

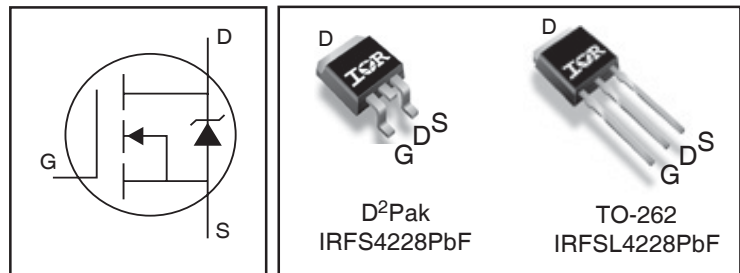
PDP SWITCH

IRFS4228PbF
IRFSL4228PbF

Features

- Advanced Process Technology
- Key Parameters Optimized for PDP Sustain, Energy Recovery and Pass Switch Applications
- Low E_{PULSE} Rating to Reduce Power Dissipation in PDP Sustain, Energy Recovery and Pass Switch Applications
- Low Q_G for Fast Response
- High Repetitive Peak Current Capability for Reliable Operation
- Short Fall & Rise Times for Fast Switching
- 175°C Operating Junction Temperature for Improved Ruggedness
- Repetitive Avalanche Capability for Robustness and Reliability

| Key Parameters | | |
|--|-----|----|
| V_{DS} min | 150 | V |
| V_{DS} (Avalanche) typ. | 180 | V |
| $R_{DS(ON)}$ typ. @ 10V | 12 | mΩ |
| I_{RP} max @ $T_C = 100^\circ\text{C}$ | 170 | A |
| T_J max | 175 | °C |



| G | D | S |
|------|-------|--------|
| Gate | Drain | Source |

Description

This HEXFET® Power MOSFET is specifically designed for Sustain; Energy Recovery & Pass switch applications in Plasma Display Panels. This MOSFET utilizes the latest processing techniques to achieve low on-resistance per silicon area and low E_{PULSE} rating. Additional features of this MOSFET are 175°C operating junction temperature and high repetitive peak current capability. These features combine to make this MOSFET a highly efficient, robust and reliable device for PDP driving applications.

Absolute Maximum Ratings

| | Parameter | Max. | Units |
|--------------------------------------|--|------------------|-------|
| V_{GS} | Gate-to-Source Voltage | ±30 | V |
| I_D @ $T_C = 25^\circ\text{C}$ | Continuous Drain Current, V_{GS} @ 10V | 83 | A |
| I_D @ $T_C = 100^\circ\text{C}$ | Continuous Drain Current, V_{GS} @ 10V | 59 | |
| I_{DM} | Pulsed Drain Current ① | 330 | |
| I_{RP} @ $T_C = 100^\circ\text{C}$ | Repetitive Peak Current ⑤ | 170 | |
| P_D @ $T_C = 25^\circ\text{C}$ | Power Dissipation | 330 | W |
| P_D @ $T_C = 100^\circ\text{C}$ | Power Dissipation | 170 | |
| | Linear Derating Factor | 2.2 | W/°C |
| T_J | Operating Junction and | -40 to + 175 | °C |
| T_{STG} | Storage Temperature Range | | |
| | Soldering Temperature for 10 seconds | 300 | |
| | Mounting Torque, 6-32 or M3 Screw | 10lb·in (1.1N·m) | N |

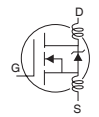
Thermal Resistance

| | Parameter | Typ. | Max. | Units |
|-----------------|---|------|-------|-------|
| $R_{\theta JC}$ | Junction-to-Case ④ | — | 0.45* | °C/W |
| $R_{\theta JA}$ | Junction-to-Ambient (PCB Mount) , D²Pak ⑥ | — | 40 | |

* $R_{\theta JC}$ (end of life) for D²Pak and TO-262 = 0.65°C/W. This is the maximum measured value after 1000 temperature cycles from -55 to 150°C and is accounted for by the physical wearout of the die attach medium.

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

| | Parameter | Min. | Typ. | Max. | Units | Conditions |
|--------------------------------|--------------------------------------|------|------|------|-------|--|
| BV_{DSS} | Drain-to-Source Breakdown Voltage | 150 | — | — | V | $V_{GS} = 0V, I_D = 250\mu A$ |
| $\Delta BV_{DSS}/\Delta T_J$ | Breakdown Voltage Temp. Coefficient | — | 150 | — | mV/°C | Reference to $25^\circ\text{C}, I_D = 1mA$ |
| $R_{DS(on)}$ | Static Drain-to-Source On-Resistance | — | 12 | 15 | mΩ | $V_{GS} = 10V, I_D = 33A$ ③ |
| $V_{GS(th)}$ | Gate Threshold Voltage | 3.0 | — | 5.0 | V | $V_{DS} = V_{GS}, I_D = 250\mu A$ |
| $\Delta V_{GS(th)}/\Delta T_J$ | Gate Threshold Voltage Coefficient | — | -14 | — | mV/°C | |
| I_{DSS} | Drain-to-Source Leakage Current | — | — | 20 | μA | $V_{DS} = 150V, V_{GS} = 0V$ |
| | | — | — | 1.0 | mA | $V_{DS} = 150V, V_{GS} = 0V, T_J = 125^\circ\text{C}$ |
| I_{GSS} | Gate-to-Source Forward Leakage | — | — | 100 | nA | $V_{GS} = 20V$ |
| | Gate-to-Source Reverse Leakage | — | — | -100 | nA | $V_{GS} = -20V$ |
| g_{fs} | Forward Transconductance | 170 | — | — | S | $V_{DS} = 25V, I_D = 50A$ |
| Q_g | Total Gate Charge | — | 71 | 107 | nC | $V_{DD} = 75V, I_D = 50A, V_{GS} = 10V$ ③ |
| Q_{gd} | Gate-to-Drain Charge | — | 21 | — | nC | |
| $t_{d(on)}$ | Turn-On Delay Time | — | 18 | — | ns | $V_{DD} = 75V, V_{GS} = 10V$ ③ $I_D = 50A$ $R_G = 2.5\Omega$ See Fig. 22 |
| t_r | Rise Time | — | 59 | — | | |
| $t_{d(off)}$ | Turn-Off Delay Time | — | 24 | — | | |
| t_f | Fall Time | — | 33 | — | | |
| t_{st} | Shoot Through Blocking Time | 100 | — | — | ns | $V_{DD} = 120V, V_{GS} = 15V, R_G = 5.1\Omega$ |
| E_{PULSE} | Energy per Pulse | — | 58 | — | μJ | $L = 220nH, C = 0.3\mu F, V_{GS} = 15V$ $V_{DS} = 120V, R_G = 5.1\Omega, T_J = 25^\circ\text{C}$ |
| | | — | 110 | — | | $L = 220nH, C = 0.3\mu F, V_{GS} = 15V$ $V_{DS} = 120V, R_G = 5.1\Omega, T_J = 100^\circ\text{C}$ |
| C_{iss} | Input Capacitance | — | 4530 | — | pF | $V_{GS} = 0V$ |
| C_{oss} | Output Capacitance | — | 550 | — | | $V_{DS} = 25V$ |
| C_{rss} | Reverse Transfer Capacitance | — | 100 | — | | $f = 1.0MHz$ |
| $C_{oss\ eff.}$ | Effective Output Capacitance | — | 480 | — | | $V_{GS} = 0V, V_{DS} = 0V\ to\ 120V$ |
| 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 | — | | |

