

International **IR** Rectifier

PD - 94946

SMPS MOSFET

IRFB31N20DPbF
 IRFS31N20DPbF
 IRFSL31N20DPbF

HEXFET® Power MOSFET

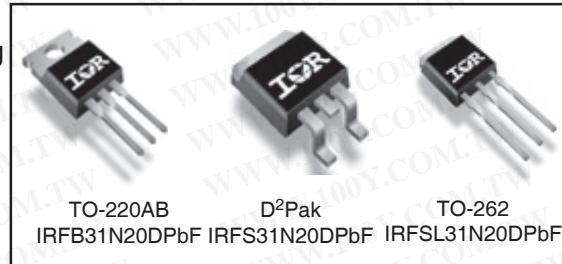
Applications

- High Frequency DC-DC converters
- Lead-Free

| | | |
|------------------------|-------------------------------|----------------------|
| V_{DSS} | R_{DS(on)} max | I_D |
| 200V | 0.082Ω | 31A |

Benefits

- Low Gate to Drain to Reduce Switching Losses
- Fully Characterized Capacitance Including Effective COSS to Simplify Design,(See AN 1001)
- Fully Characterized Avalanche Voltage and Current



Absolute Maximum Ratings

| | Parameter | Max. | Units |
|---|---|------------------------|-------|
| I _D @ T _C = 25°C | Continuous Drain Current, V _{GS} @ 10V | 31 | A |
| I _D @ T _C = 100°C | Continuous Drain Current, V _{GS} @ 10V | 21 | |
| I _{DM} | Pulsed Drain Current ① | 124 | |
| P _D @ T _A = 25°C | Power Dissipation ② | 3.1 | W |
| P _D @ T _C = 25°C | Power Dissipation | 200 | |
| | Linear Derating Factor | 1.3 | W/°C |
| V _{GS} | Gate-to-Source Voltage | ± 30 | V |
| dv/dt | Peak Diode Recovery dv/dt ③ | 2.1 | V/ns |
| T _J | Operating Junction and | -55 to + 175 | °C |
| T _{STG} | Storage Temperature Range | | |
| | Soldering Temperature, for 10 seconds | 300 (1.6mm from case) | |
| | Mounting torque, 6-32 or M3 screw ④ | 10 lbf•in (1.1N•m) | |

Applicable Off Line SMPS Topologies

- Telecom 48V Input DC/DC Active Clamp Reset Forward Converter

Notes ① through ④ are on page 11

www.irf.com

IRFB/S/SL31N20DPbF

International
IR Rectifier

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

| | Parameter | Min. | Typ. | Max. | Units | Conditions |
|---------------------------------|--------------------------------------|------|------|-------|----------|---|
| $V_{(BR)DSS}$ | Drain-to-Source Breakdown Voltage | 200 | — | — | V | $V_{GS} = 0V, I_D = 250\mu A$ |
| $\Delta V_{(BR)DSS}/\Delta T_J$ | Breakdown Voltage Temp. Coefficient | — | 0.25 | — | V/°C | Reference to $25^\circ\text{C}, I_D = 1\text{mA}$ |
| $R_{DS(on)}$ | Static Drain-to-Source On-Resistance | — | — | 0.082 | Ω | $V_{GS} = 10V, I_D = 18A$ ④ |
| $V_{GS(th)}$ | Gate Threshold Voltage | 3.0 | — | 5.5 | V | $V_{DS} = V_{GS}, I_D = 250\mu A$ |
| I_{DSS} | Drain-to-Source Leakage Current | — | — | 25 | μA | $V_{DS} = 200V, V_{GS} = 0V$ |
| | | — | — | 250 | | $V_{DS} = 160V, V_{GS} = 0V, T_J = 150^\circ\text{C}$ |
| I_{GSS} | Gate-to-Source Forward Leakage | — | — | 100 | nA | $V_{GS} = 30V$ |
| | Gate-to-Source Reverse Leakage | — | — | -100 | | $V_{GS} = -30V$ |

