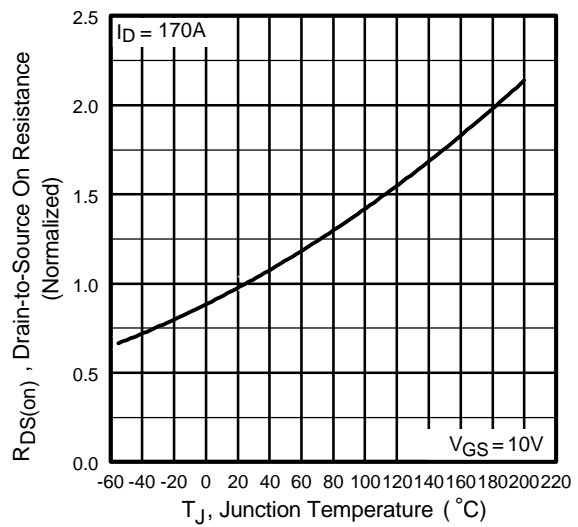
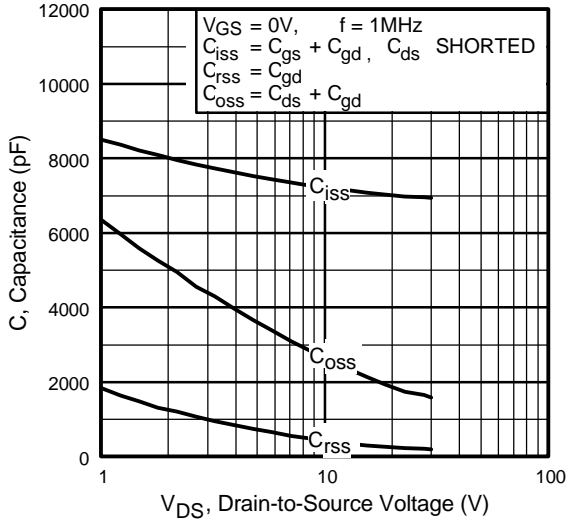
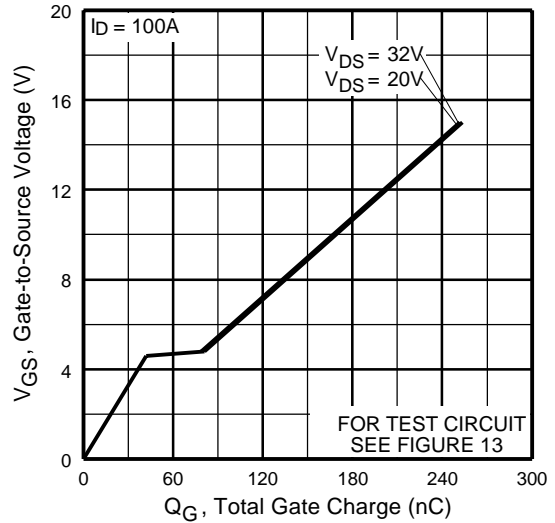


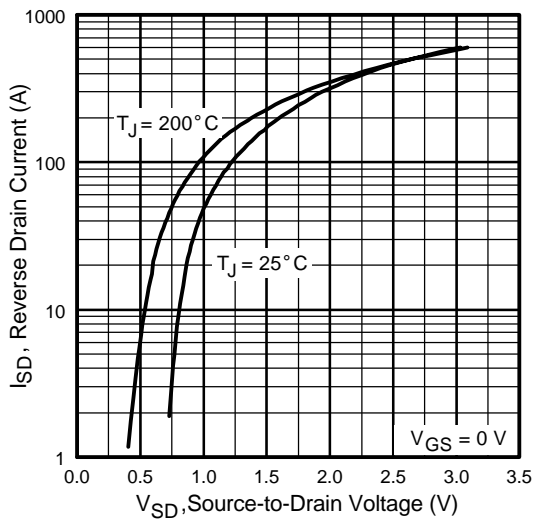
Fig 4. Normalized On-Resistance Vs. Temperature



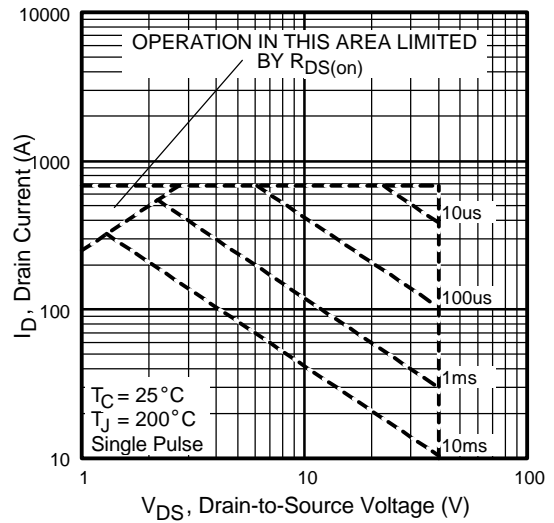
**Fig 5.** Typical Capacitance Vs. Drain-to-Source Voltage



