

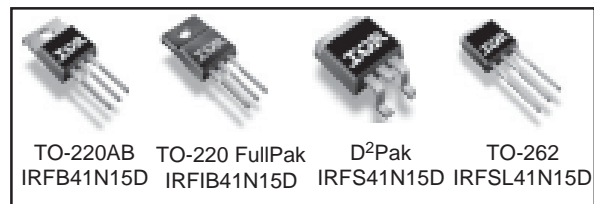
Applications

- High frequency DC-DC converters
- Lead-Free

Benefits

- Low Gate-to-Drain Charge to Reduce Switching Losses
- Fully Characterized Capacitance Including Effective C_{OSS} to Simplify Design, (See App. Note AN1001)
- Fully Characterized Avalanche Voltage and Current

| | | |
|------------------------|-------------------------------|----------------------|
| V_{DSS} | R_{DS(on)} max | I_D |
| 150V | 0.045Ω | 41A |



Absolute Maximum Ratings

| | Parameter | Max. | Units |
|---|---|--------------|--------------|
| I _D @ T _C = 25°C | Continuous Drain Current, V _{GS} @ 10V | 41 | A |
| I _D @ T _C = 100°C | Continuous Drain Current, V _{GS} @ 10V | 29 | |
| I _{DM} | Pulsed Drain Current ① | 164 | |
| P _D @ T _A = 25°C | Power Dissipation, D ² Pak | 3.1 | W |
| P _D @ T _C = 25°C | Power Dissipation, TO-220 | 200 | |
| P _D @ T _C = 25°C | Power Dissipation, Fullpak | 48 | |
| | Linear Derating Factor, TO-220 | 1.3 | W/°C |
| | Linear Derating Factor, Fullpak | 0.32 | |
| V _{GS} | Gate-to-Source Voltage | ± 30 | V |
| dv/dt | Peak Diode Recovery dv/dt ③ | 2.7 | V/ns |
| T _J | Operating Junction and | -55 to + 175 | °C |
| T _{STG} | Storage Temperature Range | | |
| | Soldering Temperature, for 10 seconds | | |
| | Mounting torque, 6-32 or M3 screw | 1.1(10) | N•m (lbf•in) |

Thermal Resistance

| | Parameter | Typ. | Max. | Units |
|------------------|---|------|------|-------|
| R _{θJC} | Junction-to-Case | — | 0.75 | °C/W |
| R _{θJC} | Junction-to-Case, Fullpak | — | 3.14 | |
| R _{θCS} | Case-to-Sink, Flat, Greased Surface ④ | 0.50 | — | |
| R _{θJA} | Junction-to-Ambient, TO-220 ⑥ | — | 62 | |
| R _{θJA} | Junction-to-Ambient, D ² Pak ⑦ | — | 40 | |
| R _{θJA} | Junction-to-Ambient, Fullpak | — | 65 | |

Notes ① through ⑦ are on page 12

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Static @ T_J = 25°C (unless otherwise specified)

| | Parameter | Min. | Typ. | Max. | Units | Conditions |
|--------------------------------------|--------------------------------------|------|------|-------|-------|--|
| V _{(BR)DSS} | Drain-to-Source Breakdown Voltage | 150 | — | — | V | V _{GS} = 0V, I _D = 250μA |
| ΔV _{(BR)DSS/ΔT_J} | Breakdown Voltage Temp. Coefficient | — | 0.17 | — | V/°C | Reference to 25°C, I _D = 1mA |
| R _{DS(on)} | Static Drain-to-Source On-Resistance | — | — | 0.045 | Ω | V _{GS} = 10V, I _D = 25A ④ |
| V _{GS(th)} | Gate Threshold Voltage | 3.0 | — | 5.5 | V | V _{DS} = V _{GS} , I _D = 250μA |
| I _{DSS} | Drain-to-Source Leakage Current | — | — | 25 | μA | V _{DS} = 150V, V _{GS} = 0V |
| | | — | — | 250 | | V _{DS} = 120V, V _{GS} = 0V, T _J = 150°C |
| I _{GSS} | Gate-to-Source Forward Leakage | — | — | 100 | nA | V _{GS} = 30V |
| | Gate-to-Source Reverse Leakage | — | — | -100 | | V _{GS} = -30V |

Dynamic @ T_J = 25°C (unless otherwise specified)

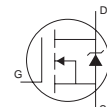
| | Parameter | Min. | Typ. | Max. | Units | Conditions |
|-----------------------|---------------------------------|------|------|------|-------|---|
| g _{fs} | Forward Transconductance | 18 | — | — | S | V _{DS} = 50V, I _D = 25A |
| Q _g | Total Gate Charge | — | 72 | 110 | nC | I _D = 25A V _{DS} = 120V V _{GS} = 10V ④ |
| Q _{gs} | Gate-to-Source Charge | — | 21 | 31 | | |
| Q _{gd} | Gate-to-Drain ("Miller") Charge | — | 35 | 52 | | |
| t _{d(on)} | Turn-On Delay Time | — | 16 | — | ns | V _{DD} = 75V I _D = 25A R _G = 2.5Ω V _{GS} = 10V ④ |
| t _r | Rise Time | — | 63 | — | | |
| t _{d(off)} | Turn-Off Delay Time | — | 25 | — | | |
| t _f | Fall Time | — | 14 | — | | |
| C _{iss} | Input Capacitance | — | 2520 | — | pF | V _{GS} = 0V V _{DS} = 25V f = 1.0MHz V _{GS} = 0V, V _{DS} = 1.0V, f = 1.0MHz V _{GS} = 0V, V _{DS} = 120V, f = 1.0MHz V _{GS} = 0V, V _{DS} = 0V to 120V ⑤ |
| C _{oss} | Output Capacitance | — | 510 | — | | |
| C _{rss} | Reverse Transfer Capacitance | — | 110 | — | | |
| C _{oss} | Output Capacitance | — | 3090 | — | | |
| C _{oss} | Output Capacitance | — | 230 | — | | |
| C _{oss eff.} | Effective Output Capacitance | — | 250 | — | | |

