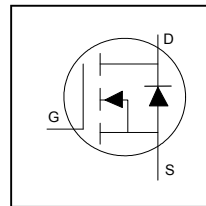


HEXFET® Power MOSFET

**Application**

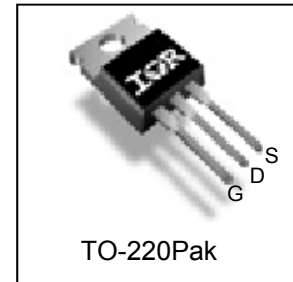
- High Efficiency Synchronous Rectification in SMPS
- Uninterruptible Power Supply
- High Speed Power Switching
- Hard Switched and High Frequency Circuits



|                                |             |
|--------------------------------|-------------|
| <b>V<sub>DSS</sub></b>         | <b>300V</b> |
| <b>R<sub>DS(on)</sub> typ.</b> | <b>56mΩ</b> |
|                                | <b>69mΩ</b> |
| <b>I<sub>D</sub></b>           | <b>38A</b>  |

**Benefits**

- Improved Gate, Avalanche and Dynamic dV/dt Ruggedness
- Fully Characterized Capacitance and Avalanche SOA
- Enhanced body diode dV/dt and dI/dt Capability
- Lead-Free, RoHS Compliant



|          |          |          |
|----------|----------|----------|
| <b>G</b> | <b>D</b> | <b>S</b> |
| Gate     | Drain    | Source   |

| Base part number | Package Type | Standard Pack |          | Orderable Part Number |
|------------------|--------------|---------------|----------|-----------------------|
|                  |              | Form          | Quantity |                       |
| IRFB4137PbF      | TO-220Pak    | Tube          | 50       | IRFB4137PbF           |

|   | Parameter   | Max.                | Units |
|---|---|---------------------|-------|
| I <sub>D</sub> @ T <sub>C</sub> = 25°C  | Continuous Drain Current, V <sub>GS</sub> @ 10V         | 38                  | A     |
| I <sub>D</sub> @ T <sub>C</sub> = 100°C | Continuous Drain Current, V <sub>GS</sub> @ 10V         | 27                  |       |
| I <sub>DM</sub>                         | Pulsed Drain Current ①                                  | 152                 |       |
| P <sub>D</sub> @ T <sub>C</sub> = 25°C  | Maximum Power Dissipation                               | 341                 | W     |
|   | Linear Derating Factor                                  | 2.3                 | W/°C  |
| V <sub>GS</sub>                         | Gate-to-Source Voltage                                  | ± 20                | V     |
| dv/dt                                   | Peak Diode Recovery dv/dt③                              | 8.9                 | V/ns  |
| T <sub>J</sub><br>T <sub>STG</sub>      | Operating Junction and Storage Temperature Range        | -55 to + 175        | °C    |
|   | Soldering Temperature, for 10 seconds (1.6mm from case) | 300                 |       |
|   | Mounting Torque, 6-32 or M3 Screw                       | 10 lbf-in (1.1 N·m) |       |

**Avalanche Characteristics**

|                                     |                                 |     |    |
|-------------------------------------|---------------------------------|-----|----|
| E <sub>AS</sub> (Thermally limited) | Single Pulse Avalanche Energy ② | 414 | mJ |
|-------------------------------------|---------------------------------|-----|----|

**Thermal Resistance**

|                  | Parameter                          | Typ. | Max. | Units |
|------------------|------------------------------------|------|------|-------|
| R <sub>θJC</sub> | Junction-to-Case ④                 | —    | 0.44 | °C/W  |
| R <sub>θCS</sub> | Case-to-Sink, Flat Greased Surface | 0.50 | —    |       |
| R <sub>θJA</sub> | Junction-to-Ambient ⑦⑧             | —    | 62   |       |

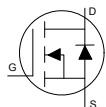
**Static @ T<sub>J</sub> = 25°C (unless otherwise specified)**

|  | Parameter                            | Min. | Typ. | Max. | Units | Conditions   |
|--|--------------------------------------|------|------|------|-------|--|
| V <sub>(BR)DSS</sub>                   | Drain-to-Source Breakdown Voltage    | 300  | —    | —    | V     | V <sub>GS</sub> = 0V, I <sub>D</sub> = 250μA                         |
| ΔV <sub>(BR)DSS</sub> /ΔT <sub>J</sub> | Breakdown Voltage Temp. Coefficient  | —    | 0.24 | —    | V/°C  | Reference to 25°C, I <sub>D</sub> = 3.5mA                            |
| R <sub>DS(on)</sub>                    | Static Drain-to-Source On-Resistance | —    | 56   | 69   | mΩ    | V <sub>GS</sub> = 10V, I <sub>D</sub> = 24A ④                        |
| V <sub>GS(th)</sub>                    | Gate Threshold Voltage               | 3.0  | —    | 5.0  | V     | V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = 250μA           |
| I <sub>DSS</sub>                       | Drain-to-Source Leakage Current      | —    | —    | 20   | μA    | V <sub>DS</sub> = 300V, V <sub>GS</sub> = 0V                         |
|  |                                      | —    | —    | 250  |       | V <sub>DS</sub> = 300V, V <sub>GS</sub> = 0V, T <sub>J</sub> = 125°C |
| I <sub>GSS</sub>                       | Gate-to-Source Forward Leakage       | —    | —    | 100  | nA    | V <sub>GS</sub> = 20V  |
|  | Gate-to-Source Reverse Leakage       | —    | —    | -100 |       | V <sub>GS</sub> = -20V   |
| R <sub>G</sub>                         | Gate Resistance                      | —    | 1.3  | —    | Ω     |  |

