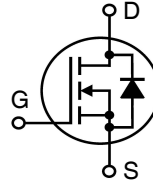


# X3-Class Power MOSFET™

**IXTA20N65X2**  
**IXTP20N65X2**  
**IXTH20N65X2**

**V<sub>DSS</sub> = 650V**  
**I<sub>D25</sub> = 20A**  
**R<sub>DS(on)</sub> ≤ 185mΩ**

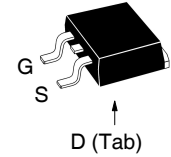
N-Channel Enhancement Mode  
Avalanche Rated



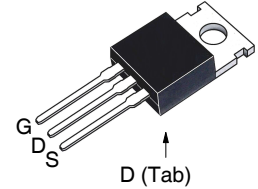
| Symbol            | Test Conditions                                                                                | Maximum Ratings    |          |
|-------------------|------------------------------------------------------------------------------------------------|--------------------|----------|
| V <sub>DSS</sub>  | T <sub>J</sub> = 25°C to 150°C                                                                 | 650                | V        |
| V <sub>DGR</sub>  | T <sub>J</sub> = 25°C to 150°C, R <sub>GS</sub> = 1MΩ                                          | 650                | V        |
| V <sub>GSS</sub>  | Continuous                                                                                     | ±30                | V        |
| V <sub>GSM</sub>  | Transient                                                                                      | ±40                | V        |
| I <sub>D25</sub>  | T <sub>C</sub> = 25°C                                                                          | 20                 | A        |
| I <sub>DM</sub>   | T <sub>C</sub> = 25°C, Pulse Width Limited by T <sub>JM</sub>                                  | 22                 | A        |
| I <sub>A</sub>    | T <sub>C</sub> = 25°C                                                                          | 5                  | A        |
| E <sub>AS</sub>   | T <sub>C</sub> = 25°C                                                                          | 400                | mJ       |
| dv/dt             | I <sub>S</sub> ≤ I <sub>DM</sub> , V <sub>DD</sub> ≤ V <sub>DSS</sub> , T <sub>J</sub> ≤ 150°C | 50                 | V/ns     |
| P <sub>D</sub>    | T <sub>C</sub> = 25°C                                                                          | 290                | W        |
| T <sub>J</sub>    |                                                                                                | -55 ... +150       | °C       |
| T <sub>JM</sub>   |                                                                                                | 150                | °C       |
| T <sub>stg</sub>  |                                                                                                | -55 ... +150       | °C       |
| T <sub>L</sub>    | Maximum Lead Temperature for Soldering                                                         | 300                | °C       |
| T <sub>SOLD</sub> | 1.6 mm (0.062in.) from Case for 10s                                                            | 260                | °C       |
| F <sub>C</sub>    | Mounting Force (TO-263)                                                                        | 10..65 / 2.2..14.6 | N/lb     |
| M <sub>d</sub>    | Mounting Torque (TO-220 & TO-247)                                                              | 1.13 / 10          | Nm/lb.in |
| Weight            | TO-263                                                                                         | 2.5                | g        |
|                   | TO-220                                                                                         | 3.0                | g        |
|                   | TO-247                                                                                         | 6.0                | g        |

| Symbol              | Test Conditions<br>(T <sub>J</sub> = 25°C, Unless Otherwise Specified)              | Characteristic Values |      |               |
|---------------------|-------------------------------------------------------------------------------------|-----------------------|------|---------------|
|                     |                                                                                     | Min.                  | Typ. | Max.          |
| BV <sub>DSS</sub>   | V <sub>GS</sub> = 0V, I <sub>D</sub> = 250μA                                        | 650                   |      | V             |
| V <sub>GS(th)</sub> | V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = 250μA                          | 2.5                   |      | 4.5 V         |
| I <sub>GSS</sub>    | V <sub>GS</sub> = ±30V, V <sub>DS</sub> = 0V                                        |                       |      | ±100 nA       |
| I <sub>DSS</sub>    | V <sub>DS</sub> = V <sub>DSS</sub> , V <sub>GS</sub> = 0V<br>T <sub>J</sub> = 125°C |                       |      | 5 μA<br>50 μA |
| R <sub>DS(on)</sub> | V <sub>GS</sub> = 10V, I <sub>D</sub> = 0.5 • I <sub>D25</sub> , Note 1             | 155                   | 185  | mΩ            |

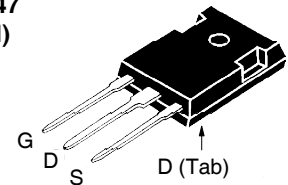
TO-263  
(IXTA)



TO-220  
(IXTP)



TO-247  
(IXTH)