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

| | Parameter | Min. | Typ. | Max. | Units | Conditions |
|-----------------|---------------------------------|------|------|------|-------|---|
| g_{fs} | Forward Transconductance | 17 | — | — | S | $V_{DS} = 50V, I_D = 18A$ |
| Q_g | Total Gate Charge | — | 70 | 107 | nC | $I_D = 18A$ |
| Q_{gs} | Gate-to-Source Charge | — | 18 | 23 | | $V_{DS} = 160V$ |
| Q_{gd} | Gate-to-Drain ("Miller") Charge | — | 33 | 65 | | $V_{GS} = 10V$ ④ |
| $t_{d(on)}$ | Turn-On Delay Time | — | 16 | — | ns | $V_{DD} = 100V$ |
| t_r | Rise Time | — | 38 | — | | $I_D = 18A$ |
| $t_{d(off)}$ | Turn-Off Delay Time | — | 26 | — | | $R_G = 2.5\Omega$ |
| t_f | Fall Time | — | 10 | — | | $R_D = 5.4\Omega$, ④ |
| C_{iss} | Input Capacitance | — | 2370 | — | pF | $V_{GS} = 0V$ |
| C_{oss} | Output Capacitance | — | 390 | — | | $V_{DS} = 25V$ |
| C_{rss} | Reverse Transfer Capacitance | — | 78 | — | | $f = 1.0\text{MHz}$ |
| C_{oss} | Output Capacitance | — | 2860 | — | | $V_{GS} = 0V, V_{DS} = 1.0V, f = 1.0\text{MHz}$ |
| C_{oss} | Output Capacitance | — | 150 | — | | $V_{GS} = 0V, V_{DS} = 160V, f = 1.0\text{MHz}$ |
| $C_{oss\ eff.}$ | Effective Output Capacitance | — | 170 | — | | $V_{GS} = 0V, V_{DS} = 0V\ \text{to}\ 160V$ ⑤ |

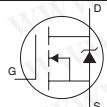
Avalanche Characteristics

| | Parameter | Typ. | Max. | Units |
|----------|--------------------------------|------|------|-------|
| E_{AS} | Single Pulse Avalanche Energy② | — | 420 | mJ |
| I_{AR} | Avalanche Current① | — | 18 | A |
| E_{AR} | Repetitive Avalanche Energy① | — | 20 | mJ |

Thermal Resistance

| | Parameter | Typ. | Max. | Units |
|-----------------|---------------------------------------|------|------|-------|
| $R_{\theta JC}$ | Junction-to-Case | — | 0.75 | °C/W |
| $R_{\theta CS}$ | Case-to-Sink, Flat, Greased Surface ⑥ | 0.50 | — | |
| $R_{\theta JA}$ | Junction-to-Ambient⑥ | — | 62 | |
| $R_{\theta JA}$ | Junction-to-Ambient⑦ | — | 40 | |

Diode Characteristics

| | Parameter | Min. | Typ. | Max. | Units | Conditions |
|----------|--|---|------|------|---------|--|
| I_S | Continuous Source Current (Body Diode) | — | — | 31 | A | MOSFET symbol showing the integral reverse p-n junction diode.  |
| I_{SM} | Pulsed Source Current (Body Diode) ① | — | — | 124 | | |
| V_{SD} | Diode Forward Voltage | — | — | 1.3 | V | $T_J = 25^\circ\text{C}, I_S = 18A, V_{GS} = 0V$ ④ |
| t_{rr} | Reverse Recovery Time | — | 200 | 300 | ns | $T_J = 25^\circ\text{C}, I_F = 18A$ |
| Q_{rr} | Reverse Recovery Charge | — | 1.7 | 2.6 | μC | $di/dt = 100A/\mu s$ ④ |
| t_{on} | Forward Turn-On Time | Intrinsic turn-on time is negligible (turn-on is dominated by $L_S + L_D$) | | | | |