Avalanche Characteristics

| | Parameter | Typ. | Max. | Units |
|-----------------|---------------------------------|------|------|-------|
| E _{AS} | Single Pulse Avalanche Energy ② | — | 470 | mJ |
| I _{AR} | Avalanche Current ① | — | 25 | A |
| E _{AR} | Repetitive Avalanche Energy ① | — | 20 | mJ |

Diode Characteristics

| | Parameter | Min. | Typ. | Max. | Units | Conditions |
|-----------------|---|--|------|------|-------|---|
| I _S | Continuous Source Current (Body Diode) | — | — | 41 | A | MOSFET symbol showing the integral reverse p-n junction diode. |
| I _{SM} | Pulsed Source Current (Body Diode) ① | — | — | 164 | | |
| V _{SD} | Diode Forward Voltage | — | — | 1.3 | V | T _J = 25°C, I _S = 25A, V _{GS} = 0V ④ |
| t _{rr} | Reverse Recovery Time | — | 170 | 260 | ns | T _J = 25°C, I _F = 25A |
| Q _{rr} | Reverse Recovery Charge | — | 1.3 | 1.9 | μC | di/dt = 100A/μs ④ |
| t _{on} | Forward Turn-On Time | Intrinsic turn-on time is negligible (turn-on is dominated by LS+LD) | | | | |