G = Gate      D = Drain  
S = Source    Tab = Drain

## Features

- International Standard Packages
- Low R<sub>DS(ON)</sub> and Q<sub>G</sub>
- Avalanche Rated
- Low Package Inductance

## Advantages

- High Power Density
- Easy to Mount
- Space Savings

## Applications

- Switch-Mode and Resonant-Mode Power Supplies
- DC-DC Converters
- PFC Circuits
- AC and DC Motor Drives
- Robotics and Servo Controls

| Symbol                              | Test Conditions<br>( $T_J = 25^\circ\text{C}$ , Unless Otherwise Specified)                                     | Characteristic Values                                |      |                         |
|-------------------------------------|-----------------------------------------------------------------------------------------------------------------|------------------------------------------------------|------|-------------------------|
|                                     |                                                                                                                 | Min.                                                 | Typ. | Max                     |
| $g_{fs}$                            | $V_{DS} = 10\text{V}$ , $I_D = 0.5 \cdot I_{D25}$ , Note 1                                                      | 11                                                   | 18   | S                       |
| $R_{Gi}$                            | Gate Input Resistance                                                                                           |                                                      | 3.7  | $\Omega$                |
| $C_{iss}$                           | $V_{GS} = 0\text{V}$ , $V_{DS} = 25\text{V}$ , $f = 1\text{MHz}$                                                |                                                      | 1450 | pF                      |
| $C_{oss}$                           |                                                                                                                 |                                                      | 1060 | pF                      |
| $C_{rss}$                           |                                                                                                                 |                                                      | 1.4  | pF                      |
| <b>Effective Output Capacitance</b> |                                                                                                                 |                                                      |      |                         |
| $C_{o(er)}$                         | Energy related                                                                                                  | $V_{GS} = 0\text{V}$<br>$V_{DS} = 0.8 \cdot V_{DSS}$ | 64   | pF                      |
| $C_{o(tr)}$                         | Time related                                                                                                    |                                                      | 250  | pF                      |
| <b>Resistive Switching Times</b>    |                                                                                                                 |                                                      |      |                         |
| $t_{d(on)}$                         | $V_{GS} = 10\text{V}$ , $V_{DS} = 0.5 \cdot V_{DSS}$ , $I_D = 0.5 \cdot I_{D25}$<br>$R_G = 10\Omega$ (External) |                                                      | 19   | ns                      |
| $t_r$                               |                                                                                                                 |                                                      | 27   | ns                      |
| $t_{d(off)}$                        |                                                                                                                 |                                                      | 47   | ns                      |
| $t_f$                               |                                                                                                                 |                                                      | 20   | ns                      |
| $Q_{g(on)}$                         | $V_{GS} = 10\text{V}$ , $V_{DS} = 0.5 \cdot V_{DSS}$ , $I_D = 0.5 \cdot I_{D25}$                                |                                                      | 27   | nC                      |
| $Q_{gs}$                            |                                                                                                                 |                                                      | 8    | nC                      |
| $Q_{gd}$                            |                                                                                                                 |                                                      | 11   | nC                      |
| $R_{thJC}$                          |                                                                                                                 |                                                      |      | 0.43 $^\circ\text{C/W}$ |
| $R_{thCS}$                          | TO-220                                                                                                          |                                                      | 0.50 | $^\circ\text{C/W}$      |
|                                     | TO-247                                                                                                          |                                                      | 0.21 | $^\circ\text{C/W}$      |

### Source-Drain Diode

| Symbol   | Test Conditions<br>( $T_J = 25^\circ\text{C}$ , Unless Otherwise Specified)    | Characteristic Values |      |               |
|----------|--------------------------------------------------------------------------------|-----------------------|------|---------------|
|          |                                                                                | Min.                  | Typ. | Max           |
| $I_S$    | $V_{GS} = 0\text{V}$                                                           |                       |      | 20 A          |
| $I_{SM}$ | Repetitive, Pulse Width Limited by $T_{JM}$                                    |                       |      | 80 A          |
| $V_{SD}$ | $I_F = I_S$ , $V_{GS} = 0\text{V}$ , Note 1                                    |                       |      | 1.4 V         |
| $t_{rr}$ | $I_F = 10\text{A}$ , $-di/dt = 100\text{A}/\mu\text{s}$<br>$V_R = 100\text{V}$ |                       | 350  | ns            |
| $Q_{RM}$ |                                                                                |                       | 4.3  | $\mu\text{C}$ |
| $I_{RM}$ |                                                                                |                       | 24.6 | A             |

Note 1. Pulse test,  $t \leq 300\mu\text{s}$ , duty cycle,  $d \leq 2\%$ .