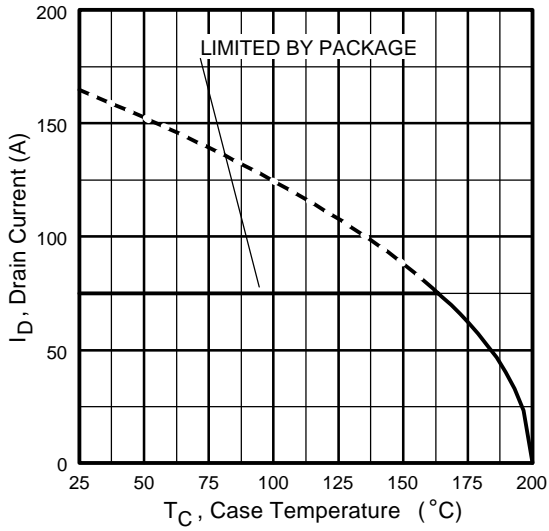
**Fig 6.** Typical Gate Charge Vs. Gate-to-Source Voltage



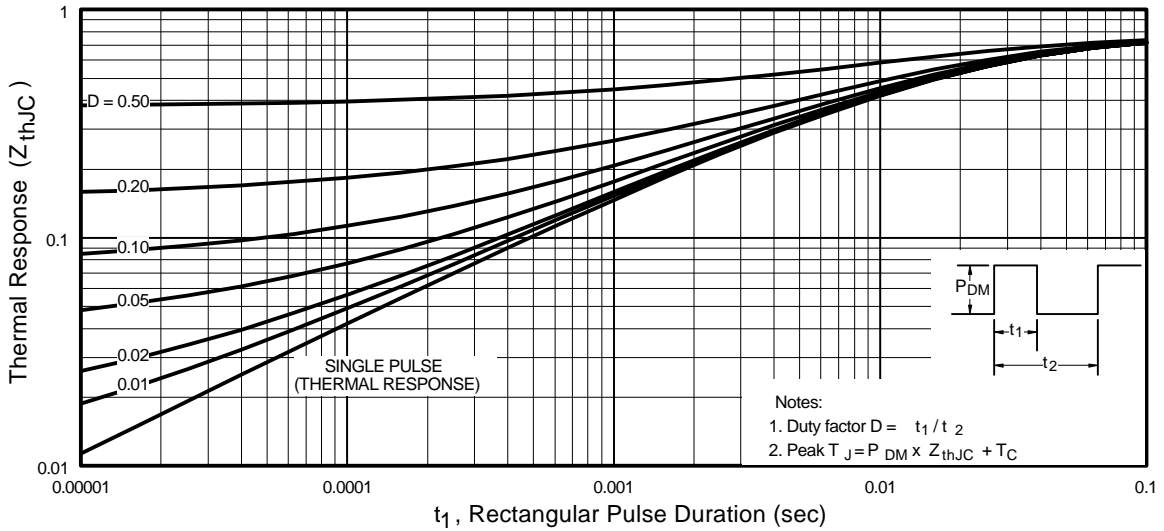
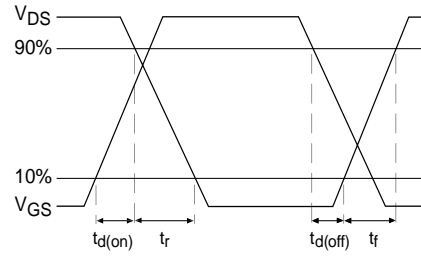
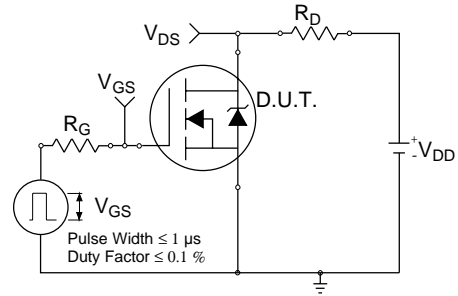
**Fig 7.** Typical Source-Drain Diode Forward Voltage