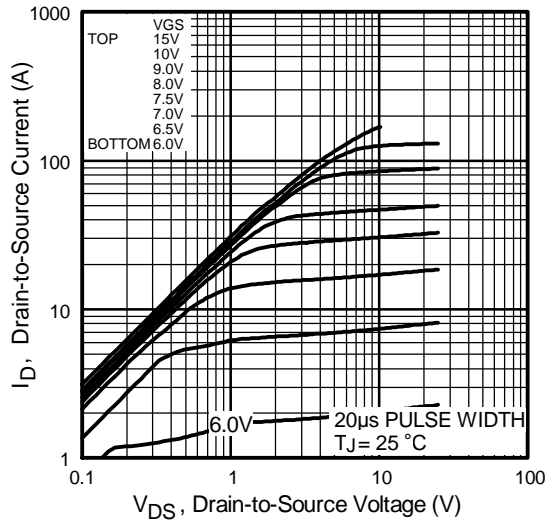


Fig 1. Typical Output Characteristics

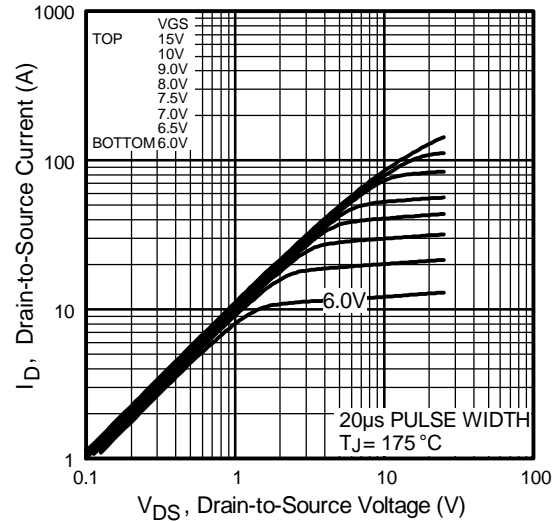


Fig 2. Typical Output Characteristics

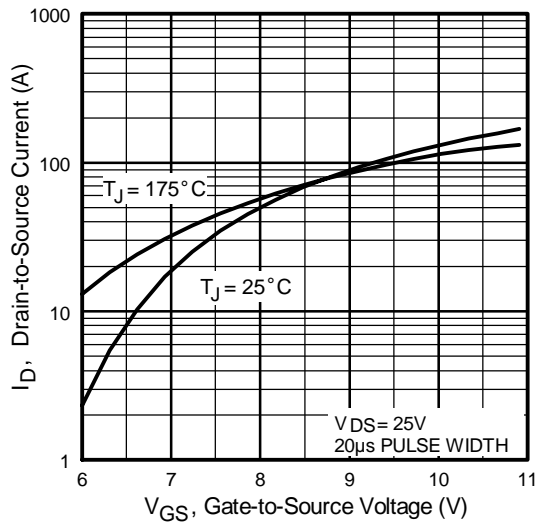


Fig 3. Typical Transfer Characteristics

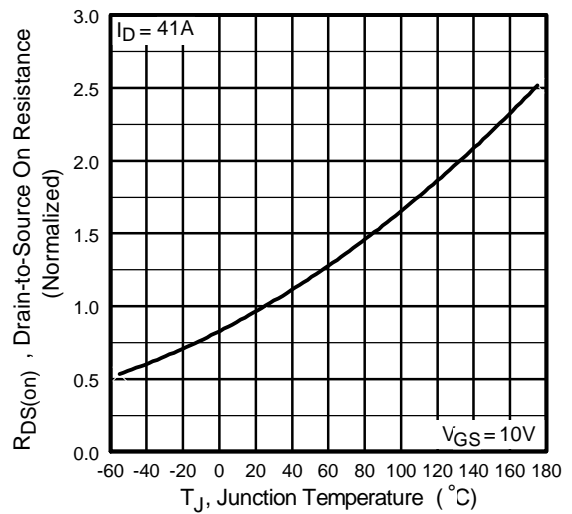


Fig 4. Normalized On-Resistance vs. Temperature

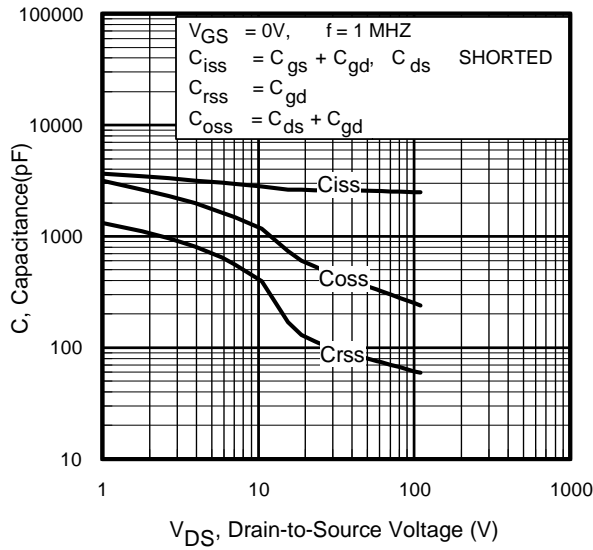


Fig 5. Typical Capacitance Vs. Drain-to-Source Voltage

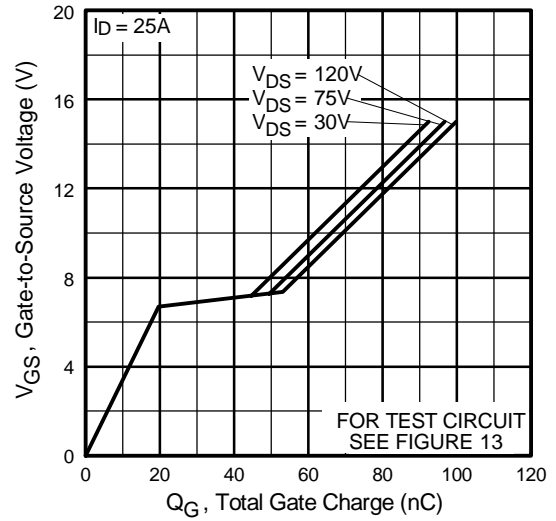


Fig 6. Typical Gate Charge Vs. Gate-to-Source Voltage

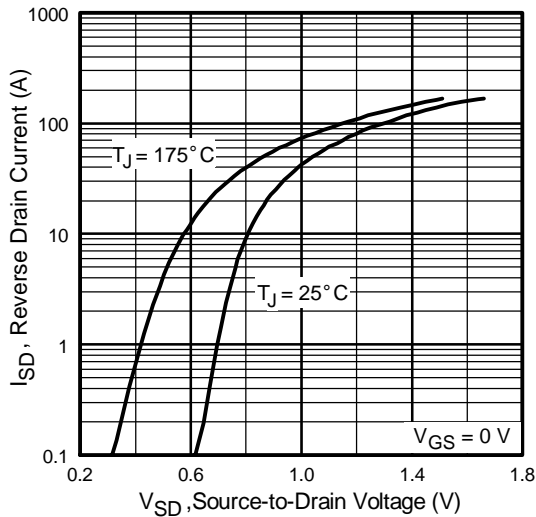


Fig 7. Typical Source-Drain Diode Forward Voltage