**Dynamic Electrical Characteristics @ T<sub>J</sub> = 25°C (unless otherwise specified)**

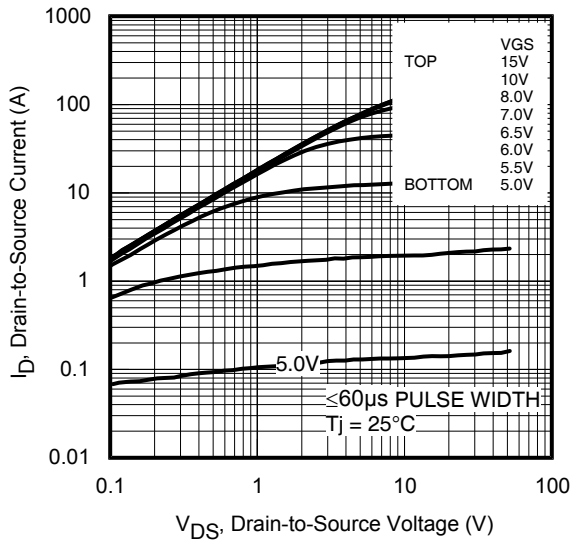
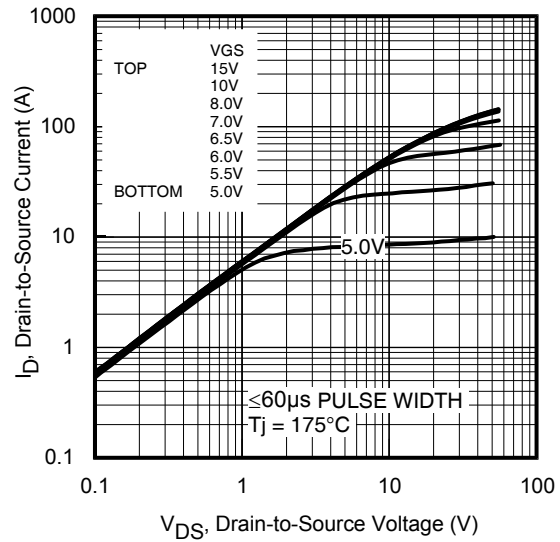
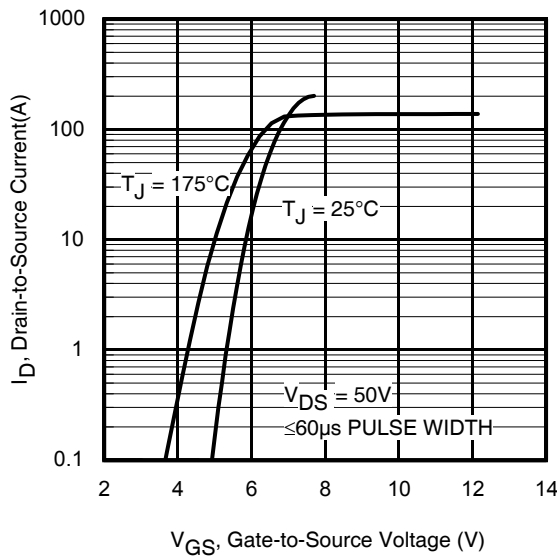
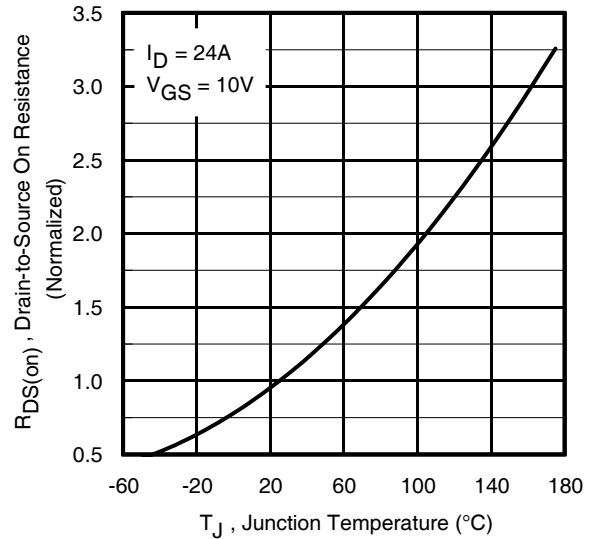
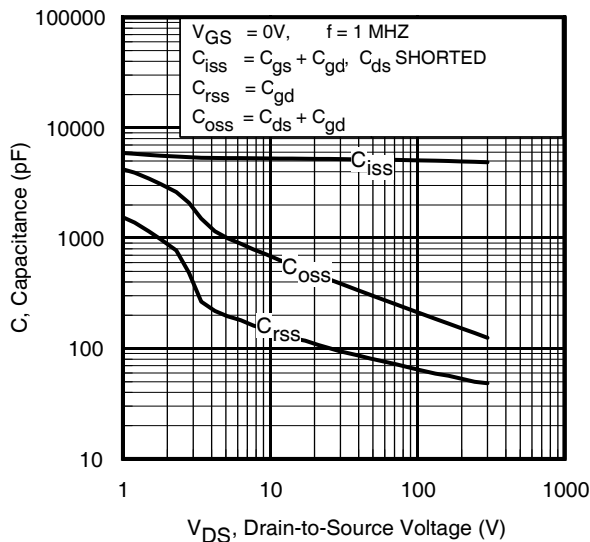
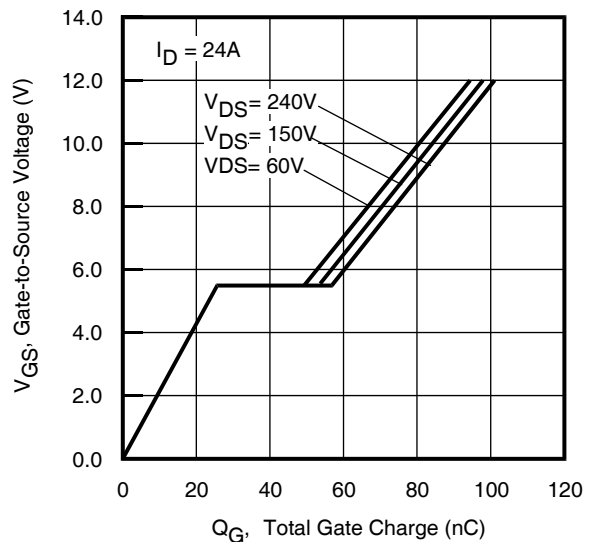
|                           |   |    |      |     |    |   |
|---------------------------|---|----|------|-----|----|---|
| g <sub>fs</sub>           | Forward Transconductance                      | 45 | —    | —   | S  | V <sub>DS</sub> = 50V, I <sub>D</sub> = 24A                     |
| Q <sub>g</sub>            | Total Gate Charge                             | —  | 83   | 125 | nC | I <sub>D</sub> = 24A  |
| Q <sub>gs</sub>           | Gate-to-Source Charge                         | —  | 28   | 42  |    | V <sub>DS</sub> = 150V  |
| Q <sub>gd</sub>           | Gate-to-Drain Charge                          | —  | 26   | 39  |    | V <sub>GS</sub> = 10V   |
| t <sub>d(on)</sub>        | Turn-On Delay Time                            | —  | 18   | —   | ns | V <sub>DD</sub> = 195V  |
| t <sub>r</sub>            | Rise Time                                     | —  | 23   | —   |    | I <sub>D</sub> = 24A  |
| t <sub>d(off)</sub>       | Turn-Off Delay Time                           | —  | 34   | —   |    | R <sub>G</sub> = 2.2Ω   |
| t <sub>f</sub>            | Fall Time                                     | —  | 20   | —   |    | V <sub>GS</sub> = 10V   |
| C <sub>iss</sub>          | Input Capacitance                             | —  | 5168 | —   | pF | V <sub>GS</sub> = 0V  |
| C <sub>oss</sub>          | Output Capacitance                            | —  | 300  | —   |    | V <sub>DS</sub> = 50V   |
| C <sub>rss</sub>          | Reverse Transfer Capacitance                  | —  | 77   | —   |    | f = 1.0MHz  |
| C <sub>oss eff.(ER)</sub> | Effective Output Capacitance (Energy Related) | —  | 196  | —   |    | V <sub>GS</sub> = 0V, V <sub>DS</sub> = 0V to 240V <sup>⑥</sup> |
| C <sub>oss eff.(TR)</sub> | Output Capacitance (Time Related)             | —  | 265  | —   |    | See Fig.11  |
|                           |   |    |      |     |    | V <sub>GS</sub> = 0V, V <sub>DS</sub> = 0V to 240V <sup>⑤</sup> |