IXYS Reserves the Right to Change Limits, Test Conditions, and Dimensions.

|                                                                                  |           |           |           |           |             |             |             |             |             |             |
|----------------------------------------------------------------------------------|-----------|-----------|-----------|-----------|-------------|-------------|-------------|-------------|-------------|-------------|
| IXYS MOSFETs and IGBTs are covered by one or more of the following U.S. patents: | 4,835,592 | 4,931,844 | 5,049,961 | 5,237,481 | 6,162,665   | 6,404,065B1 | 6,683,344   | 6,727,585   | 7,005,734B2 | 7,157,338B2 |
|                                                                                  | 4,860,072 | 5,017,508 | 5,063,307 | 5,381,025 | 6,259,123B1 | 6,534,343   | 6,710,405B2 | 6,759,692   | 7,063,975B2 |             |
|                                                                                  | 4,881,106 | 5,034,796 | 5,187,117 | 5,486,715 | 6,306,728B1 | 6,583,505   | 6,710,463   | 6,771,478B2 | 7,071,537   |             |

Fig. 1. Output Characteristics @  $T_J = 25^\circ\text{C}$

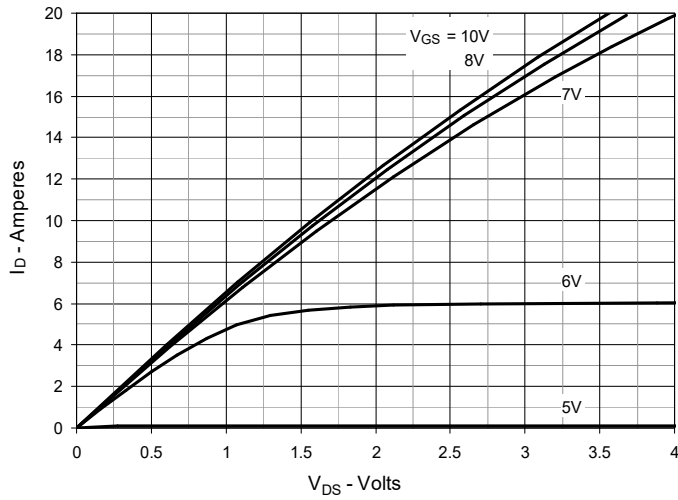


Fig. 2. Extended Output Characteristics @  $T_J = 25^\circ\text{C}$

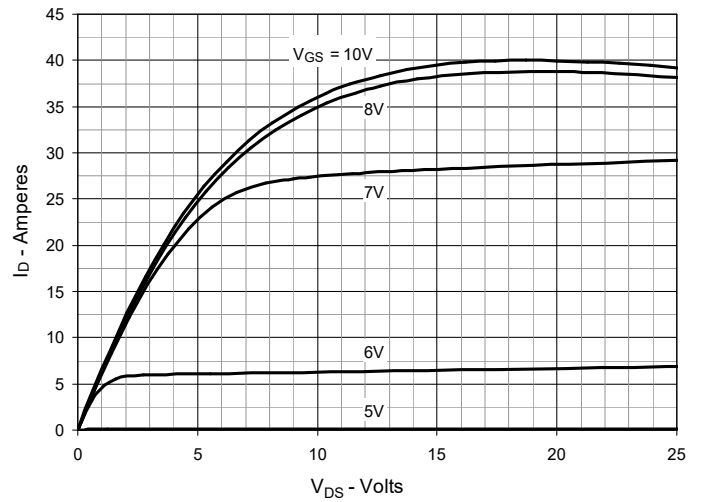


Fig. 3. Output Characteristics @  $T_J = 125^\circ\text{C}$

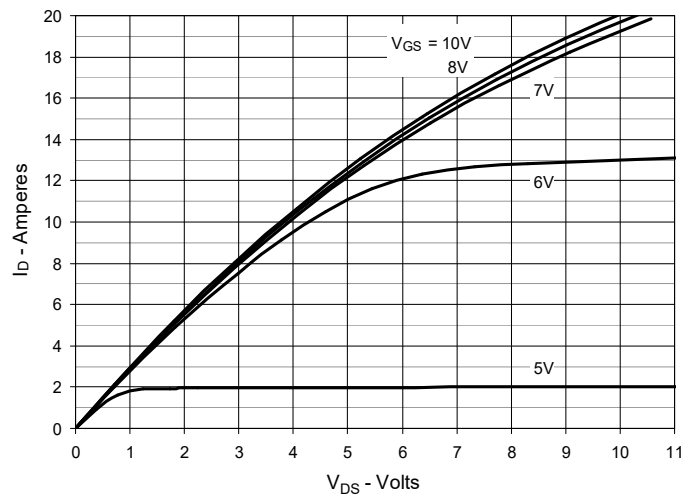


Fig. 4.  $R_{DS(on)}$  Normalized to  $I_D = 10\text{A}$  Value vs. Junction Temperature