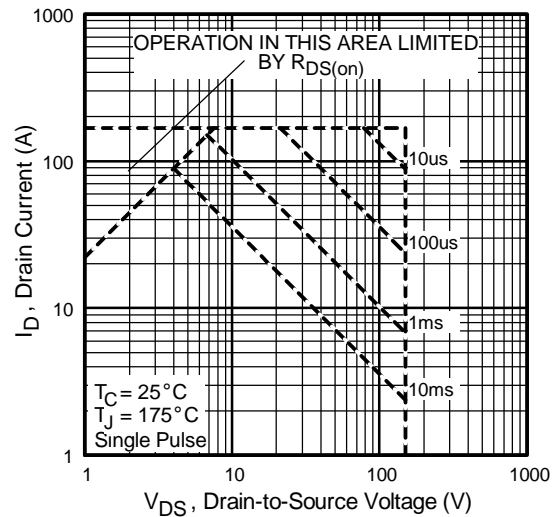


Fig 8. Maximum Safe Operating Area

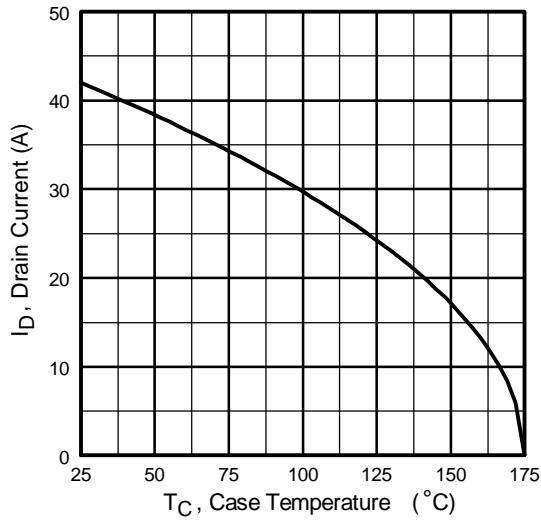


Fig 9. Maximum Drain Current Vs. Case Temperature

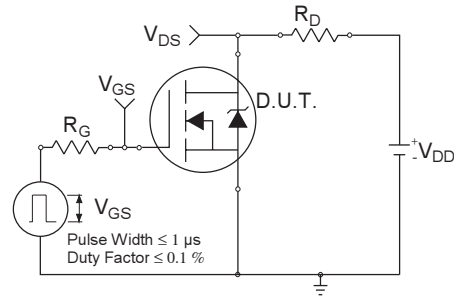


Fig 10a. Switching Time Test Circuit



Fig 10b. Switching Time Waveforms

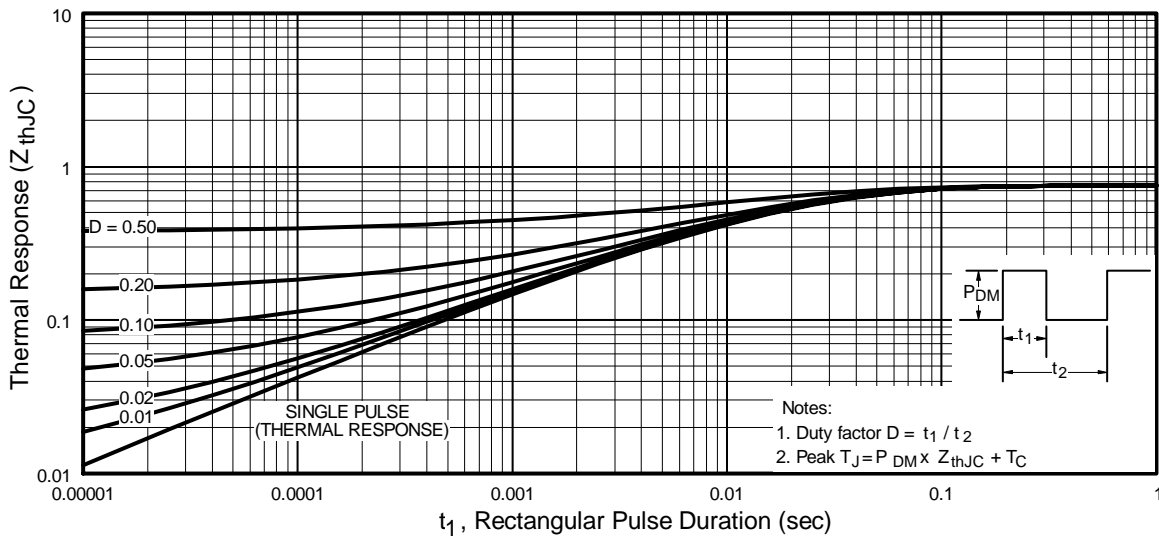


Fig 11. Maximum Effective Transient Thermal Impedance, Junction-to-Case

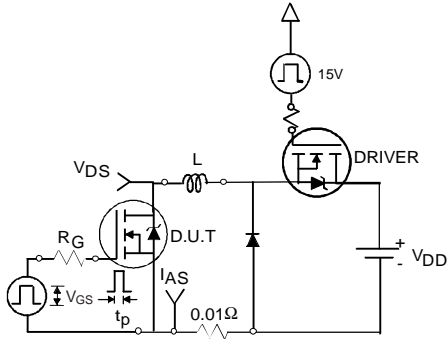


Fig 12a. Unclamped Inductive Test Circuit

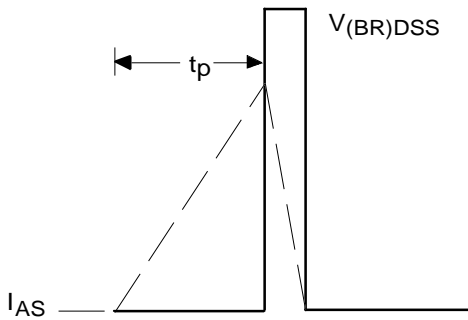


Fig 12b. Unclamped Inductive Waveforms

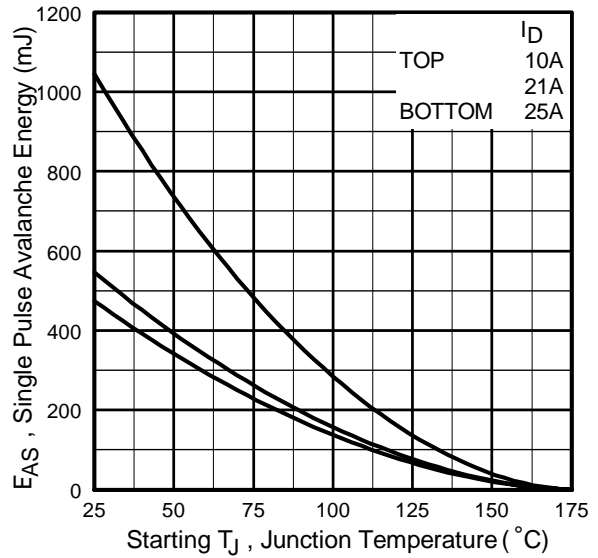


Fig 12c. Maximum Avalanche Energy Vs. Drain Current