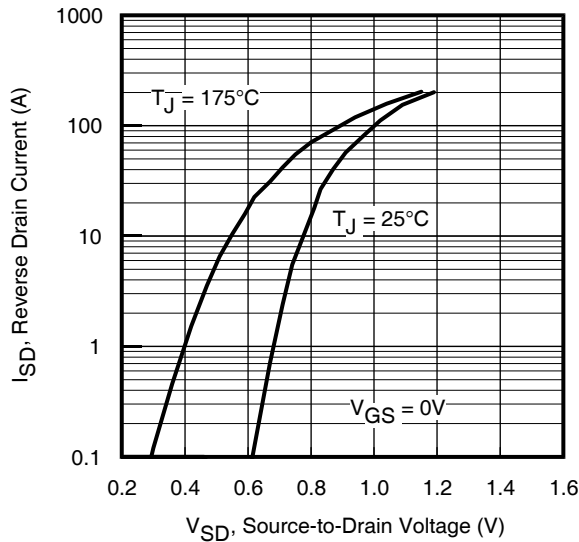
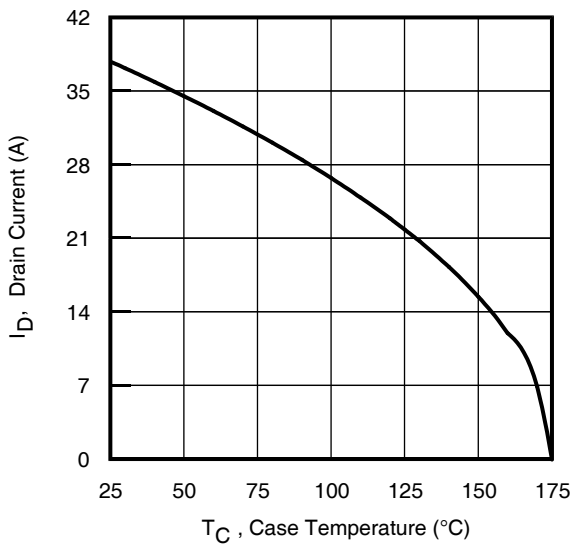
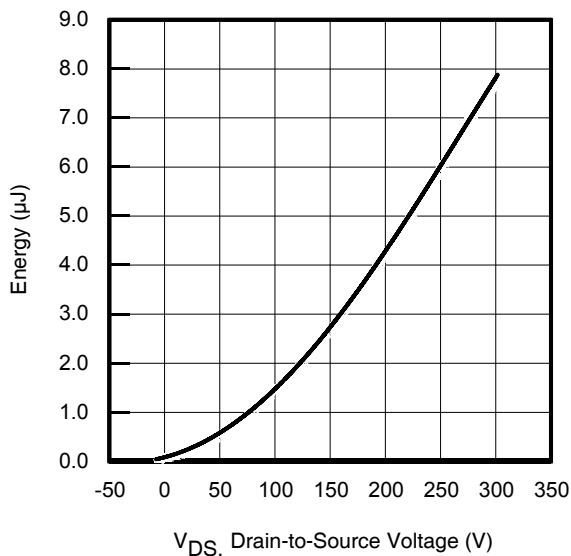
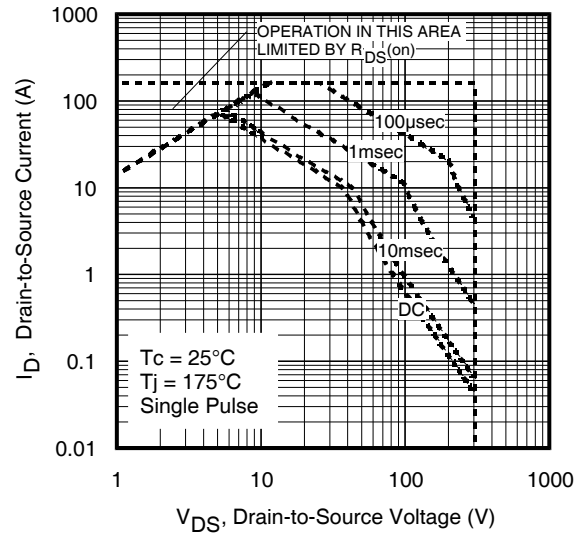
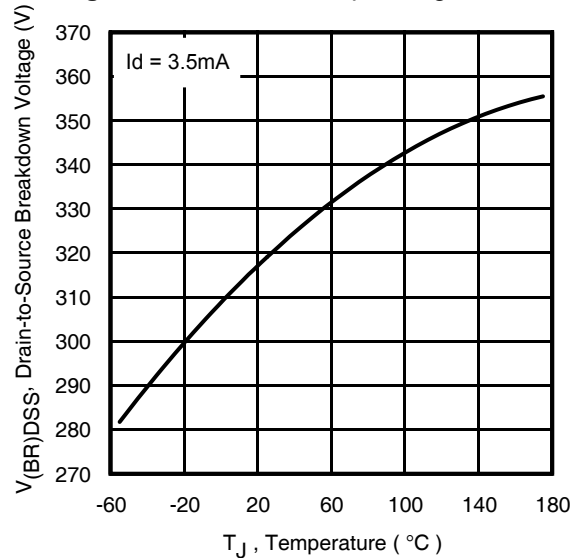
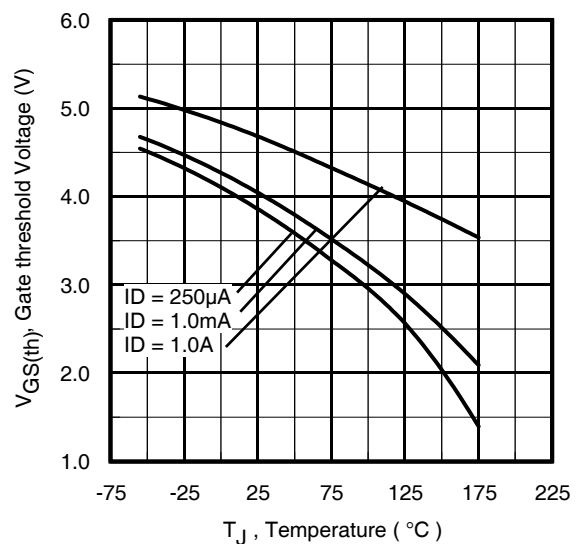
**Diode Characteristics**