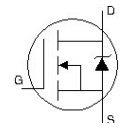


Avalanche Characteristics

| | Parameter | Typ. | Max. | Units |
|---------------------|---------------------------------|------|------|-------|
| E_{AS} | Single Pulse Avalanche Energy ② | — | 120 | mJ |
| E_{AR} | Repetitive Avalanche Energy ① | — | 33 | mJ |
| $V_{DS(Avalanche)}$ | Repetitive Avalanche Voltage ① | 180 | — | V |
| I_{AS} | Avalanche Current ② | — | 50 | A |

Diode Characteristics

| | Parameter | Min. | Typ. | Max. | Units | Conditions |
|--------------------------------|---|------|------|------|-------|---|
| $I_S @ T_C = 25^\circ\text{C}$ | Continuous Source Current (Body Diode) | — | — | 83 | A | MOSFET symbol showing the integral reverse p-n junction diode. |
| I_{SM} | Pulsed Source Current (Body Diode) ① | — | — | 330 | | |
| V_{SD} | Diode Forward Voltage | — | — | 1.3 | V | $T_J = 25^\circ\text{C}, I_S = 50A, V_{GS} = 0V$ ③ |
| t_{rr} | Reverse Recovery Time | — | 76 | 110 | ns | $T_J = 25^\circ\text{C}, I_F = 50A, V_{DD} = 50V$ |
| Q_{rr} | Reverse Recovery Charge | — | 230 | 350 | nC | $di/dt = 100A/\mu s$ ③ |