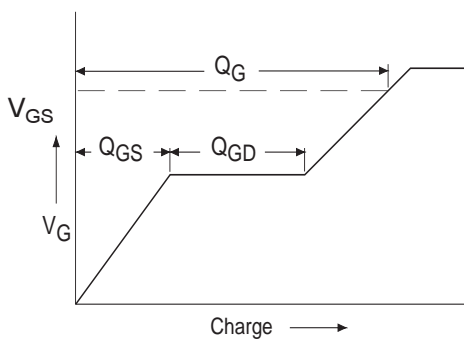


Fig 13a. Basic Gate Charge Waveform

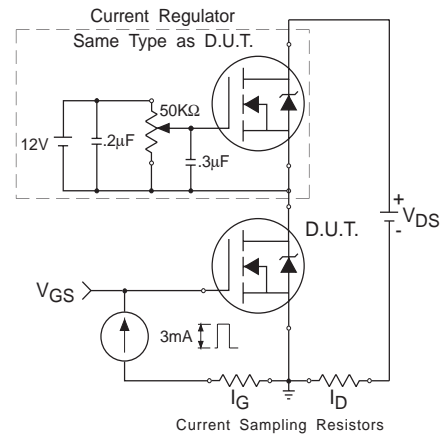


Fig 13b. Gate Charge Test Circuit

Peak Diode Recovery dv/dt Test Circuit



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

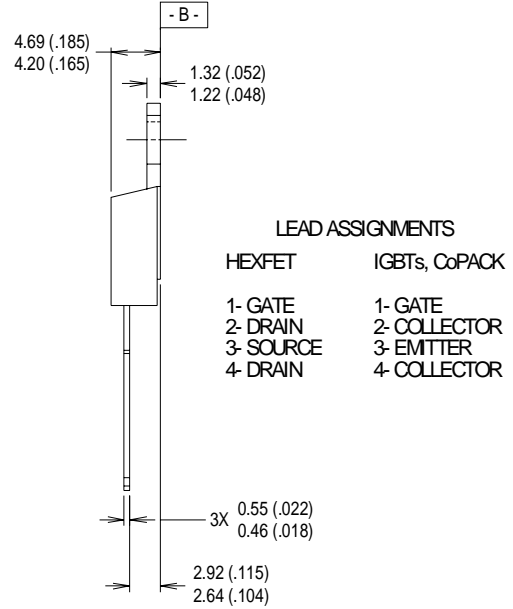
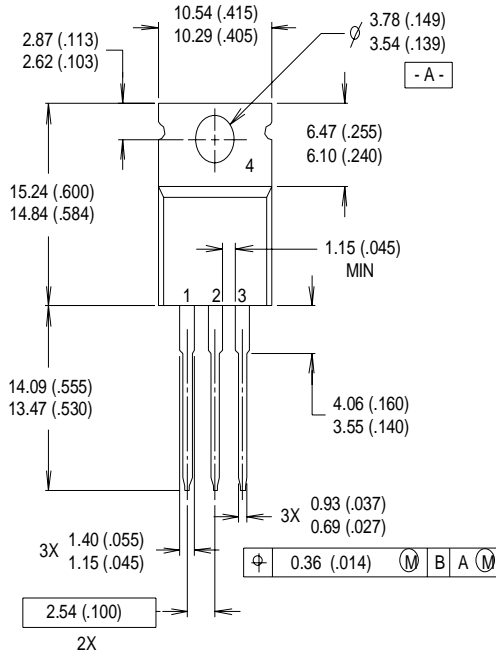
Fig 14. For N-Channel HEXFET® Power MOSFETs

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TO-220AB Package Outline

Dimensions are shown in millimeters (inches)

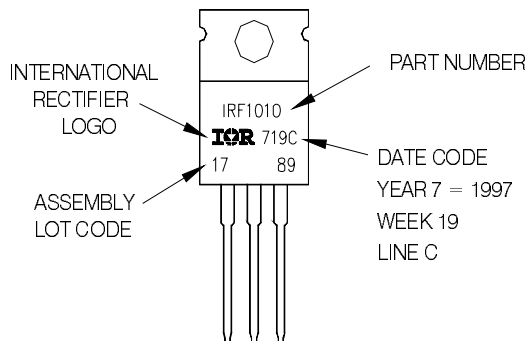


NOTES:

- 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.