|                  | Parameter                                | Min. | Typ. | Max. | Units | Conditions   |
|------------------|--|------|------|------|-------|--|
| I <sub>S</sub>   | Continuous Source Current (Body Diode) ① | —    | —    | 38   | A     | MOSFET symbol showing the integral reverse p-n junction diode.  |
| I <sub>SM</sub>  | Pulsed Source Current (Body Diode) ①     | —    | —    | 152  |       |  |
| V <sub>SD</sub>  | Diode Forward Voltage                    | —    | —    | 1.3  | V     | T <sub>J</sub> = 25°C, I <sub>S</sub> = 24A, V <sub>GS</sub> = 0V ④  |
| t <sub>rr</sub>  | Reverse Recovery Time                    | —    | 302  | —    | ns    | T <sub>J</sub> = 25°C V <sub>DD</sub> = 255V   |
|                  |  | —    | 379  | —    |       | T <sub>J</sub> = 125°C I <sub>F</sub> = 24A,   |
| Q <sub>rr</sub>  | Reverse Recovery Charge                  | —    | 1739 | —    | nC    | T <sub>J</sub> = 25°C di/dt = 100A/μs ④  |
|                  |  | —    | 2497 | —    |       | T <sub>J</sub> = 125°C   |
| I <sub>RSM</sub> | Reverse Recovery Current                 | —    | 13   | —    | A     | T <sub>J</sub> = 25°C  |