IRFB/S/SL31N20DPbF

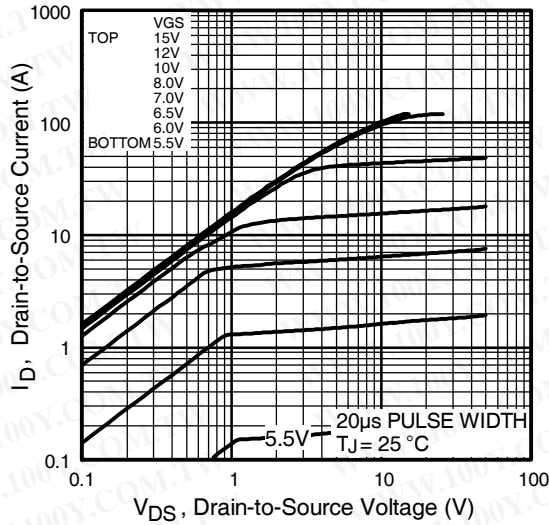


Fig 1. Typical Output Characteristics

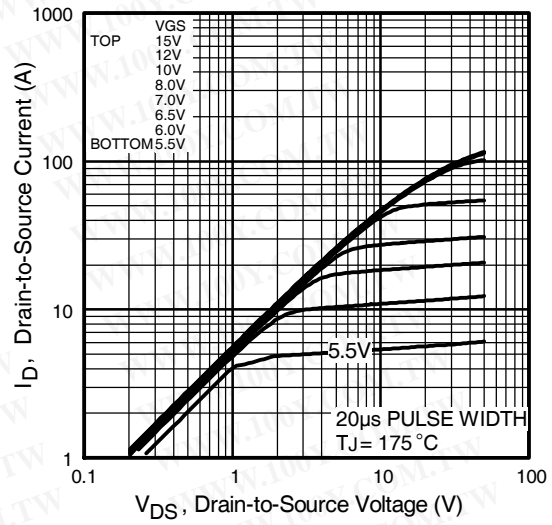


Fig 2. Typical Output Characteristics

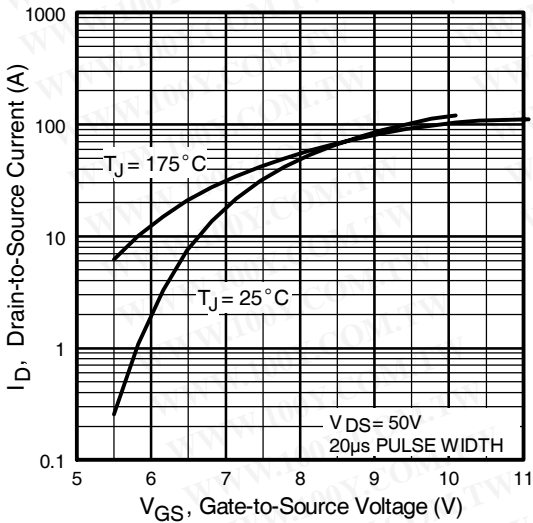


Fig 3. Typical Transfer Characteristics

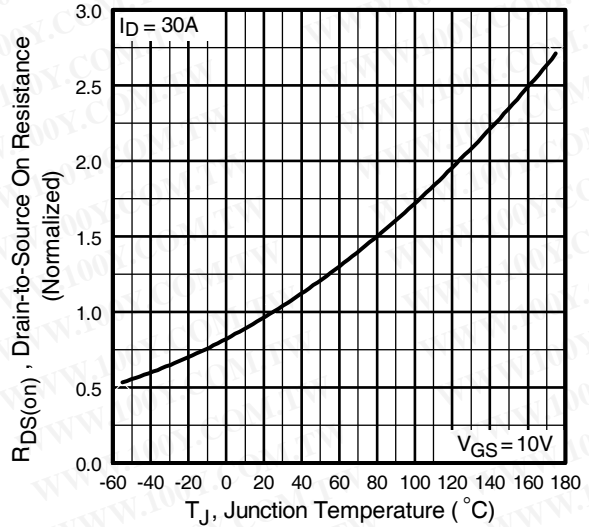


Fig 4. Normalized On-Resistance Vs. Temperature

IRFB/S/SL31N20DPbF

International
IR Rectifier

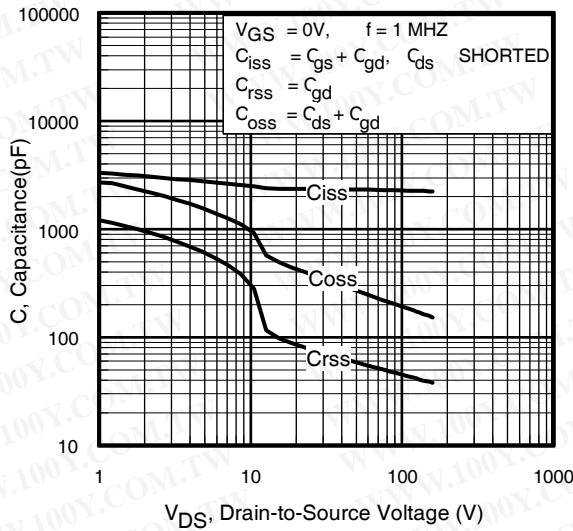