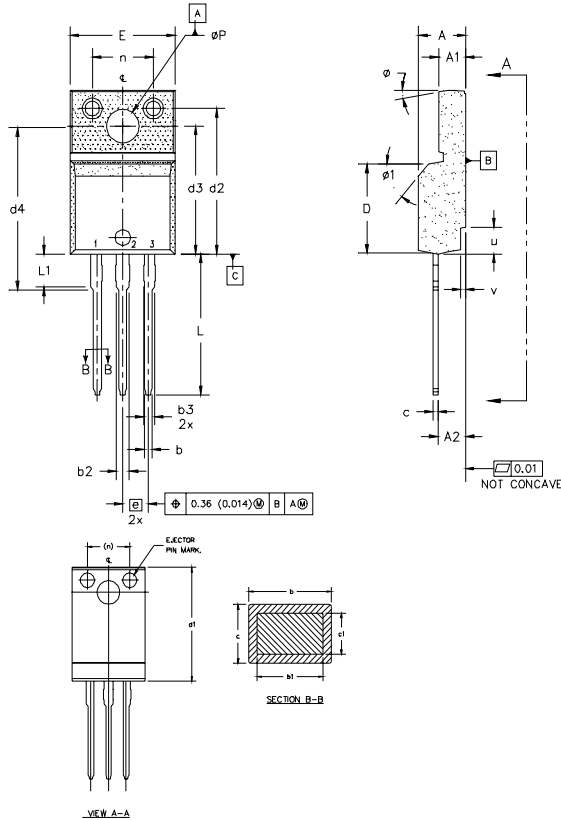
TO-220AB Part Marking Information

EXAMPLE: THIS IS AN IRF1010
 LOT CODE 1789
 ASSEMBLED ON WW 19, 1997
 IN THE ASSEMBLY LINE "C"
Note: "P" in assembly line
 position indicates "Lead-Free"



TO-220 Full-Pak Package Outline

Dimensions are shown in millimeters (inches)



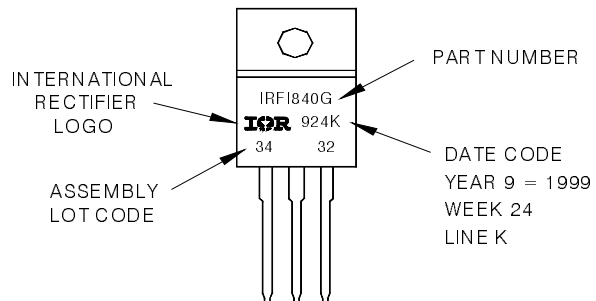
- NOTES:
- 1.0 DIMENSIONING AND TOLERANCING PER ASME Y14.5 M- 1994.
 - 2.0 DIMENSIONS ARE SHOWN IN MILLIMETERS [INCHES].
 - 3.0 LEAD DIMENSION AND FINISH UNCONTROLLED IN L1.
 - 4.0 DIMENSION D & E DO NOT INCLUDE MOLD FLASH. MOLD FLASH SHALL NOT EXCEED 0.005" (0.127) PER SIDE. THESE DIMENSIONS ARE MEASURED AT THE OUTERMOST EXTREMES OF THE PLASTIC BODY.
 - 5.0 DIMENSION b1 APPLY TO BASE METAL ONLY.
 - 6.0 STEP OPTIONAL ON PLASTIC BODY DEFINED BY DIMENSIONS u & v.
 - 7.0 CONTROLLING DIMENSION : INCHES.

| SYMBOL | DIMENSIONS | | | | NOTES | LEAD ASSIGNMENTS |
|--------|-------------|-------|-----------|-------|-------|--|
| | MILLIMETERS | | INCHES | | | |
| | MIN. | MAX. | MIN. | MAX. | | |
| A | 4.57 | 4.83 | 0.180 | 0.190 | | |
| A1 | 2.57 | 2.83 | 0.101 | 0.114 | | |
| A2 | 2.51 | 2.85 | 0.099 | 0.112 | | |
| b | 0.622 | 0.89 | 0.024 | 0.035 | | 1 - GATE 2 - DRAIN 3 - SOURCE |
| b1 | 0.622 | 0.838 | 0.024 | 0.033 | 5 | |
| b2 | 1.229 | 1.400 | 0.048 | 0.055 | | |
| b3 | 1.229 | 1.400 | 0.048 | 0.055 | | |
| c | 0.440 | 0.629 | 0.017 | 0.025 | | |
| c1 | 0.440 | 0.584 | 0.017 | 0.023 | | |
| D | 8.65 | 9.80 | 0.341 | 0.386 | 4 | |
| d1 | 15.80 | 16.12 | 0.622 | 0.635 | | 1 - GATE 2 - COLLECTOR 3 - EMITTER |
| d2 | 13.97 | 14.22 | 0.550 | 0.560 | | |
| d3 | 12.30 | 12.82 | 0.484 | 0.509 | | |
| d4 | 8.64 | 9.91 | 0.340 | 0.390 | | |
| E | 10.36 | 10.63 | 0.408 | 0.419 | 4 | |
| e | 2.54 BSC | | 0.100 BSC | | | |
| L | 13.20 | 13.73 | 0.520 | 0.541 | | |
| L1 | 3.10 | 3.50 | 0.122 | 0.138 | 3 | |
| n | 6.05 | 6.15 | 0.238 | 0.242 | | |
| phi P | 3.05 | 3.45 | 0.120 | 0.136 | | |
| u | 2.40 | 2.50 | 0.094 | 0.098 | 6 | |
| v | 0.40 | 0.50 | 0.016 | 0.020 | 6 | |
| phi 1 | 5" | 7" | 5" | 7" | | |
| phi 7 | 45" | 45" | 45" | 45" | | |

TO-220 Full-Pak Part Marking Information

EXAMPLE: THIS IS AN IRF1840G
WITH ASSEMBLY
LOT CODE 3432
ASSEMBLED ON WW 24 1999
IN THE ASSEMBLY LINE "K"