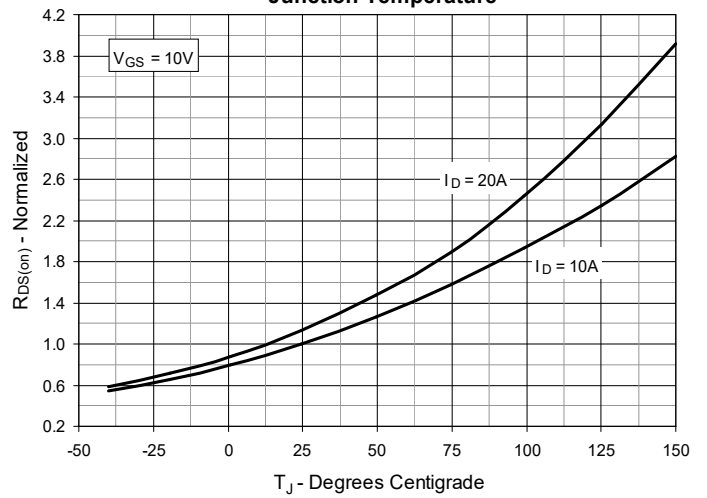


Fig. 5.  $R_{DS(on)}$  Normalized to  $I_D = 10\text{A}$  Value vs. Drain Current