Fig 5. Typical Capacitance Vs. Drain-to-Source Voltage

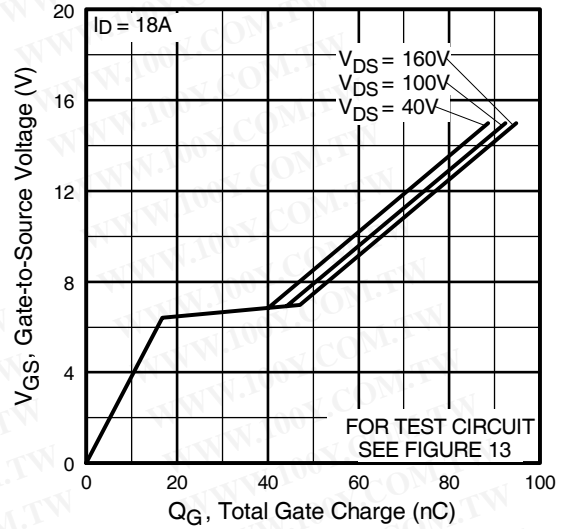


Fig 6. Typical Gate Charge Vs. Gate-to-Source Voltage

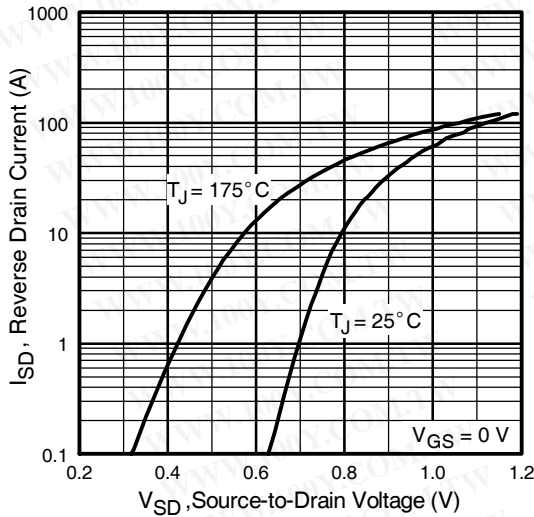


Fig 7. Typical Source-Drain Diode Forward Voltage

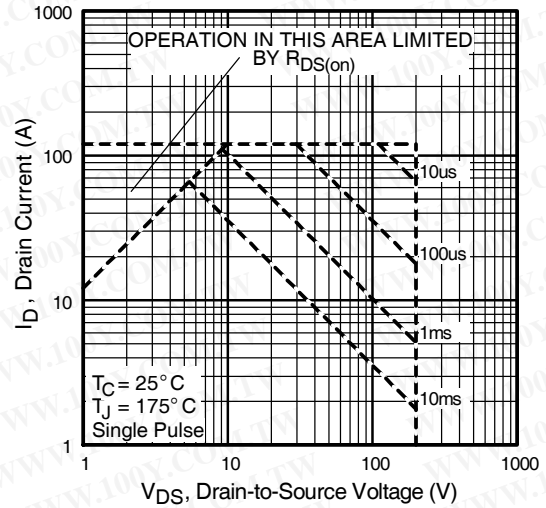


Fig 8. Maximum Safe Operating Area

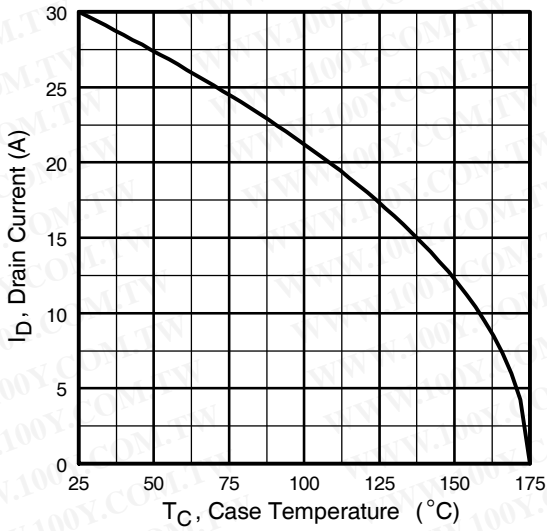


Fig 9. Maximum Drain Current Vs. Case Temperature

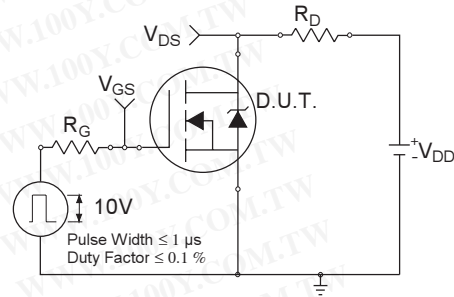


Fig 10a. Switching Time Test Circuit