**Notes:**

- ① Repetitive rating; pulse width limited by max. junction temperature.
- ② Recommended max EAS limit, starting T<sub>J</sub> = 25°C, L = 1.56mH, R<sub>G</sub> = 50Ω, I<sub>AS</sub> = 24A, V<sub>GS</sub> = 10V.
- ③ I<sub>SD</sub> ≤ 24A, di/dt ≤ 1771A/μs, V<sub>DD</sub> ≤ V<sub>(BR)DSS</sub>, T<sub>J</sub> ≤ 175°C.
- ④ Pulse width ≤ 400μs; duty cycle ≤ 2%.
- ⑤ C<sub>oss eff. (TR)</sub> is a fixed capacitance that gives the same charging time as C<sub>oss</sub> while V<sub>DS</sub> is rising from 0 to 80% V<sub>DSS</sub>.
- ⑥ C<sub>oss eff. (ER)</sub> is a fixed capacitance that gives the same energy as C<sub>oss</sub> while V<sub>DS</sub> is rising from 0 to 80% V<sub>DSS</sub>.
- ⑦ When mounted on 1" square PCB (FR-4 or G-10 Material). For recommended footprint and soldering techniques refer to application note #AN-994
- ⑧ R<sub>θ</sub> is measured at T<sub>J</sub> approximately 90°C