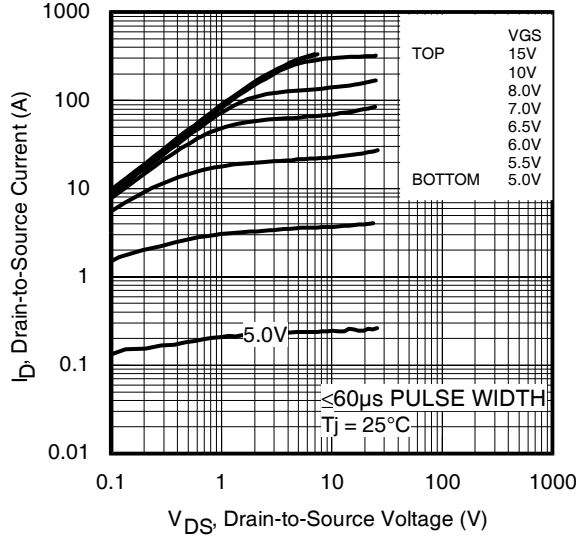


Fig 1. Typical Output Characteristics

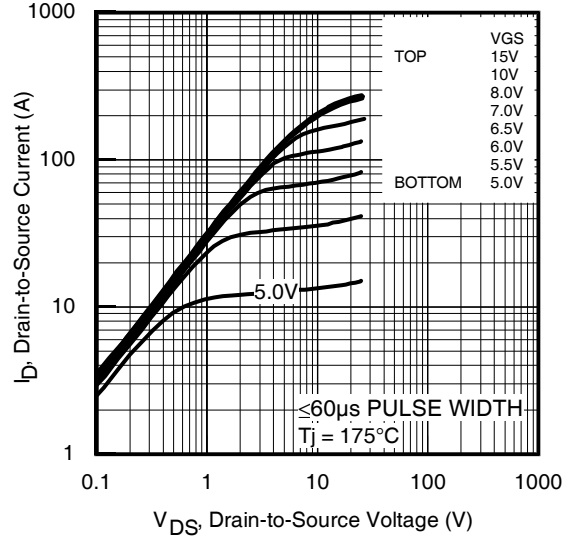


Fig 2. Typical Output Characteristics

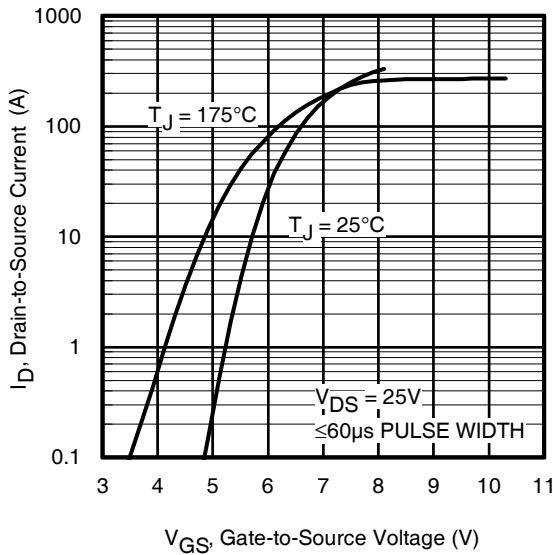


Fig 3. Typical Transfer Characteristics

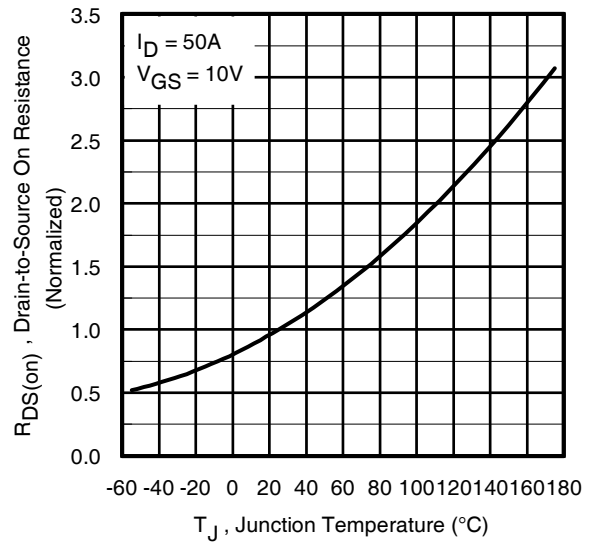


Fig 4. Normalized On-Resistance vs. Temperature

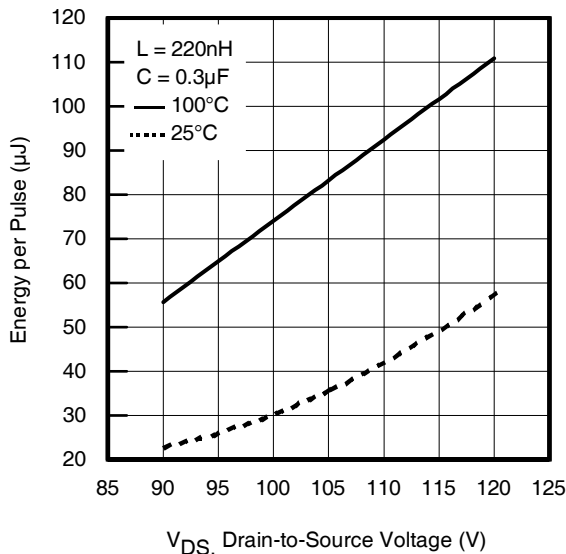


Fig 5. Typical E_{PULSE} vs. Drain-to-Source Voltage

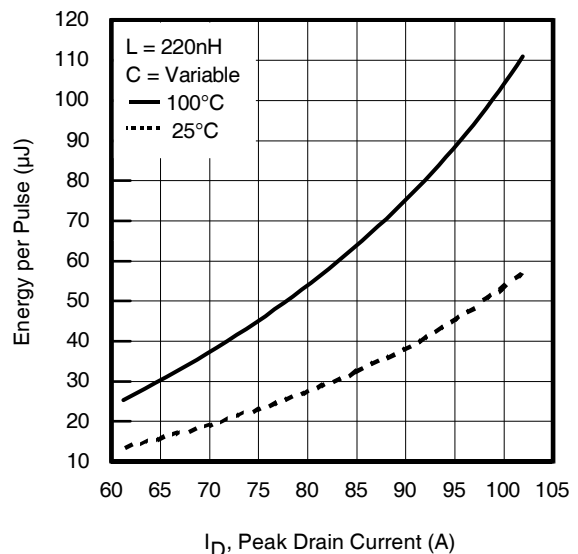


Fig 6. Typical E_{PULSE} vs. Drain Current

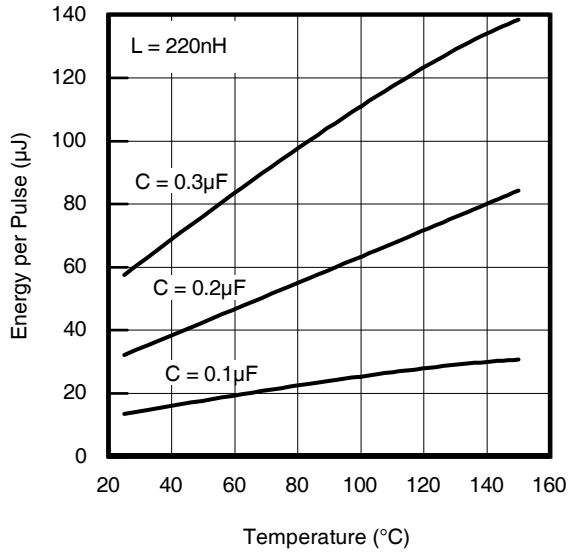


Fig 7. Typical E_{PULSE} vs. Temperature

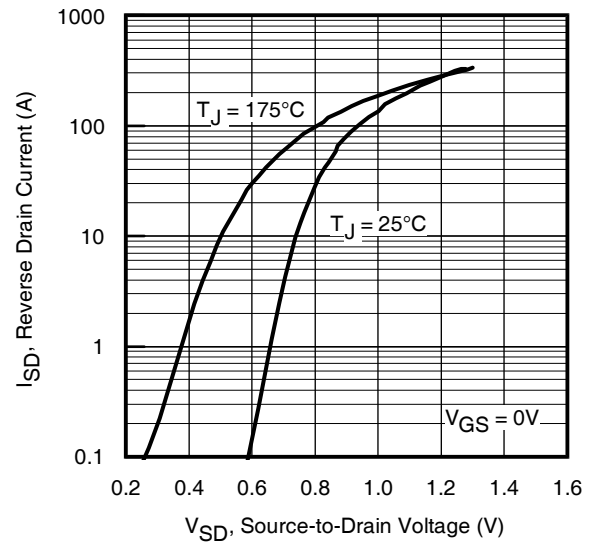


Fig 8. Typical Source-Drain Diode Forward Voltage

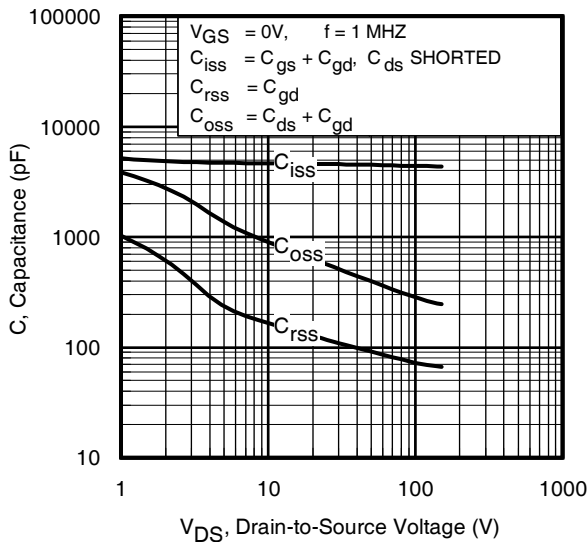