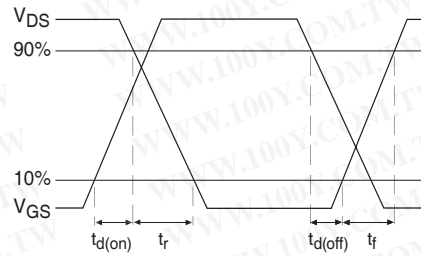


Fig 10b. Switching Time Waveforms

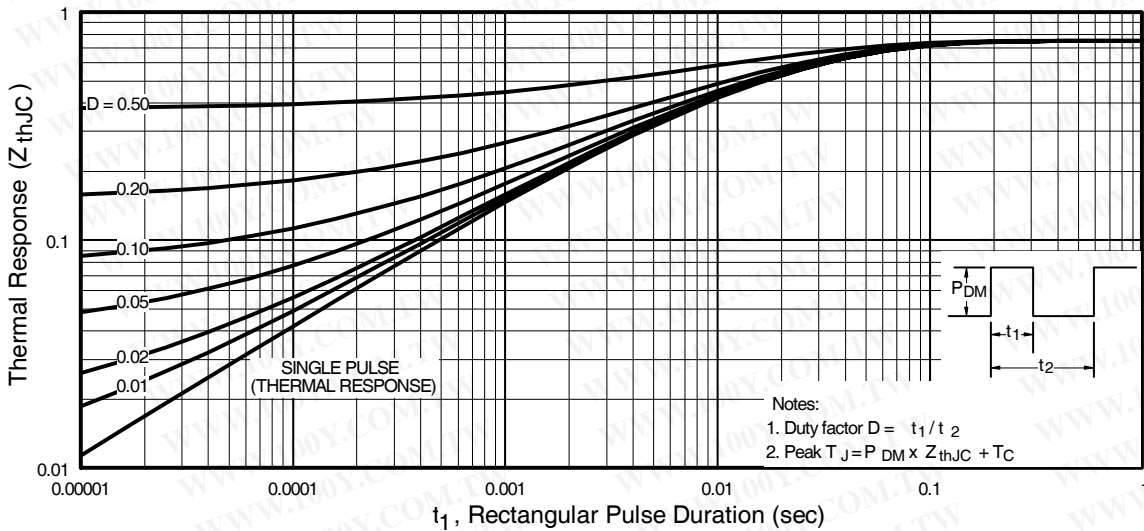


Fig 11. Maximum Effective Transient Thermal Impedance, Junction-to-Case

IRFB/S/SL31N20DPbF

International
IR Rectifier

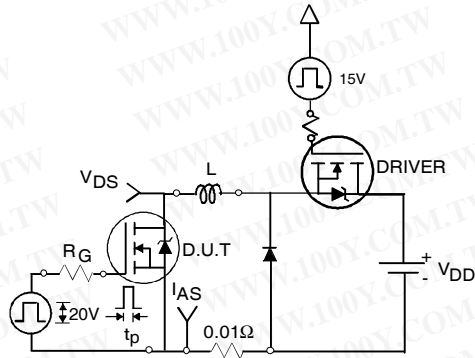


Fig 12a. Unclamped Inductive Test Circuit

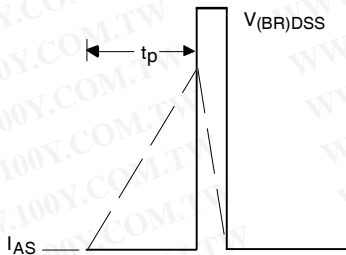


Fig 12b. Unclamped Inductive Waveforms

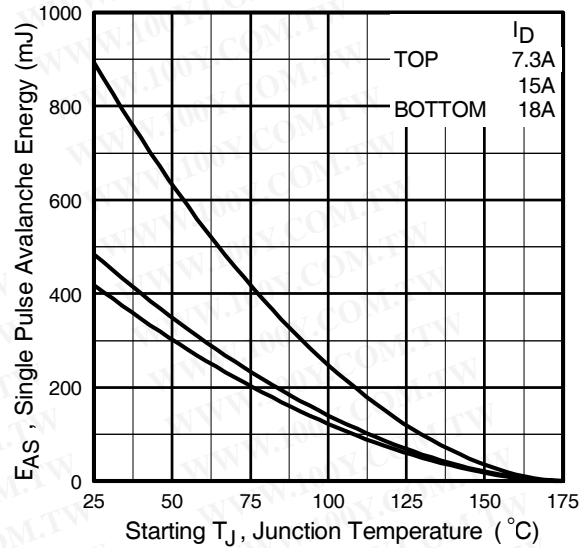