**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 9.** Maximum Drain Current vs. Case Temperature

**Fig 11.** Typical  $C_{oss}$  Stored Energy

**Fig 8.** Maximum Safe Operating Area

**Fig 10.** Drain-to-Source Breakdown Voltage

**Fig 12.** Threshold Voltage vs. Temperature

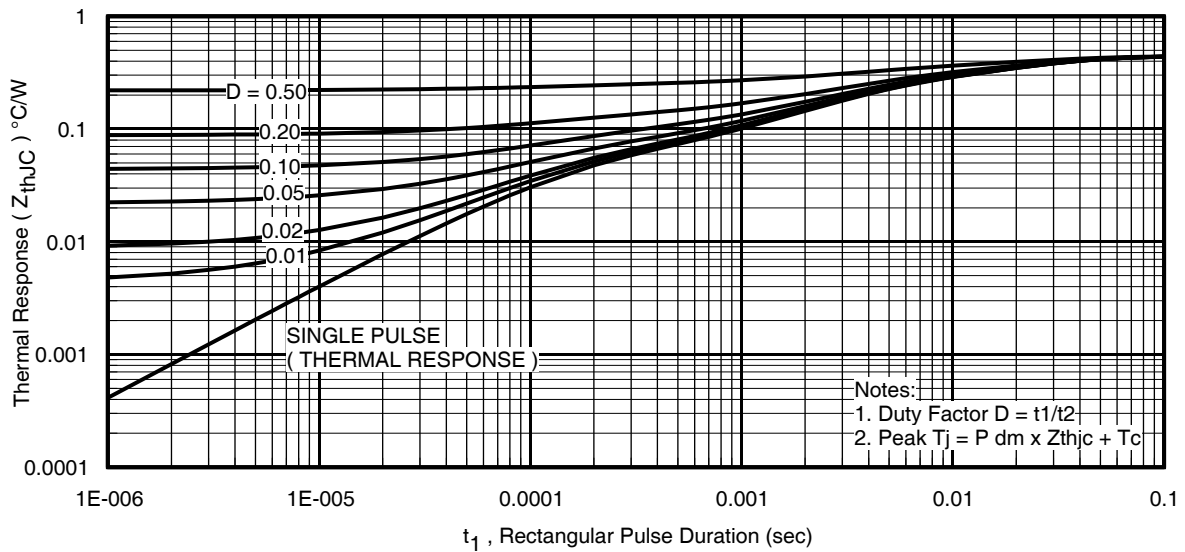


Fig 13. Maximum Effective Transient Thermal Impedance, Junction-to-Case

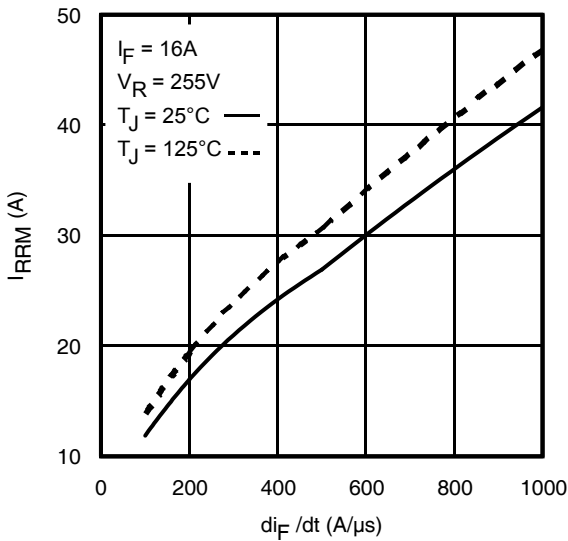


Fig 14. Typical Recovery Current vs. dif/dt

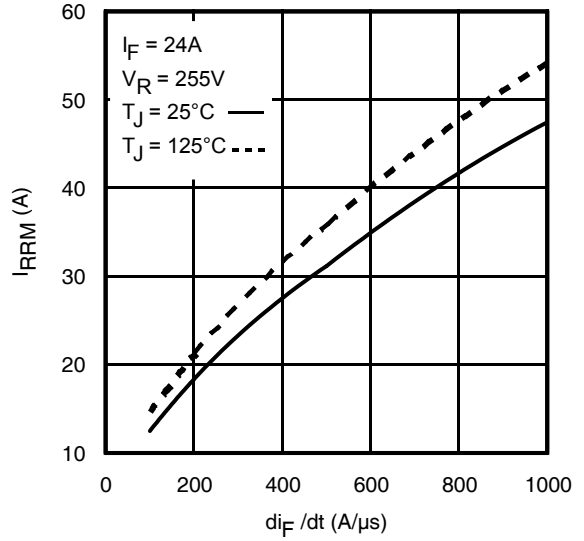


Fig 15. Typical Recovery Current vs. dif/dt

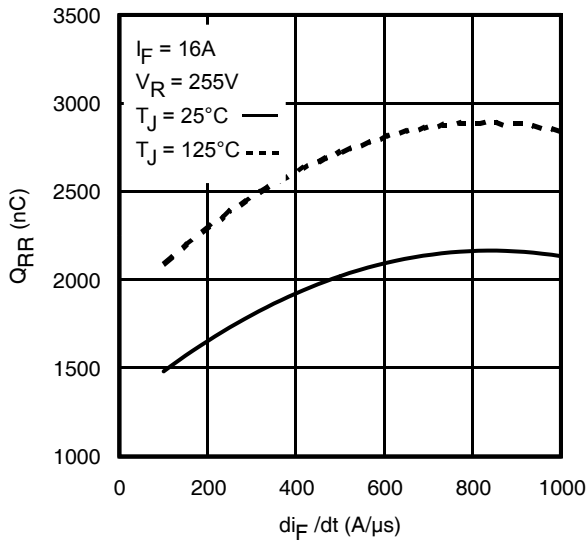


Fig 16. Typical Stored Charge vs. dif/dt

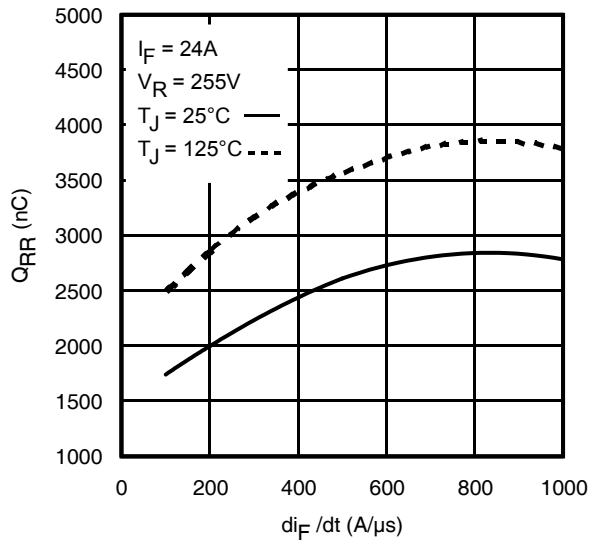
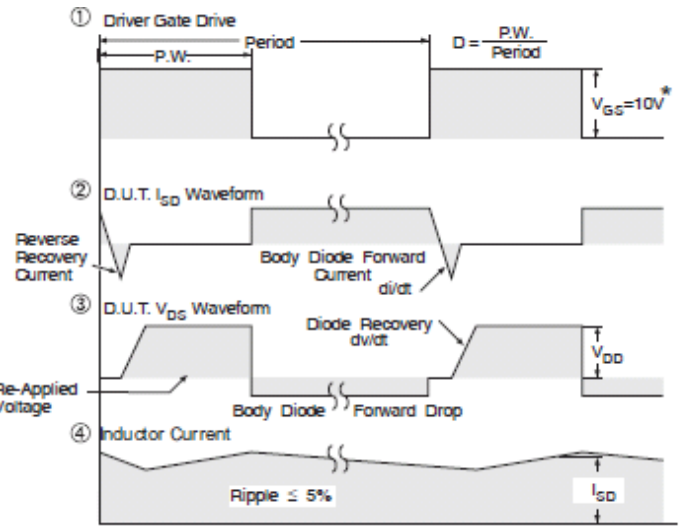
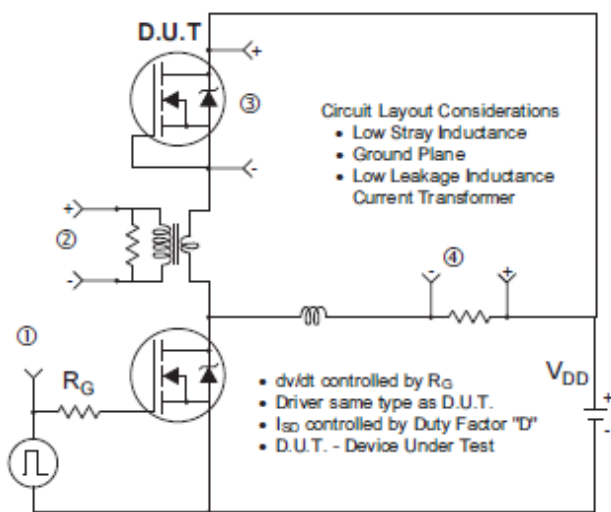
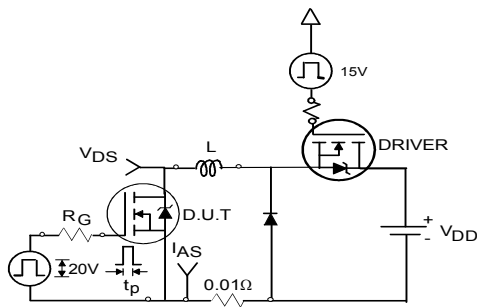