Fig 9. Typical Capacitance vs. Drain-to-Source Voltage

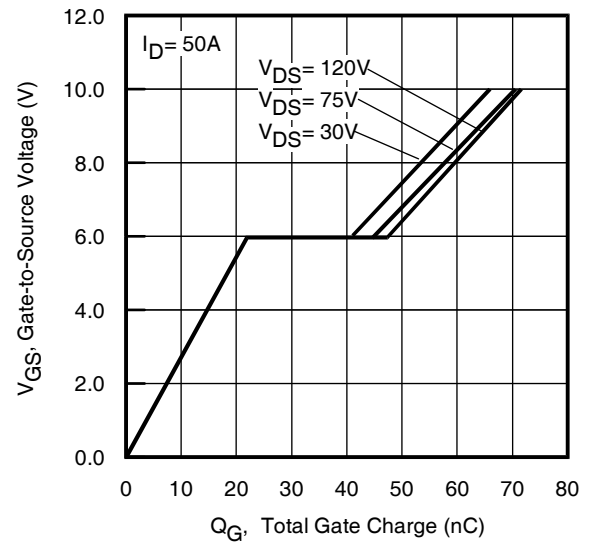


Fig 10. Typical Gate Charge vs. Gate-to-Source Voltage

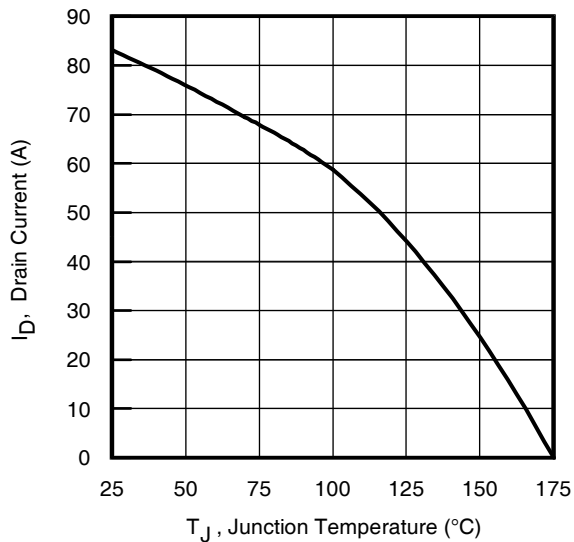


Fig 11. Maximum Drain Current vs. Case Temperature

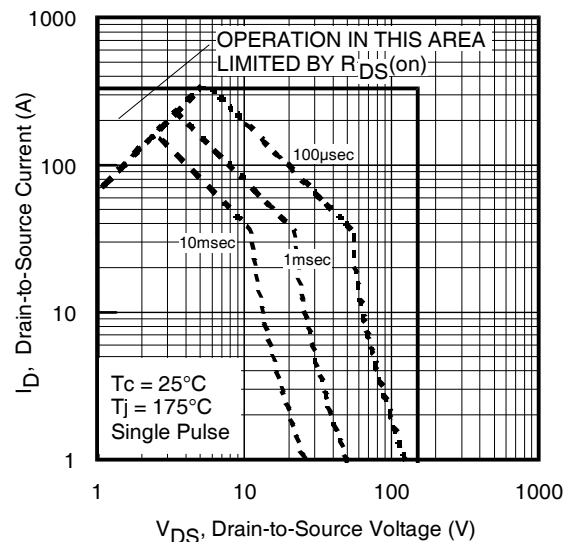


Fig 12. Maximum Safe Operating Area

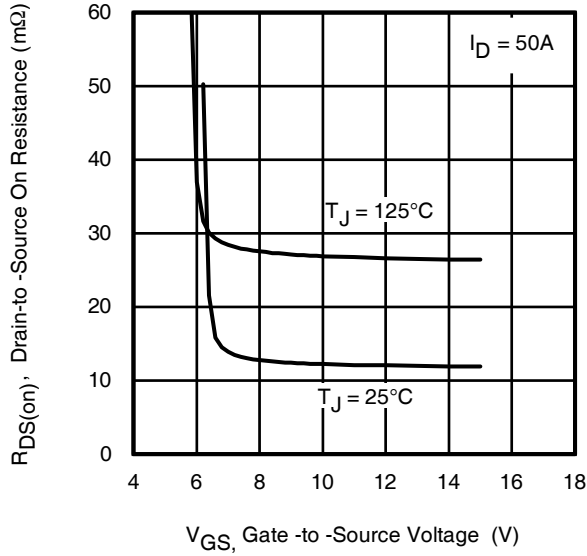


Fig 13. On-Resistance vs. Gate Voltage

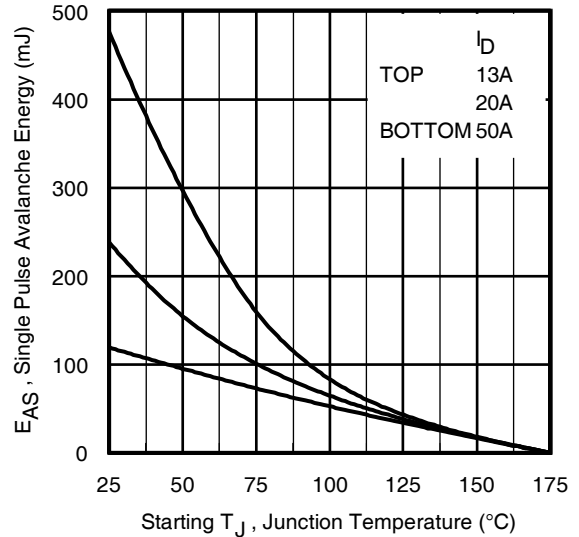


Fig 14. Maximum Avalanche Energy vs. Temperature

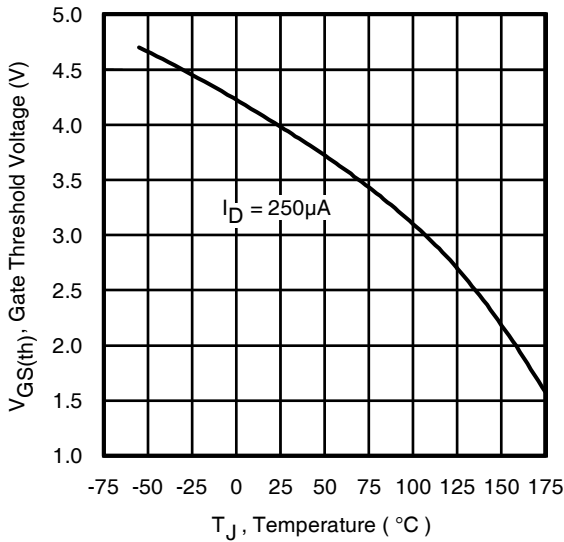


Fig 15. Threshold Voltage vs. Temperature

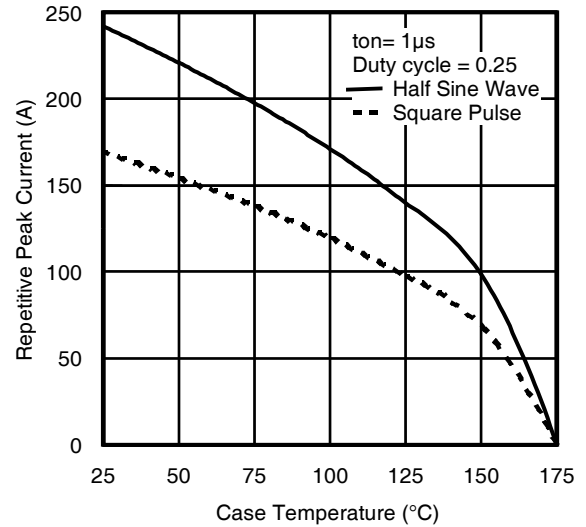


Fig 16. Typical Repetitive peak Current vs. Case temperature

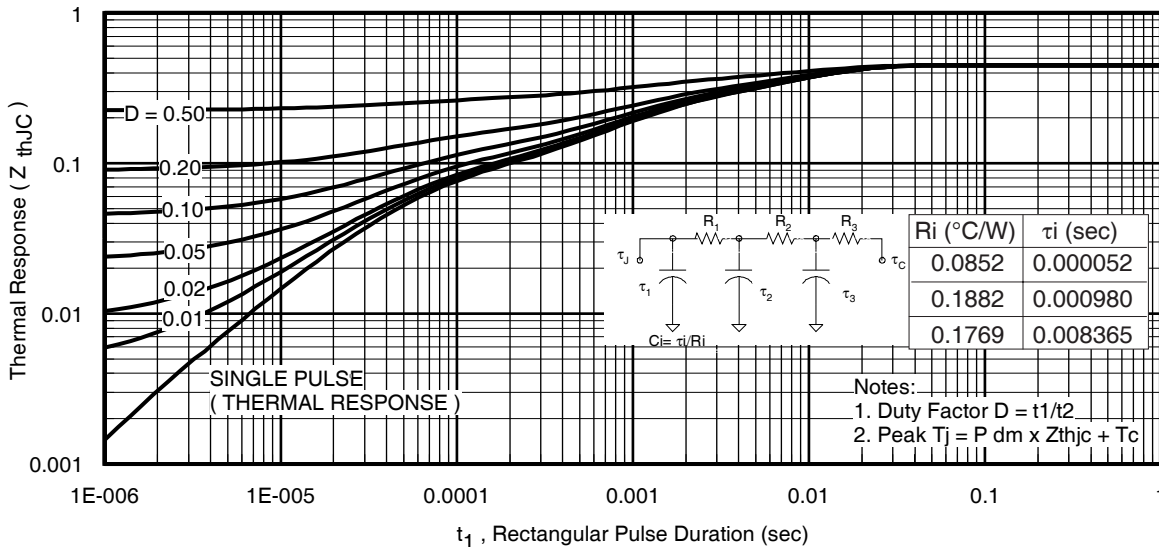