Fig 12c. Maximum Avalanche Energy Vs. Drain Current

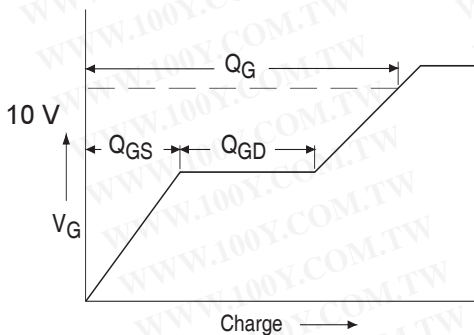


Fig 13a. Basic Gate Charge Waveform

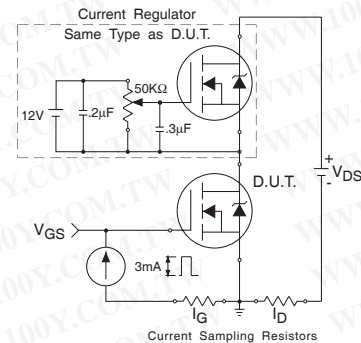
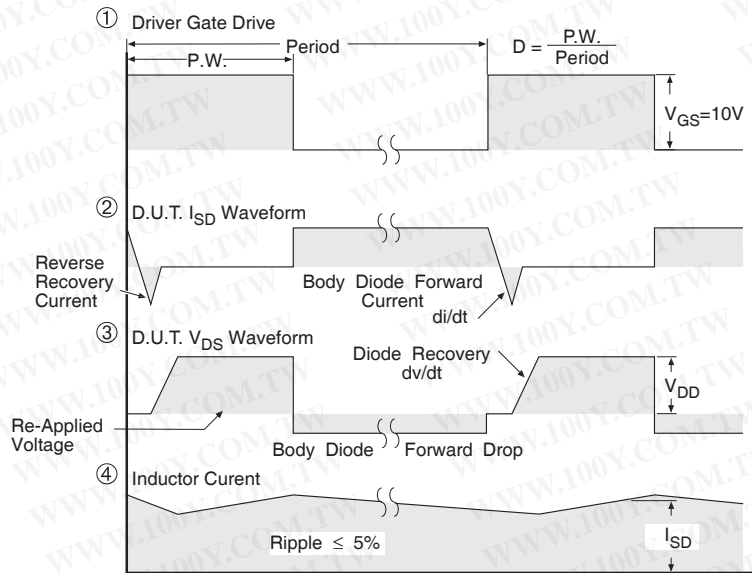
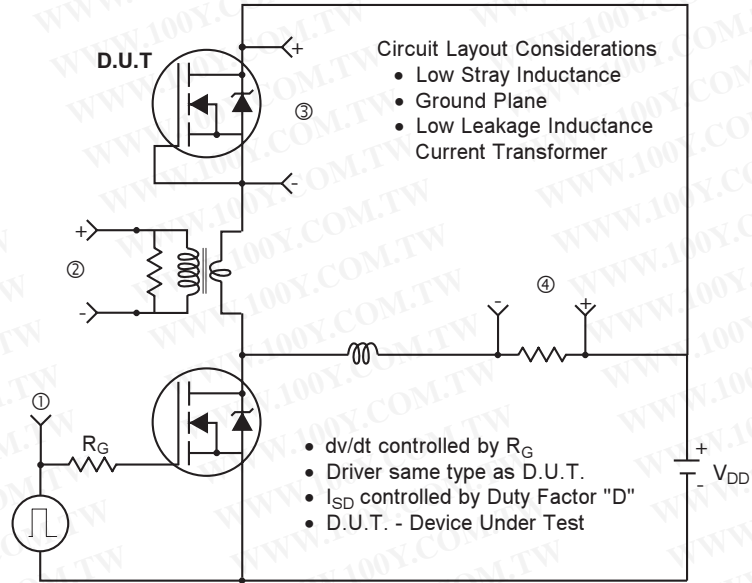


Fig 13b. Gate Charge Test Circuit

Peak Diode Recovery dv/dt Test Circuit



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

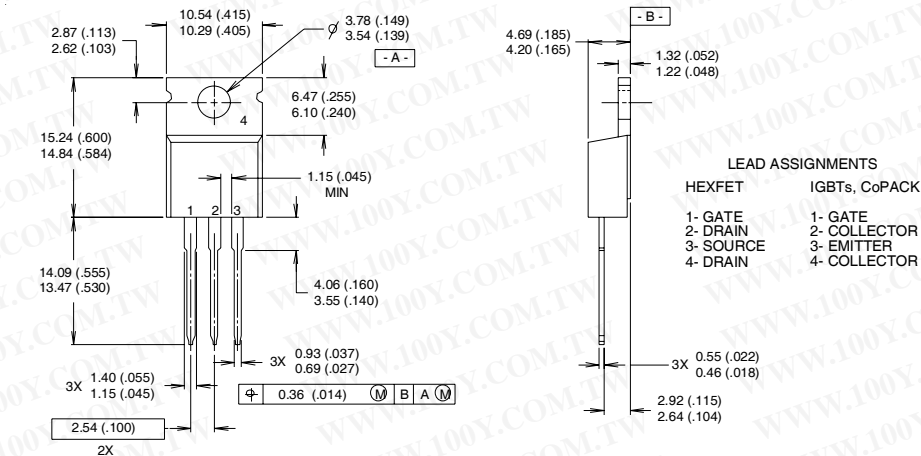
Fig 14. For N-Channel HEXFET® Power MOSFETs