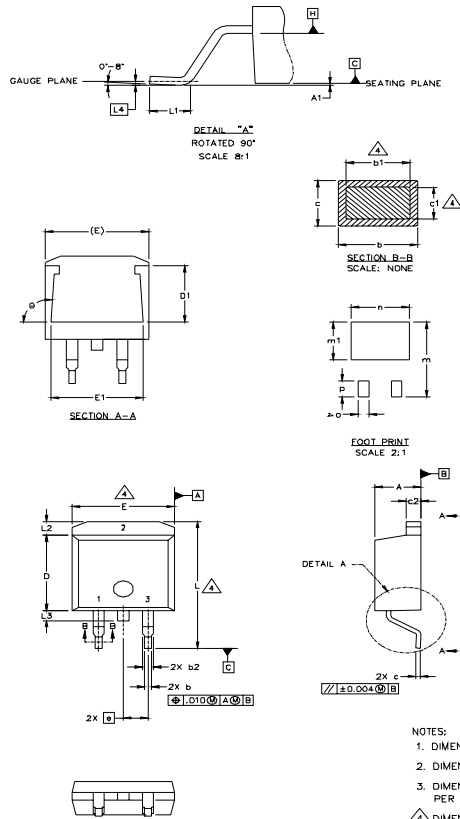
Note: "P" in assembly line position indicates "Lead-Free"



IRFB/IRFIB/IRFS/IRFSL41N15DPbF

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IR Rectifier

D²Pak Package Outline



| SYMBOL | DIMENSIONS | | | | NOTES |
|--------|-------------|-------|----------|------|-------|
| | MILLIMETERS | | INCHES | | |
| | MIN. | MAX. | MIN. | MAX. | |
| A | 4.06 | 4.83 | .160 | .190 | 4 |
| A1 | | 0.127 | | | |
| b | 0.51 | 0.99 | .020 | .039 | |
| b1 | 0.51 | 0.89 | .020 | .035 | |
| b2 | 1.14 | 1.40 | .045 | .055 | 4 |
| c | 0.43 | 0.63 | .017 | .025 | |
| c1 | 0.38 | 0.74 | .015 | .029 | |
| c2 | 1.14 | 1.40 | .045 | .055 | 3 |
| D | 8.51 | 9.65 | .335 | .380 | |
| D1 | 5.33 | | .210 | | 3 |
| E | 9.65 | 10.67 | .380 | .420 | |
| E1 | 6.22 | | .245 | | |
| e | 2.54 BSC | | .100 BSC | | |
| L | 14.61 | 15.88 | .575 | .625 | |
| L1 | 1.78 | 2.79 | .070 | .110 | |
| L2 | | 1.65 | | .065 | |
| L3 | 1.27 | 1.78 | .050 | .070 | |
| L4 | 0.25 BSC | | .010 BSC | | |
| m | 17.78 | | .700 | | |
| m1 | 8.89 | | .350 | | |
| n | 11.43 | | .450 | | |
| o | 2.08 | | .082 | | |
| p | 3.81 | | .150 | | |
| θ | 90° | 93° | 90° | 93° | |

LEAD ASSIGNMENTS

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

* PART DEPENDENT.

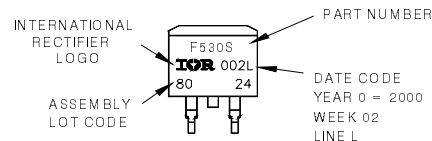
NOTES:

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. DIMENSION b1 AND c1 APPLY TO BASE METAL ONLY.
5. CONTROLLING DIMENSION: INCH.

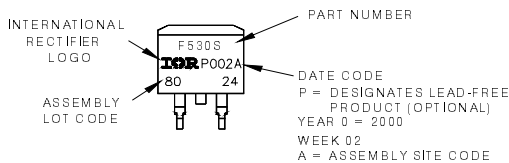
D²Pak Part Marking Information (Lead-Free)

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'

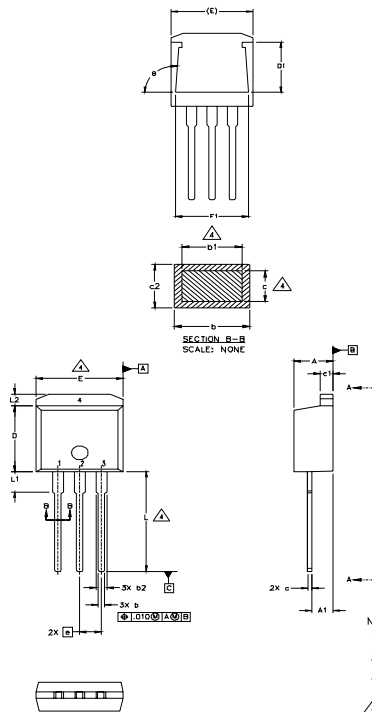


OR



TO-262 Package Outline

Dimensions are shown in millimeters (inches)



| SYMBOL | DIMENSIONS | | | | NOTES |
|--------|-------------|-------|--------|------|-------|
| | MILLIMETERS | | INCHES | | |
| | MIN. | MAX. | MIN. | MAX. | |
| A | 4.06 | 4.83 | .160 | .190 | |
| A1 | 2.03 | 2.92 | .080 | .115 | |
| b | 0.51 | 0.99 | .020 | .039 | |
| b1 | 0.51 | 0.89 | .020 | .035 | 4 |
| b2 | 1.14 | 1.40 | .045 | .055 | |
| c | 0.38 | 0.63 | .015 | .025 | 4 |
| c1 | 1.14 | 1.40 | .045 | .055 | |
| c2 | 0.43 | .063 | .017 | .029 | |
| D | 8.51 | 9.65 | .335 | .380 | 3 |
| D1 | 5.33 | | .210 | | |
| E | 9.65 | 10.67 | .380 | .420 | 3 |
| E1 | 6.22 | | .245 | | |
| e | 2.54 | BSC | .100 | BSC | |
| L | 13.46 | 14.09 | .530 | .555 | |
| L1 | 3.56 | 3.71 | .140 | .146 | |
| L2 | | 1.65 | | .065 | |