Fig 17. Maximum Effective Transient Thermal Impedance, Junction-to-Case

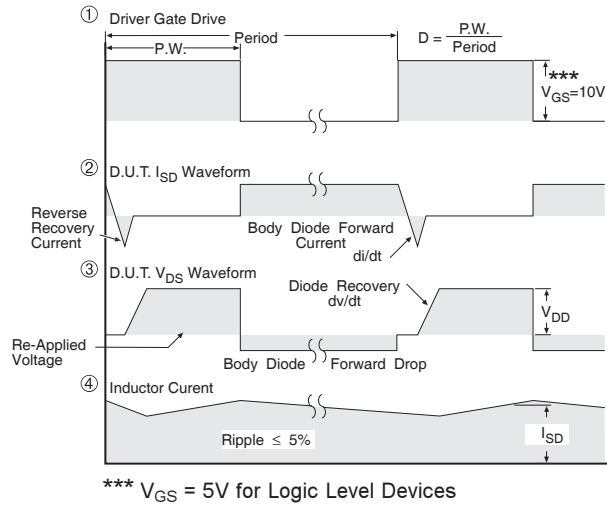


Fig 18. Diode Reverse Recovery Test Circuit for HEXFET® Power MOSFETs



Fig 19a. Unclamped Inductive Test Circuit

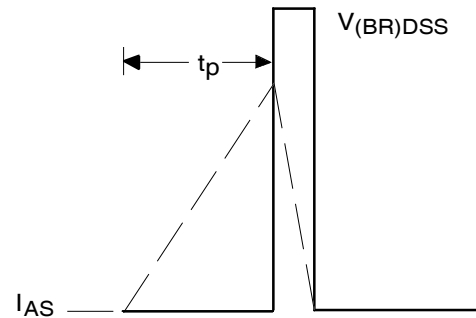


Fig 19b. Unclamped Inductive Waveforms

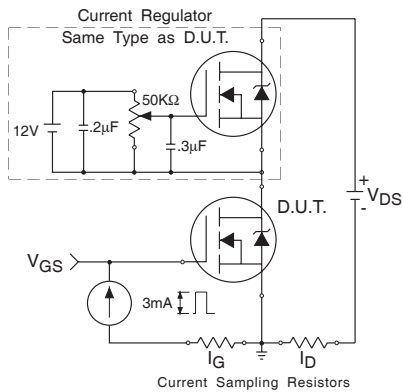


Fig 20a. Gate Charge Test Circuit



Fig 20b. Gate Charge Waveform

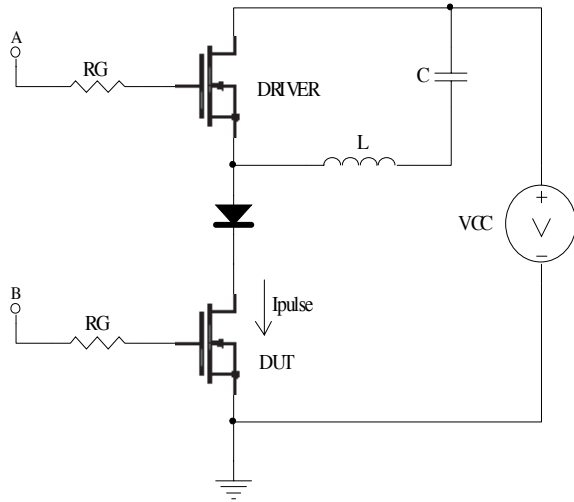


Fig 21a. t_{st} and E_{PULSE} Test Circuit

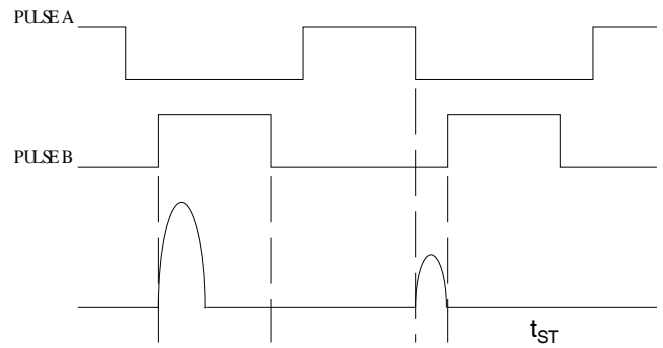


Fig 21b. t_{st} Test Waveforms

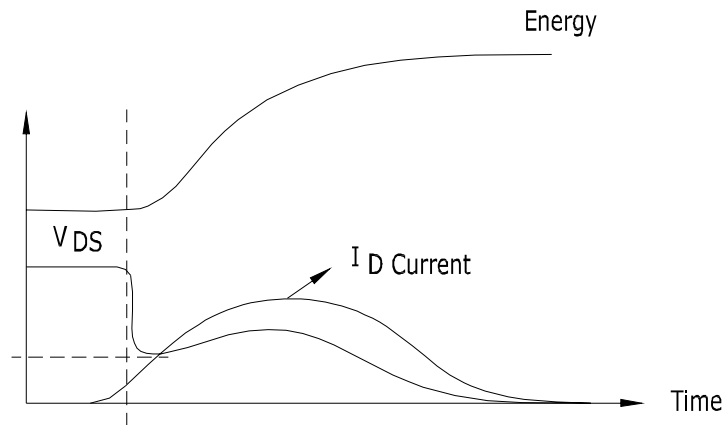


Fig 21c. E_{PULSE} Test Waveforms

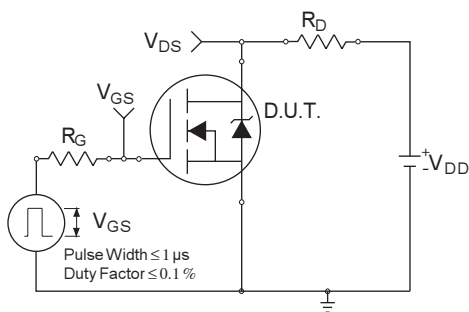


Fig 22a. Switching Time Test Circuit