Fig 17. Typical Stored Charge vs. dif/dt

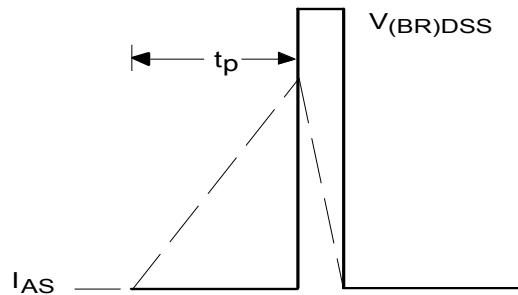


\*  $V_{GS} = 5V$  for Logic Level Devices

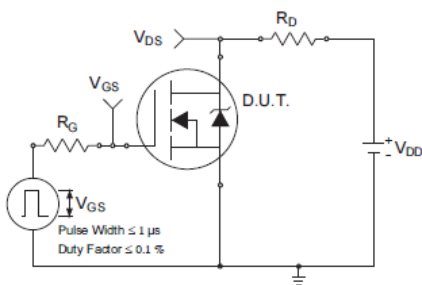
**Fig 18.** Peak Diode Recovery  $dv/dt$  Test Circuit for N-Channel HEXFET<sup>®</sup> Power MOSFETs



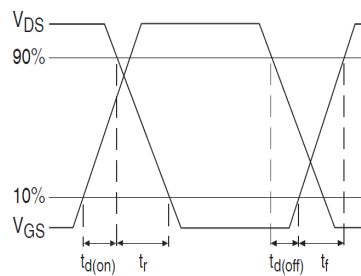
**Fig 19a.** Unclamped Inductive Test Circuit



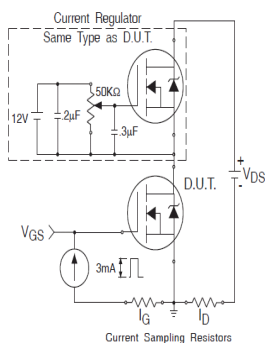
**Fig 19b.** Unclamped Inductive Waveforms



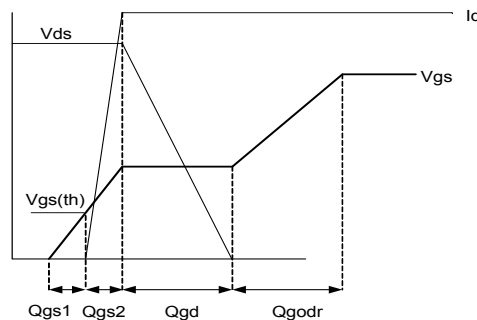
**Fig 20a.** Switching Time Test Circuit