**Fig 8.** Maximum Safe Operating Area



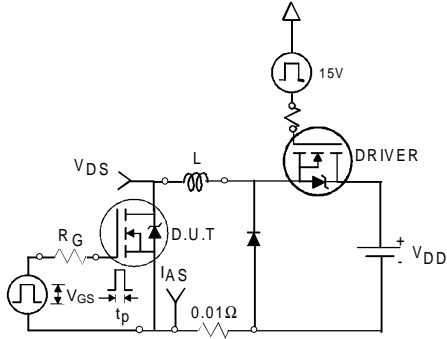
**Fig 9.** Maximum Drain Current Vs. Case Temperature



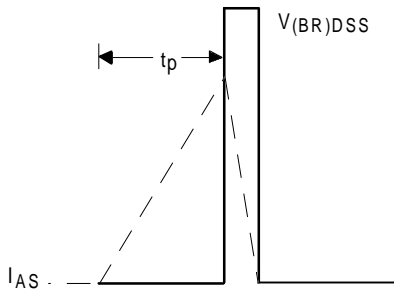
**Fig 11.** Maximum Effective Transient Thermal Impedance, Junction-to-Case

# IRF1704

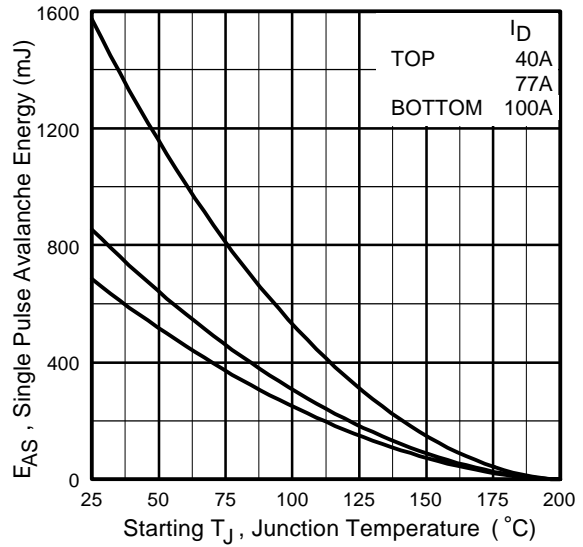
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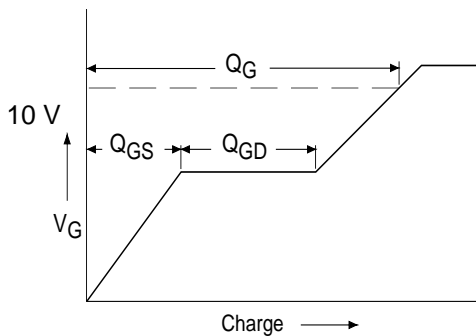
**Fig 12a.** Unclamped Inductive Test Circuit



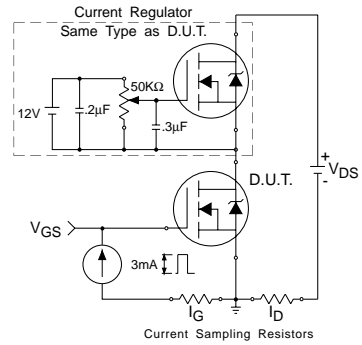
**Fig 12b.** Unclamped Inductive Waveforms