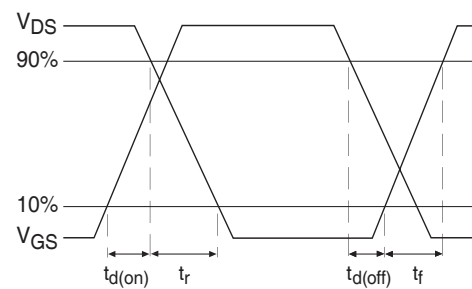
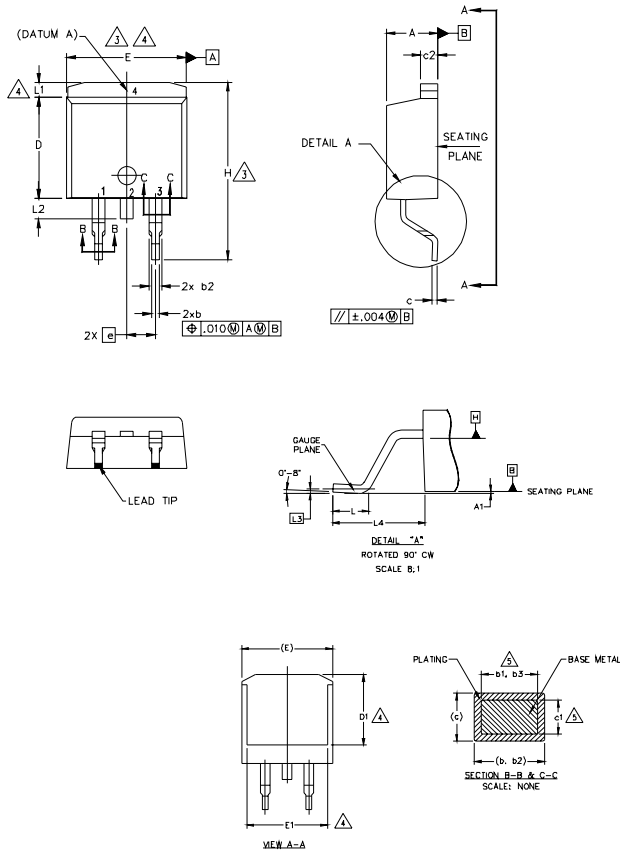


Fig 22b. Switching Time Waveforms

IRFS/SL4228PbF

D²Pak (TO-263AB) Package Outline

Dimensions are shown in millimeters (inches)



NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M-1994
2. DIMENSIONS ARE SHOWN IN MILLIMETERS [INCHES].
3. DIMENSION D & E DO NOT INCLUDE MOLD FLASH. MOLD FLASH SHALL NOT EXCEED 0.127 [0.005"] PER SIDE. THESE DIMENSIONS ARE MEASURED AT THE OUTMOST EXTREMES OF THE PLASTIC BODY AT DATUM H.
4. THERMAL PAD CONTOUR OPTIONAL WITHIN DIMENSION E, L1, D1 & E1.
5. DIMENSION b1 AND c1 APPLY TO BASE METAL ONLY.
6. DATUM A & B TO BE DETERMINED AT DATUM PLANE H.
7. CONTROLLING DIMENSION: INCH.
8. OUTLINE CONFORMS TO JEDEC OUTLINE TO-263AB.