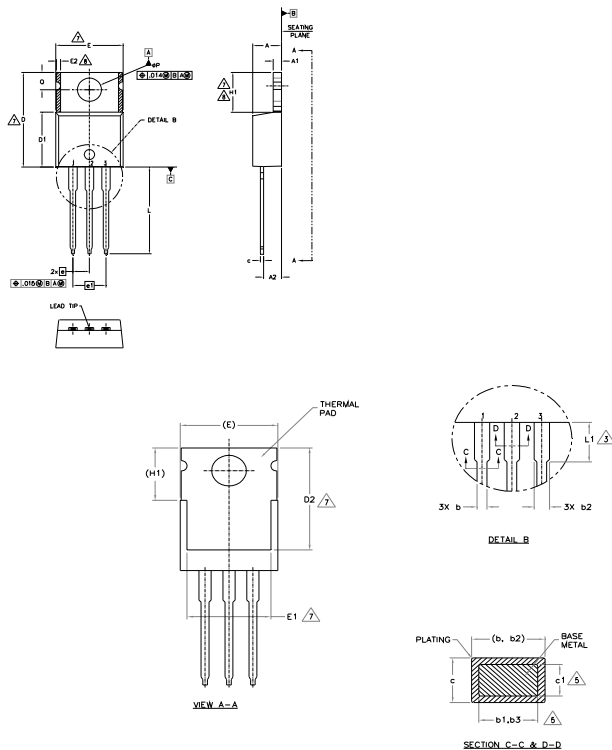
**Fig 20b.** Switching Time Waveforms



**Fig 21a.** Gate Charge Test Circuit



**Fig 21b.** Gate Charge Waveform

**TO-220AB Package Outline (Dimensions are shown in millimeters (inches))**


- NOTES:
- 1.- DIMENSIONING AND TOLERANCING AS PER ASME Y14.5 M- 1994.
  - 2.- DIMENSIONS ARE SHOWN IN INCHES [MILLIMETERS].
  - 3.- LEAD DIMENSION AND FINISH UNCONTROLLED IN L1.
  - 4.- DIMENSION D, D1 & E DO NOT INCLUDE MOLD FLASH. MOLD FLASH SHALL NOT EXCEED .005" (0.127) PER SIDE. THESE DIMENSIONS ARE MEASURED AT THE OUTERMOST EXTREMES OF THE PLASTIC BODY.
  - 5.- DIMENSION b1, b3 & c1 APPLY TO BASE METAL ONLY.
  - 6.- CONTROLLING DIMENSION : INCHES.
  - 7.- THERMAL PAD CONTOUR OPTIONAL WITHIN DIMENSIONS E,H1,D2 & E1
  - 8.- DIMENSION E2 X H1 DEFINE A ZONE WHERE STAMPING AND SINGULATION IRREGULARITIES ARE ALLOWED.
  - 9.- OUTLINE CONFORMS TO JEDEC TO-220, EXCEPT A2 (max.) AND D2 (min.) WHERE DIMENSIONS ARE DERIVED FROM THE ACTUAL PACKAGE OUTLINE.

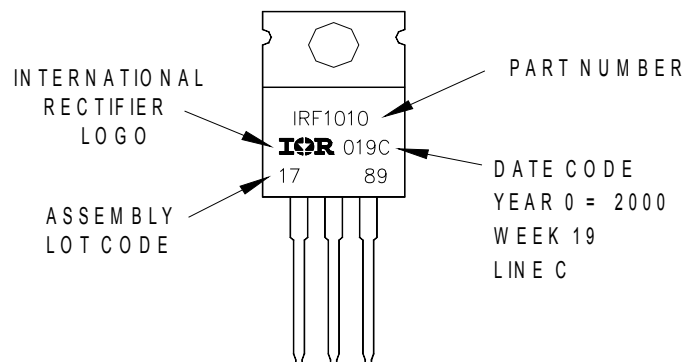
| SYMBOL | DIMENSIONS  |       |          |      | NOTES |
|--------|-------------|-------|----------|------|-------|
|        | MILLIMETERS |       | INCHES   |      |       |
|        | MIN.        | MAX.  | MIN.     | MAX. |       |
| A      | 3.56        | 4.83  | .140     | .190 |       |
| A1     | 0.51        | 1.40  | .020     | .055 |       |
| A2     | 2.03        | 2.92  | .080     | .115 |       |
| b      | 0.38        | 1.01  | .015     | .040 |       |
| b1     | 0.38        | 0.97  | .015     | .038 | 5     |
| b2     | 1.14        | 1.78  | .045     | .070 |       |
| b3     | 1.14        | 1.73  | .045     | .068 | 5     |
| c      | 0.36        | 0.61  | .014     | .024 |       |
| c1     | 0.36        | 0.56  | .014     | .022 | 5     |
| D      | 14.22       | 16.51 | .560     | .650 | 4     |
| D1     | 8.38        | 9.02  | .330     | .355 |       |
| D2     | 11.68       | 12.88 | .460     | .507 | 7     |
| E      | 9.65        | 10.67 | .380     | .420 | 4,7   |
| E1     | 6.86        | 8.89  | .270     | .350 | 7     |
| E2     | -           | 0.76  | -        | .030 | 8     |
| e      | 2.54 BSC    |       | .100 BSC |      |       |
| e1     | 5.08 BSC    |       | .200 BSC |      |       |
| H1     | 5.84        | 6.86  | .230     | .270 | 7,8   |
| L      | 12.70       | 14.73 | .500     | .580 |       |
| L1     | 3.56        | 4.06  | .140     | .160 | 3     |
| øP     | 3.54        | 4.08  | .139     | .161 |       |
| Q      | 2.54        | 3.42  | .100     | .135 |       |

- LEAD ASSIGNMENTS
- HEXFET
- 1.- GATE
  - 2.- DRAIN
  - 3.- SOURCE
- IGBTs, CoPACK
- 1.- GATE
  - 2.- COLLECTOR
  - 3.- EMITTER
- DIODES
- 1.- ANODE
  - 2.- CATHODE
  - 3.- ANODE

**TO-220AB Part Marking Information**

EXAMPLE: THIS IS AN IRF1010  
 LOT CODE 1789  
 ASSEMBLED ON WW 19, 2000  
 IN THE ASSEMBLY LINE "C"

Note: "P" in assembly line position indicates "Lead - Free"



TO-220AB packages are not recommended for Surface Mount Application.

Note: For the most current drawing please refer to IR website at <http://www.irf.com/package/>

**Qualification Information<sup>†</sup>**

|                                   |   |     |
|-----------------------------------|---|-----|
| <b>Qualification Level</b>        | Industrial<br>(per JEDEC JESD47F) <sup>††</sup> |     |
| <b>Moisture Sensitivity Level</b> | TO-220  | N/A |
| <b>RoHS Compliant</b>             | Yes   |     |

† Qualification standards can be found at International Rectifier's web site: <http://www.irf.com/product-info/reliability/>

†† Applicable version of JEDEC standard at the time of product release.

Data and specifications subject to change without notice.

International  
 Rectifier

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