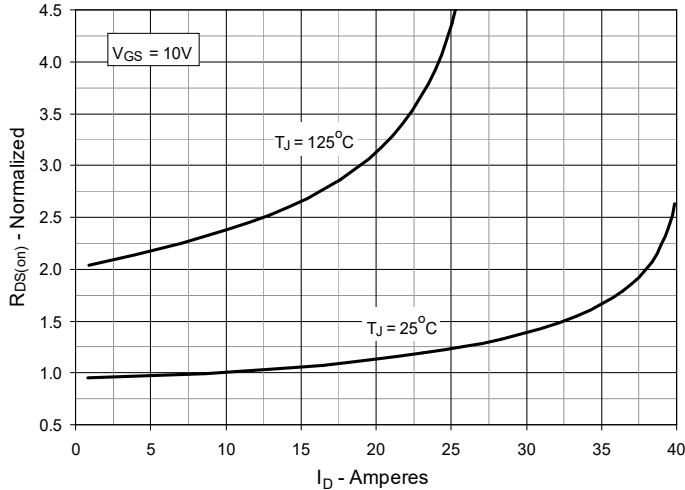


Fig. 6. Normalized Breakdown & Threshold Voltages vs. Junction Temperature

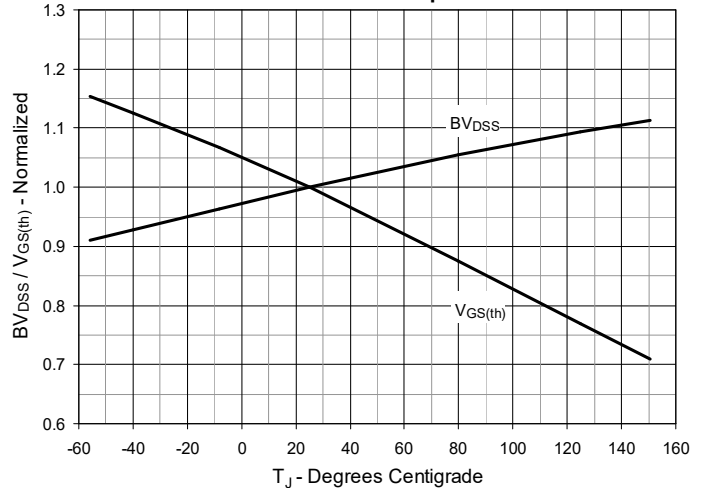


Fig. 7. Maximum Drain Current vs. Case Temperature

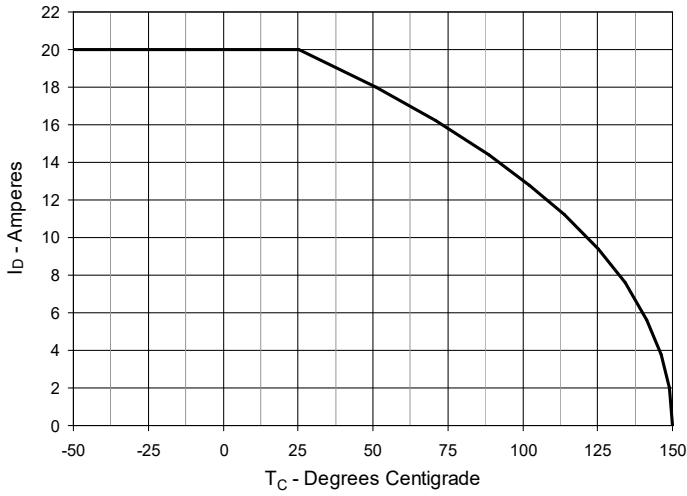


Fig. 8. Input Admittance

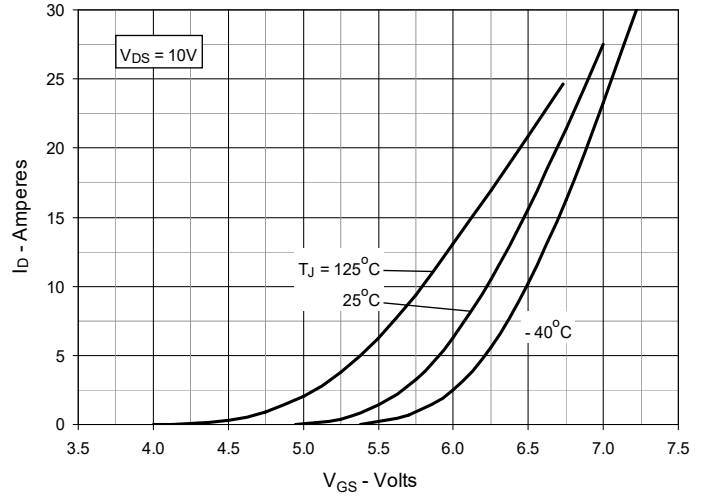


Fig. 9. Transconductance

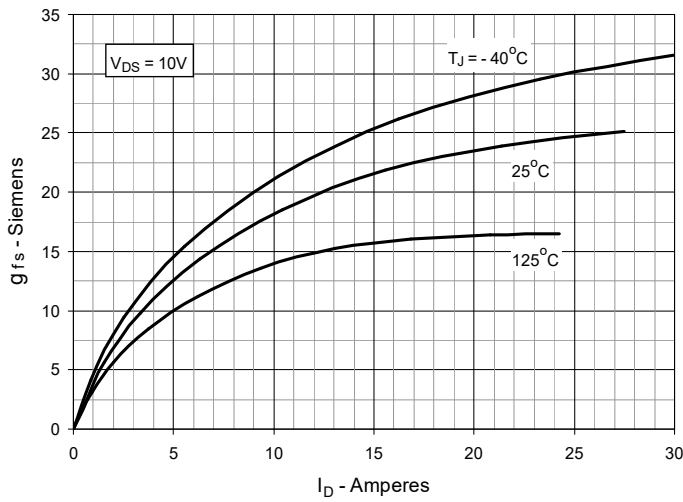


Fig. 10. Forward Voltage Drop of Intrinsic Diode

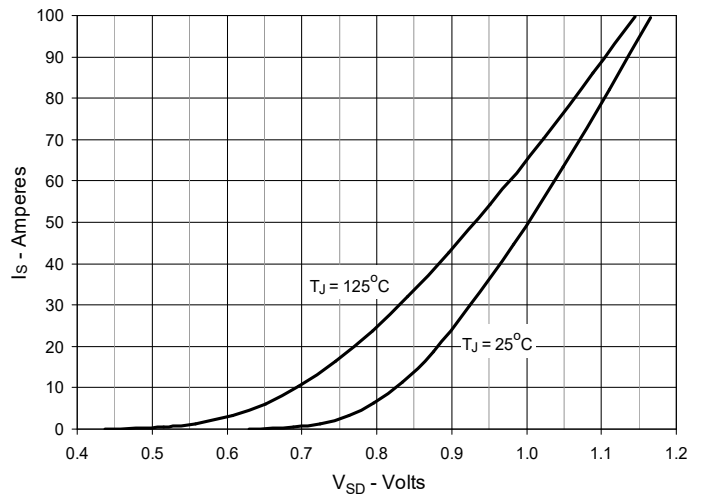


Fig. 11. Gate Charge

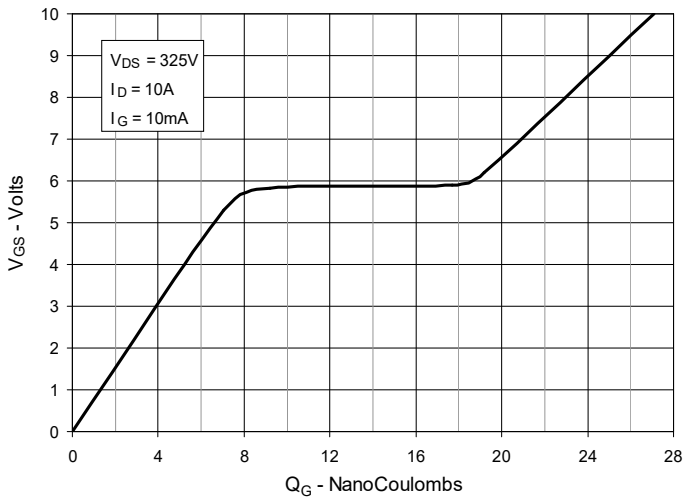


Fig. 12. Capacitance

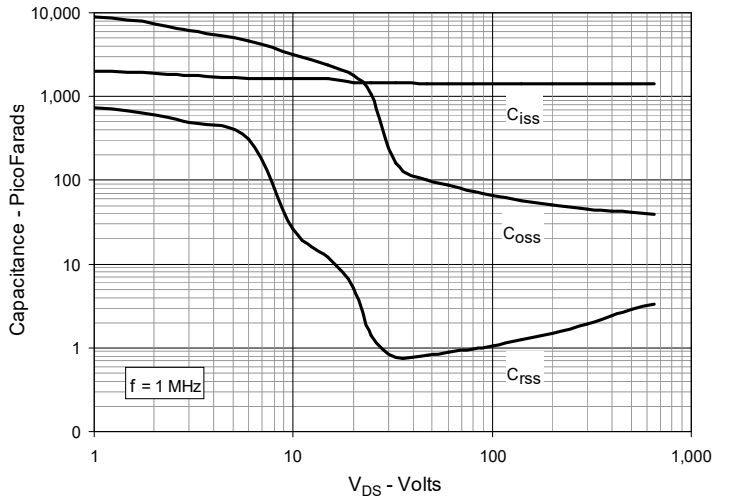


Fig. 13. Output Capacitance Stored Energy

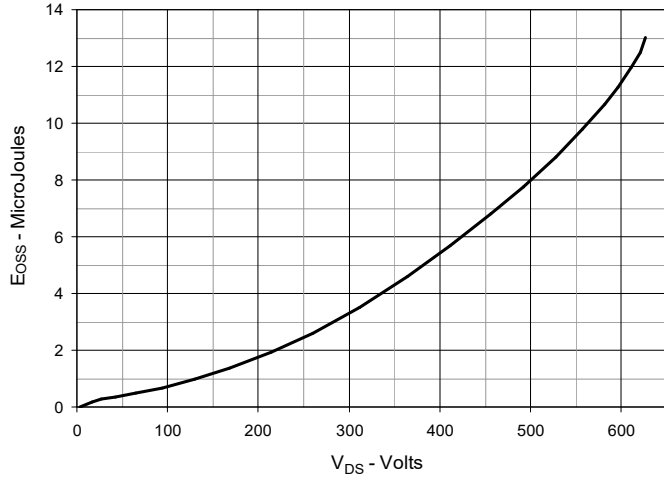


Fig. 14. Forward-Bias Safe Operating Area