**Fig 12c.** Maximum Avalanche Energy Vs. Drain Current

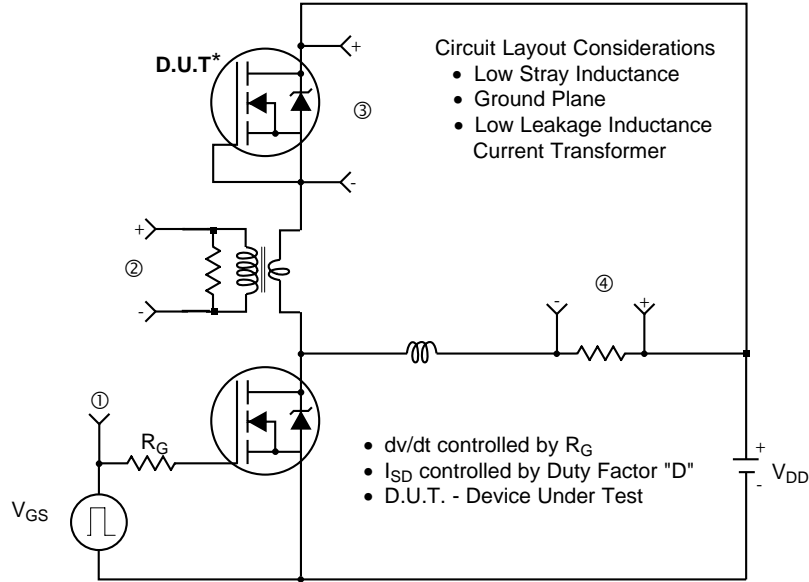


**Fig 13a.** Basic Gate Charge Waveform

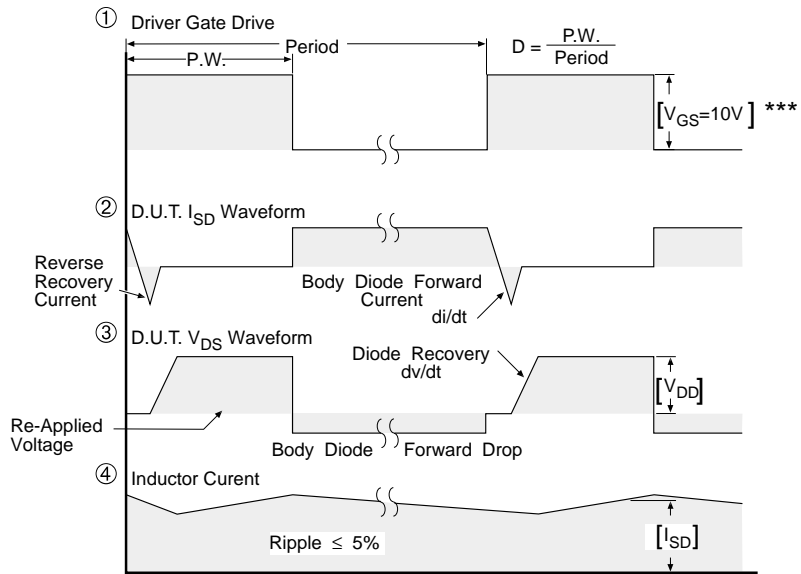


**Fig 13b.** Gate Charge Test Circuit

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



\* Reverse Polarity of D.U.T for P-Channel



\*\*\*  $V_{GS} = 5.0V$  for Logic Level and 3V Drive Devices

**Fig 14.** For N-channel HEXFET® power MOSFETs

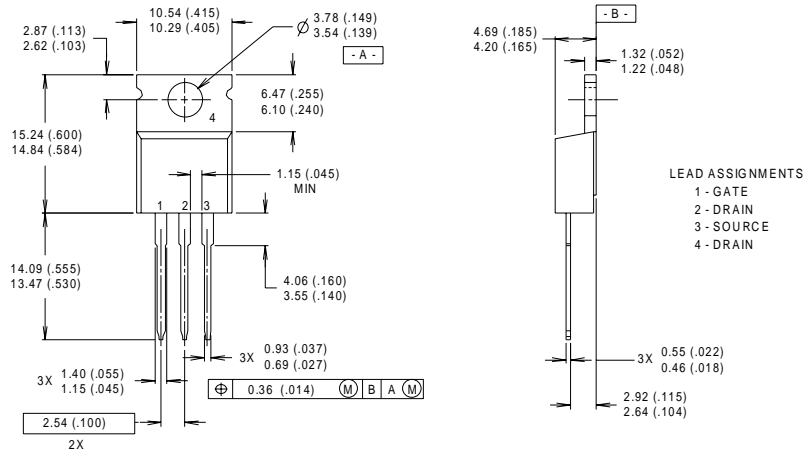
# IRF1704

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## Package Outline

### TO-220AB

Dimensions are shown in millimeters (inches)

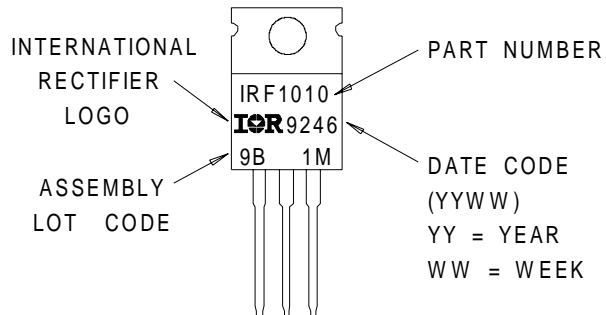


- NOTES:  
1 DIMENSIONING & TOLERANCING PER ANSI Y14.5M, 1982.  
2 CONTROLLING DIMENSION : INCH  
3 OUTLINE CONFORMS TO JEDEC OUTLINE TO-220AB.  
4 HEATSINK & LEAD MEASUREMENTS DO NOT INCLUDE BURRS.

## Part Marking Information

### TO-220AB

EXAMPLE : THIS IS AN IRF1010  
WITH ASSEMBLY  
LOT CODE 9B1M



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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**IR** Rectifier

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