IRFB/S/SL31N20DPbF

International
IR Rectifier

TO-220AB Package Outline

Dimensions are shown in millimeters (inches)

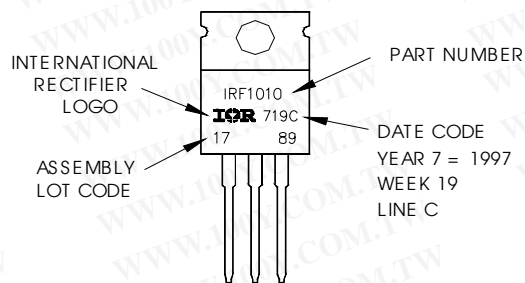


- NOTES:
- 1 DIMENSIONING & TOLERANCING PER ANSI Y14.5M, 1982.
 - 2 CONTROLLING DIMENSION : INCH
 - 3 OUTLINE CONFORMS TO JEDEC OUTLINE TO-220AB.
 - 4 HEATSINK & LEAD MEASUREMENTS DO NOT INCLUDE BURRS.

TO-220AB Part Marking Information

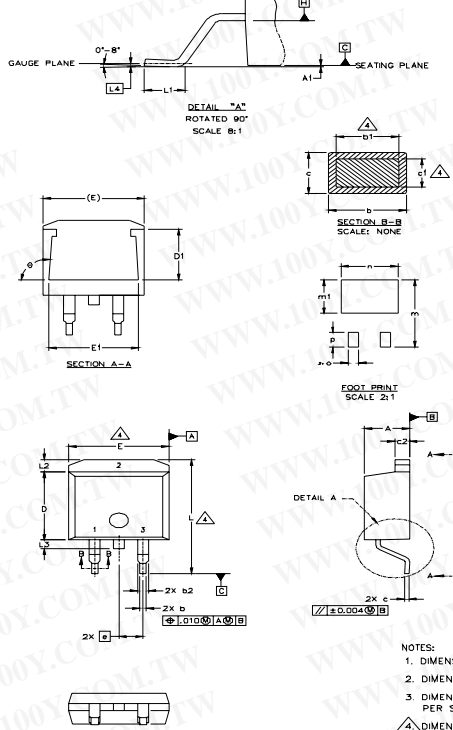
EXAMPLE: THIS IS AN IRF1010
LOT CODE 1789
ASSEMBLED ON WW 19, 1997
IN THE ASSEMBLY LINE "C"

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



D²Pak Package Outline

Dimensions are shown in millimeters (inches)



| SYMBOL | DIMENSIONS | | | | NOTES |
|--------|-------------|-------|--------|------|-------|
| | MILLIMETERS | | INCHES | | |
| | MIN. | MAX. | MIN. | MAX. | |
| A | 4.06 | 4.83 | .160 | .190 | 4 |
| A1 | | 0.127 | | .005 | |
| 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 | 3 |
| c2 | 1.14 | 1.40 | .045 | .055 | |
| 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 | 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° | | |

LEAD ASSIGNMENTS

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

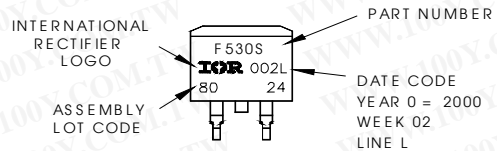
* PART DEPENDENT.

- 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 [.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.