| SYMBOL | DIMENSIONS | | | | NOTES |
|--------|-------------|-------|----------|------|-------|
| | MILLIMETERS | | INCHES | | |
| | MIN. | MAX. | MIN. | MAX. | |
| A | 4.06 | 4.83 | .160 | .190 | 5 |
| A1 | 0.00 | 0.254 | .000 | .010 | |
| b | 0.51 | 0.99 | .020 | .039 | |
| b1 | 0.51 | 0.89 | .020 | .035 | |
| b2 | 1.14 | 1.78 | .045 | .070 | 5 |
| b3 | 1.14 | 1.73 | .045 | .068 | |
| c | 0.38 | 0.74 | .015 | .029 | 5 |
| c1 | 0.38 | 0.58 | .015 | .023 | |
| c2 | 1.14 | 1.65 | .045 | .065 | 3 |
| D | 8.38 | 9.65 | .330 | .380 | |
| D1 | 6.86 | - | .270 | - | 4 |
| E | 9.65 | 10.67 | .380 | .420 | 3,4 |
| E1 | 6.22 | - | .245 | - | 4 |
| e | 2.54 BSC | | .100 BSC | | 4 |
| H | 14.61 | 15.88 | .575 | .625 | |
| L | 1.78 | 2.79 | .070 | .110 | |
| L1 | - | 1.65 | - | .066 | |
| L2 | 1.27 | 1.78 | - | .070 | 4 |
| L3 | 0.25 BSC | | .010 BSC | | |
| L4 | 4.78 | 5.28 | .188 | .208 | |

LEAD ASSIGNMENTS

HEXFET

- 1.- GATE
- 2, 4.- DRAIN
- 3.- SOURCE

IGBTs, CoPACK

- 1.- GATE
- 2, 4.- COLLECTOR
- 3.- EMITTER

DIODES

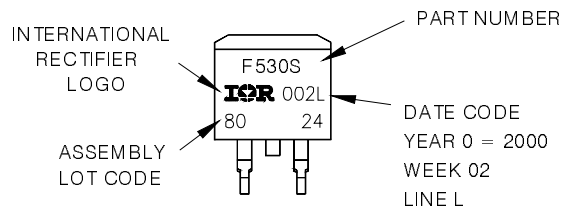
- 1.- ANODE *
- 2, 4.- CATHODE
- 3.- ANODE

* PART DEPENDENT.

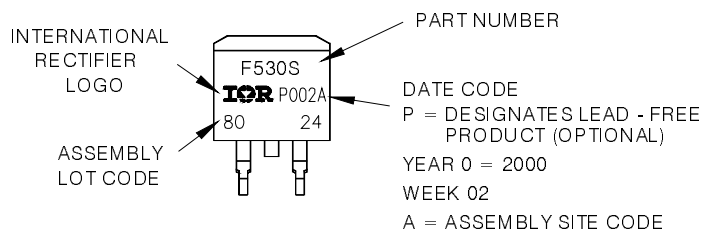
D²Pak (TO-263AB) Part Marking Information

EXAMPLE: THIS IS AN IRF530S WITH
LOT CODE 8024
ASSEMBLED ON WW 02, 2000
IN THE ASSEMBLY LINE "L"

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



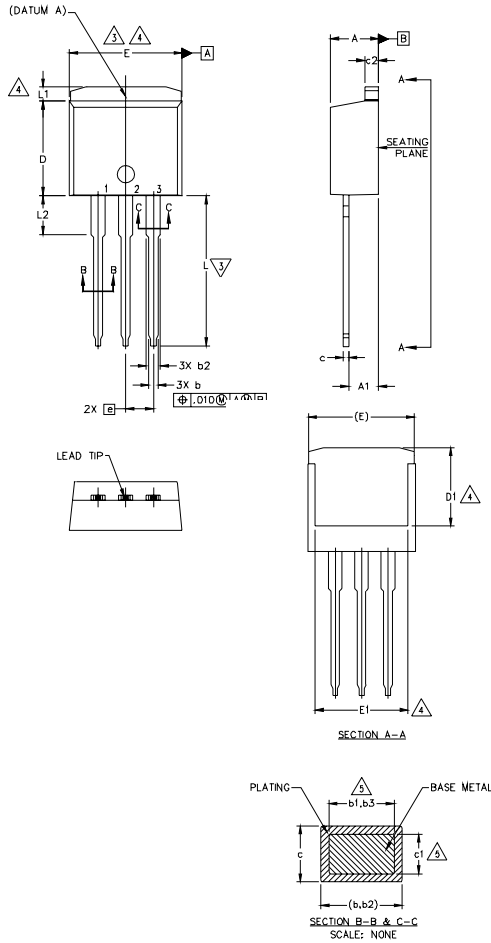
OR



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

TO-262 Package Outline

Dimensions are shown in millimeters (inches)



NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M-1994
2. DIMENSIONS ARE SHOWN IN MILLIMETERS [INCHES].
3. DIMENSION D & E DO NOT INCLUDE MOLD FLASH. MOLD FLASH SHALL NOT EXCEED 0.127 [0.005"] PER SIDE. THESE DIMENSIONS ARE MEASURED AT THE OUTMOST EXTREMES OF THE PLASTIC BODY.
4. THERMAL PAD CONTOUR OPTIONAL WITHIN DIMENSION E, L1, D1 & E1.
5. DIMENSION b1 AND c1 APPLY TO BASE METAL ONLY.
6. CONTROLLING DIMENSION: INCH.
7. OUTLINE CONFORM TO JEDEC TO-262 EXCEPT A1(max.), b(min.) AND D1(min.) WHERE DIMENSIONS DERIVED THE ACTUAL PACKAGE OUTLINE.