LEAD ASSIGNMENTS

| HEXFET | IGBT |
|------------|---------------|
| 1.- GATE | 1 - GATE |
| 2.- DRAIN | 2 - COLLECTOR |
| 3.- SOURCE | 3 - EMITTER |
| 4.- DRAIN | |

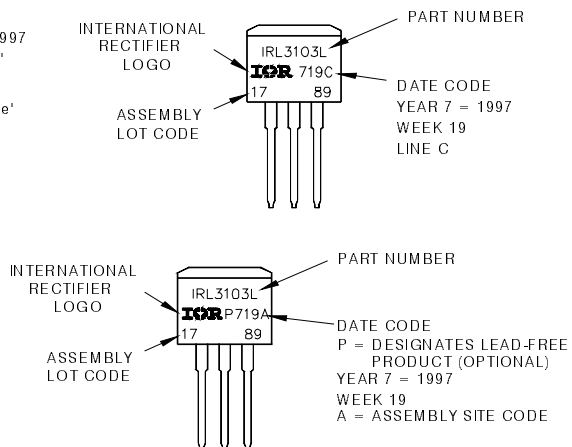
- NOTES:
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M-1994
 2. DIMENSIONS ARE SHOWN IN MILLIMETERS [INCHES]
 3. DIMENSION D & E DO NOT INCLUDE MOLD FLASH. MOLD FLASH SHALL NOT EXCEED 0.127 [0.005"] PER SIDE. THESE DIMENSIONS ARE MEASURED AT THE OUTMOST EXTREMES OF THE PLASTIC BODY.
 4. DIMENSION b1 AND c1 APPLY TO BASE METAL ONLY.
 5. CONTROLLING DIMENSION: INCH.

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'

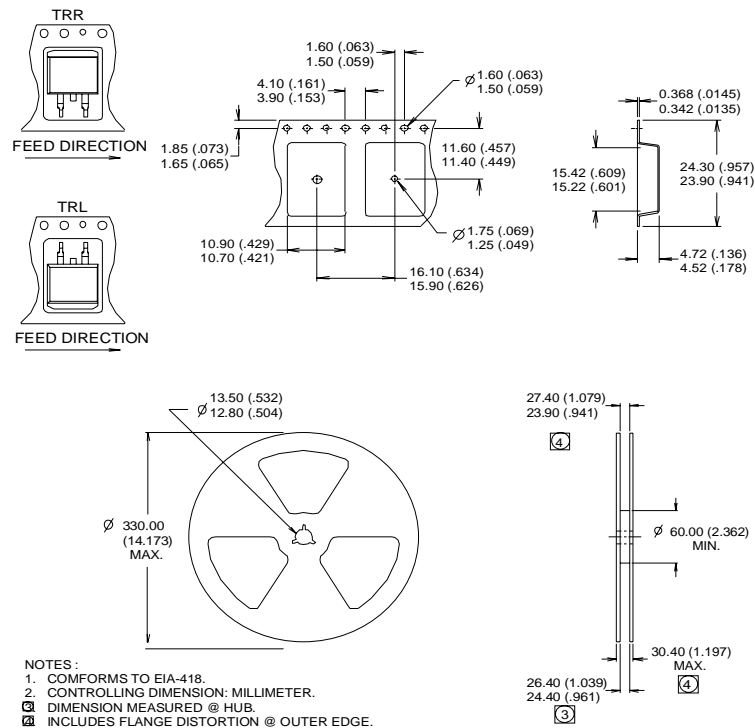
OR



IRFB/IRFIB/IRFS/IRFSL41N15DPbF

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IR Rectifier

D²Pak Tape & Reel Information



Notes:

- ① Repetitive rating; pulse width limited by max. junction temperature.
- ② Starting $T_J = 25^\circ\text{C}$, $L = 1.5\text{mH}$, $R_G = 25\Omega$, $I_{AS} = 25\text{A}$.
- ③ $I_{SD} \leq 25\text{A}$, $di/dt \leq 340\text{A}/\mu\text{s}$, $V_{DD} \leq V_{(BR)DSS}$, $T_J \leq 175^\circ\text{C}$.
- ④ Pulse width $\leq 300\mu\text{s}$; duty cycle $\leq 2\%$.
- 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} .
- ⑥ This is only applied to TO-220AB package.
- ⑦ This is applied to D²Pak, when mounted on 1" square PCB (FR-4 or G-10 Material). For recommended footprint and soldering techniques refer to application note #AN-994.

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

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.

International
IR Rectifier

IR WORLD HEADQUARTERS: 233 Kansas St., El Segundo, California 90245, USA Tel: (310) 252-7105
TAC Fax: (310) 252-7903

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www.irf.com

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