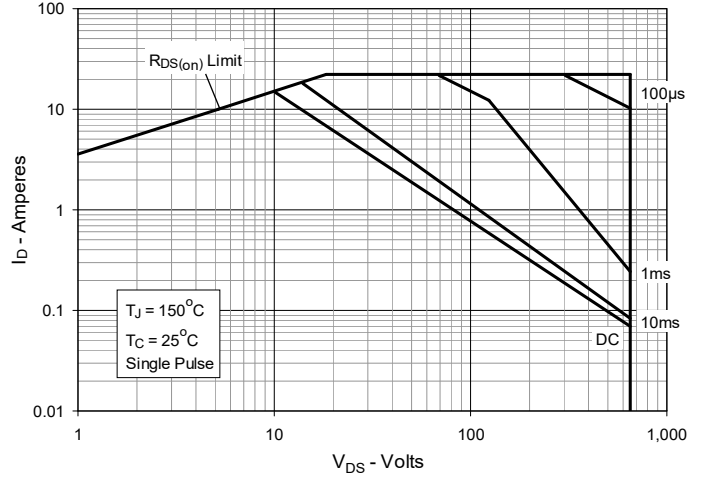
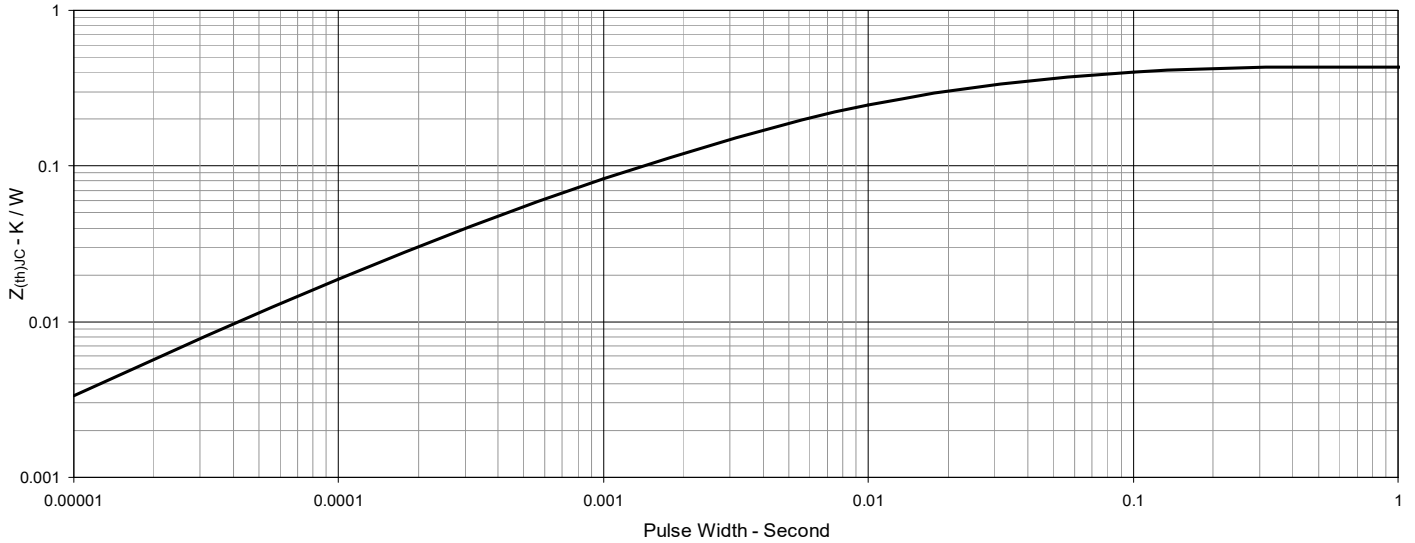
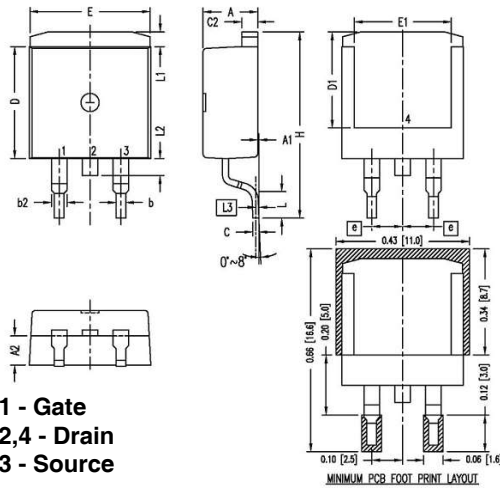


Fig. 15. Maximum Transient Thermal Impedance



**TO-263 Outline**

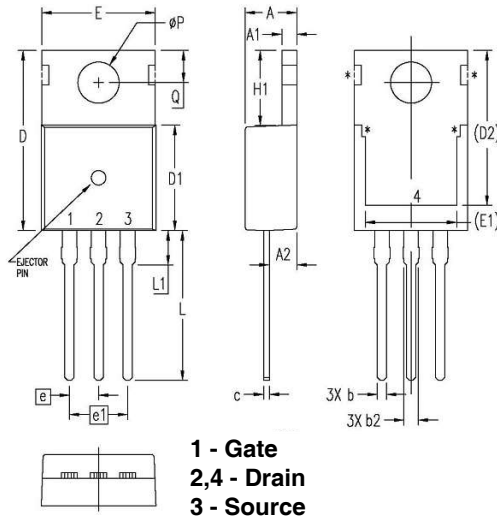


- 1 - Gate
- 2,4 - Drain
- 3 - Source

| SYM  | INCHES   |      | MILLIMETER |       |
|------|----------|------|------------|-------|
|      | MIN      | MAX  | MIN        | MAX   |
| A    | .170     | .185 | 4.30       | 4.70  |
| A1   | .000     | .008 | 0.00       | 0.20  |
| A2   | .091     | .098 | 2.30       | 2.50  |
| b    | .028     | .035 | 0.70       | 0.90  |
| b2   | .046     | .060 | 1.18       | 1.52  |
| C    | .018     | .024 | 0.45       | 0.60  |
| C2   | .049     | .060 | 1.25       | 1.52  |
| D    | .340     | .370 | 8.63       | 9.40  |
| D1   | .300     | .327 | 7.62       | 8.30  |
| E    | .380     | .410 | 9.65       | 10.41 |
| E1   | .270     | .330 | 6.86       | 8.38  |
| (E)  | .100 BSC |      | 2.54 BSC   |       |
| H    | .580     | .620 | 14.73      | 15.75 |
| L    | .075     | .105 | 1.91       | 2.67  |
| L1   | .039     | .060 | 1.00       | 1.52  |
| L2   |          | .070 |            | 1.77  |
| (L3) | .010 BSC |      | 0.254 BSC  |       |

- NOTE:
1. This drawing meets all dimensions requirement of JEDEC outlines TO-263AB.
  2. All metal surface are matte pure tin plated except trimmed area.
  3. L3 is Gauge plane to measure L.
  4. These dimension do not include mold flash and they will not exceed 0.005[0.13] per side.