| SYMBOL | DIMENSIONS | | | | NOTES |
|--------|-------------|-------|----------|------|-------|
| | MILLIMETERS | | INCHES | | |
| | MIN. | MAX. | MIN. | MAX. | |
| A | 4.06 | 4.83 | .160 | .190 | |
| A1 | 2.03 | 3.02 | .080 | .119 | |
| b | 0.51 | 0.99 | .020 | .039 | |
| b1 | 0.51 | 0.89 | .020 | .035 | 5 |
| b2 | 1.14 | 1.78 | .045 | .070 | |
| b3 | 1.14 | 1.73 | .045 | .068 | 5 |
| c | 0.38 | 0.74 | .015 | .029 | |
| c1 | 0.38 | 0.58 | .015 | .023 | 5 |
| c2 | 1.14 | 1.65 | .045 | .065 | |
| D | 8.38 | 9.65 | .330 | .380 | 3 |
| D1 | 6.86 | - | .270 | - | 4 |
| E | 9.65 | 10.67 | .380 | .420 | 3,4 |
| E1 | 6.22 | - | .245 | - | 4 |
| e | 2.54 BSC | | .100 BSC | | |
| L | 13.46 | 14.10 | .530 | .555 | |
| L1 | - | 1.65 | - | .065 | 4 |
| L2 | 3.56 | 3.71 | .140 | .146 | |

LEAD ASSIGNMENTS

HEXFET

- 1.- GATE
- 2.- DRAIN
- 3.- SOURCE
- 4.- DRAIN

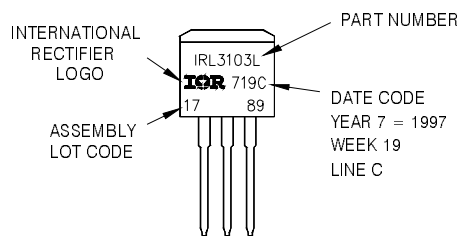
IGBTs, CoPACK

- 1.- GATE
- 2.- COLLECTOR
- 3.- EMITTER
- 4.- COLLECTOR

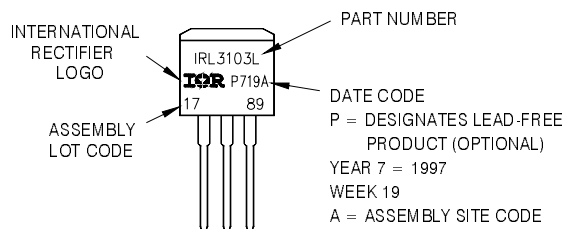
TO-262 Part Marking Information

EXAMPLE: THIS IS AN IRL3103L
LOT CODE 1789
ASSEMBLED ON WW 19, 1997
IN THE ASSEMBLY LINE 'C'

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



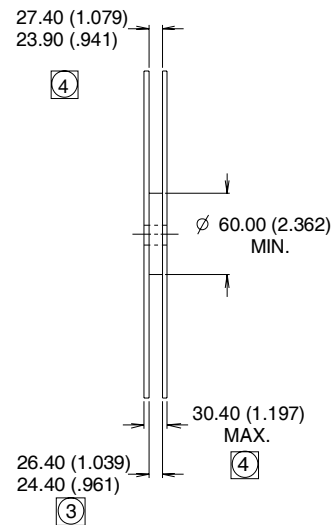
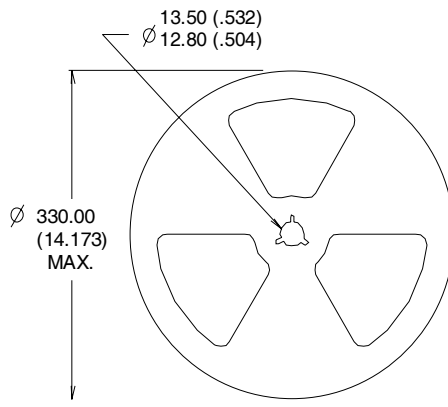
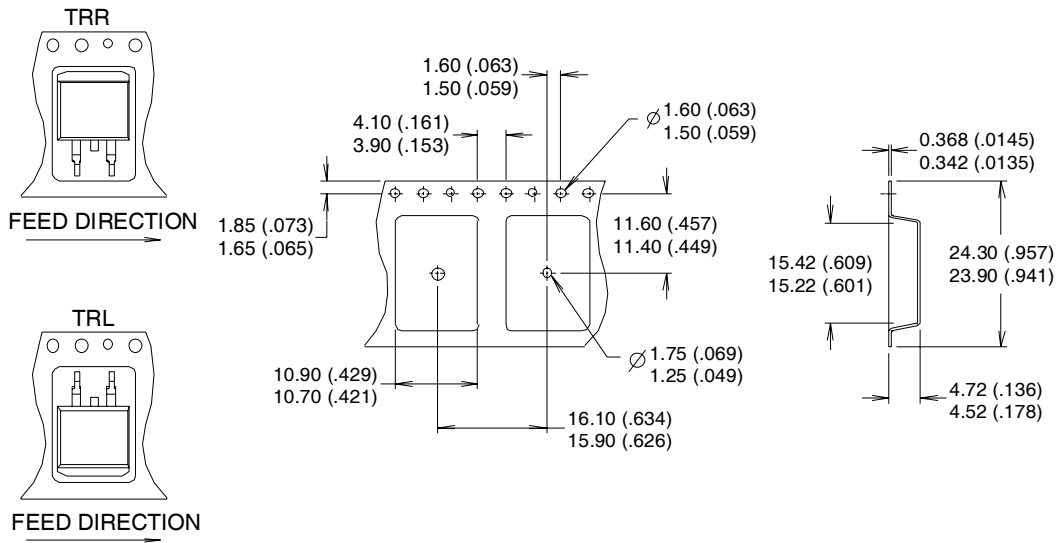
OR



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

IRFS/SL4228PbF

D²Pak (TO-263AB) Tape & Reel Information



NOTES :

1. COMFORMS TO EIA-418.
2. CONTROLLING DIMENSION: MILLIMETER.
- ③ DIMENSION MEASURED @ HUB.
- ④ INCLUDES FLANGE DISTORTION @ OUTER EDGE.

Notes:

- ① Repetitive rating; pulse width limited by max. junction temperature.
- ② Starting $T_J = 25^\circ\text{C}$, $L = 0.096\text{mH}$, $R_G = 25\Omega$, $I_{AS} = 50\text{A}$.
- ③ Pulse width $\leq 400\mu\text{s}$; duty cycle $\leq 2\%$.
- ④ R_θ is measured at T_J of approximately 90°C .
- ⑤ Half sine wave with duty cycle = 0.25, $t_{on} = 1\mu\text{sec}$.
- ⑥ When mounted on 1" square PCB (FR-4 or G-10 Material). For recommended footprint and soldering techniques refer to application note #AN-994.

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

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