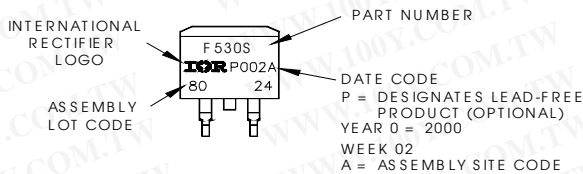
D²Pak Part Marking Information (Lead-Free)

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"



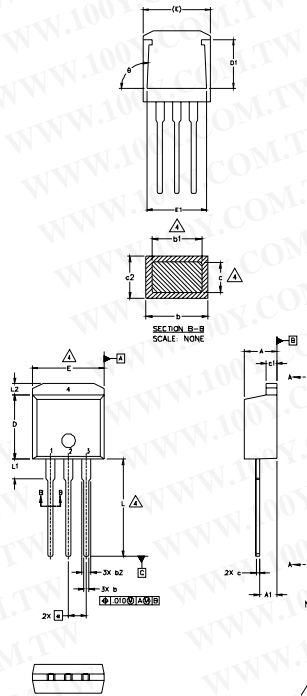
OR



IRFB/S/SL31N20DPbF

International
IR Rectifier

TO-262 Package Outline



| SYMBOL | DIMENSIONS | | | | NOTES |
|--------|-------------|-------|----------|------|-------|
| | MILLIMETERS | | INCHES | | |
| | MIN. | MAX. | MIN. | MAX. | |
| A | 4.06 | 4.83 | .160 | .190 | 4 |
| A1 | 2.03 | 2.92 | .080 | .115 | |
| b | 0.51 | 0.99 | .020 | .039 | |
| b1 | 0.51 | 0.89 | .020 | .035 | |
| b2 | 1.14 | 1.40 | .045 | .055 | 4 |
| c | 0.38 | 0.63 | .015 | .025 | |
| c1 | 1.14 | 1.40 | .045 | .055 | 3 |
| 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 | |

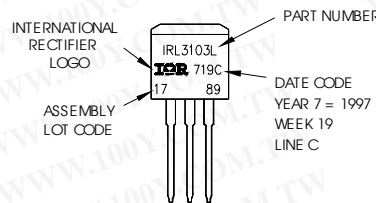
LEAD ASSIGNMENTS

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

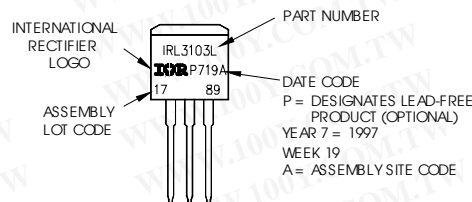
- NOTES:
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M-1994
 2. DIMENSIONS ARE SHOWN IN MILLIMETERS [INCHES].
 3. DIMENSION D & E DO NOT INCLUDE MOLD FLASH. MOLD FLASH SHALL NOT EXCEED 0.127 [0.005] PER SIDE. THESE DIMENSIONS ARE MEASURED AT THE OUTMOST EXTREMES OF THE PLASTIC BODY.
 4. DIMENSION b1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



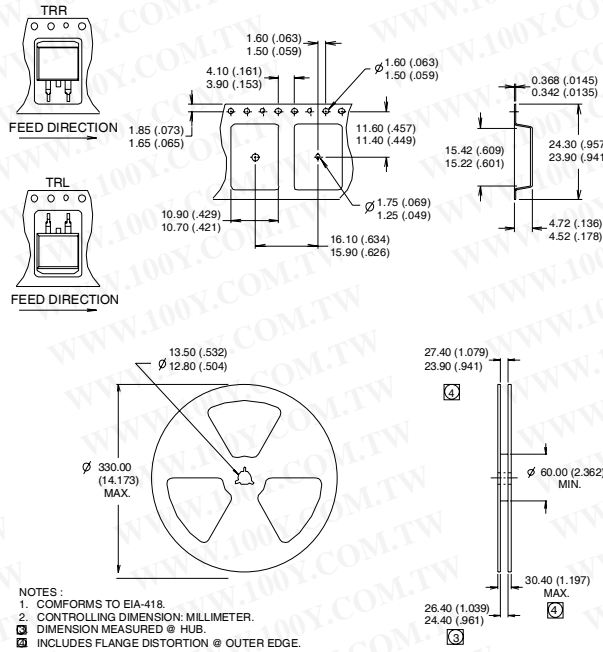
OR



IRFB/S/SL31N20DPbF

D²Pak Tape & Reel Infomation

Dimensions are shown in millimeters (inches)



Notes:

- ① Repetitive rating; pulse width limited by max. junction temperature.
- ② Starting $T_J = 25^\circ\text{C}$, $L = 3.8\text{mH}$
 $R_G = 25\Omega$, $I_{AS} = 18\text{A}$.
- ③ $I_{SD} \leq 18\text{A}$, $di/dt \leq 110\text{A}/\mu\text{s}$, $V_{DD} \leq V_{(BR)DSS}$,
 $T_J \leq 175^\circ\text{C}$
- 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.

Data and specifications subject to change without notice.