**TO-220 Outline**

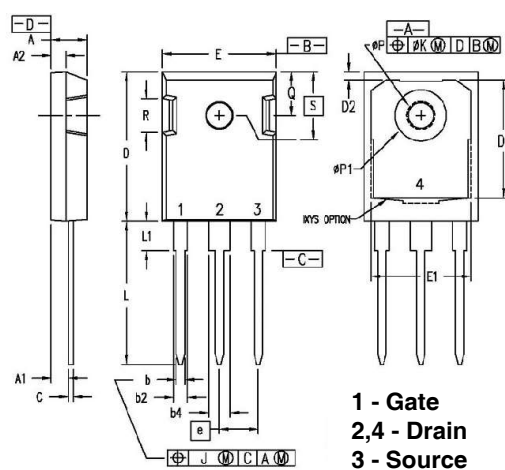


- 1 - Gate
- 2,4 - Drain
- 3 - Source

| SYM  | INCHES   |      | MILLIMETERS |       |
|------|----------|------|-------------|-------|
|      | MIN      | MAX  | MIN         | MAX   |
| A    | .169     | .185 | 4.30        | 4.70  |
| A1   | .047     | .055 | 1.20        | 1.40  |
| A2   | .079     | .106 | 2.00        | 2.70  |
| b    | .024     | .039 | 0.60        | 1.00  |
| b2   | .045     | .057 | 1.15        | 1.45  |
| c    | .014     | .026 | 0.35        | 0.65  |
| D    | .587     | .626 | 14.90       | 15.90 |
| D1   | .335     | .370 | 8.50        | 9.40  |
| (D2) | .500     | .531 | 12.70       | 13.50 |
| E    | .382     | .406 | 9.70        | 10.30 |
| (E1) | .283     | .323 | 7.20        | 8.20  |
| e    | .100 BSC |      | 2.54 BSC    |       |
| e1   | .200 BSC |      | 5.08 BSC    |       |
| H1   | .244     | .268 | 6.20        | 6.80  |
| L    | .492     | .547 | 12.50       | 13.90 |
| L1   | .110     | .154 | 2.80        | 3.90  |
| ØP   | .134     | .150 | 3.40        | 3.80  |
| Q    | .106     | .126 | 2.70        | 3.20  |

- NOTE:
1. These dimensions do not include mold protrusion.
  2. Metal finish - Matte pure tin plating except trim area.
  3. Pin call out: 1 - GATE 3 - SOURCE (EMITTER for IGBT) 4 - DRAIN (Connected with #2 internally)
  4. Ejector pin location & diameter will vary depending on packaging suppliers.
  5. \* marked area will vary depending on packaging suppliers.

**TO-247 Outline**



- 1 - Gate
- 2,4 - Drain
- 3 - Source

| SYM | INCHES   |      | MILLIMETERS |       |
|-----|----------|------|-------------|-------|
|     | MIN      | MAX  | MIN         | MAX   |
| A   | .190     | .205 | 4.83        | 5.21  |
| A1  | .090     | .100 | 2.29        | 2.54  |
| A2  | .075     | .085 | 1.91        | 2.16  |
| b   | .045     | .055 | 1.14        | 1.40  |
| b2  | .075     | .087 | 1.91        | 2.20  |
| b4  | .115     | .126 | 2.92        | 3.20  |
| C   | .024     | .031 | 0.61        | 0.80  |
| D   | .819     | .840 | 20.80       | 21.34 |
| D1  | .650     | .690 | 16.51       | 17.53 |
| D2  | .035     | .050 | 0.89        | 1.27  |
| E   | .620     | .635 | 15.75       | 16.13 |
| E1  | .545     | .565 | 13.84       | 14.35 |
| e   | .215 BSC |      | 5.45 BSC    |       |
| J   | --       | .010 | --          | 0.25  |
| K   | --       | .025 | --          | 0.64  |
| L   | .780     | .810 | 19.81       | 20.57 |
| L1  | .150     | .170 | 3.81        | 4.32  |
| ØP1 | .140     | .144 | 3.55        | 3.65  |
| ØP1 | .275     | .290 | 6.99        | 7.37  |
| Q   | .220     | .244 | 5.59        | 6.20  |
| R   | .170     | .190 | 4.32        | 4.83  |
| S   | .242 BSC |      | 6.15 BSC    |       |

- NOTE: This drawing will meet all dimensions requirement of JEDEC outlines TO-247 AD (R-PSIP-F3)



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