RoHS Compliant

# N-CHANNEL MOSFET

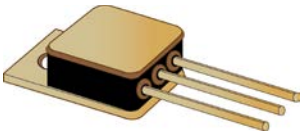
## *Qualified per MIL-PRF-19500/592*

*Qualified Levels:*
*JAN, JANTX, and JANTXV*

## DESCRIPTION

This family of switching transistors is military qualified up to the JANTXV level for high-reliability applications. These devices are also available in a low profile U surface mount package. Microsemi also offers numerous other transistor products to meet higher and lower power ratings with various switching speed requirements in both through-hole and surface-mount packages.

**Important:** For the latest information, visit our website http://www.microsemi.com.



**TO-254AA Package**

## FEATURES

- JEDEC registered 2N7224, 2N7225, 2N7227 and 2N7228 number series.
- JAN, JANTX, and JANTXV qualifications are available per MIL-PRF-19500/592. (See part nomenclature for all available options.)
- RoHS compliant by design.

Also available in:

**U (SMD-1 or TO-267AB) package**
(surface mount)
**2N7224U & 2N7228U**

## APPLICATIONS / BENEFITS

- Low-profile design.
- Military and other high-reliability applications.

## MAXIMUM RATINGS @ $T_A$ = +25ºC unless otherwise stated

| Parameters / Test Conditions | | Symbol | Value | Unit |
|---|---|---|---|---|
| Operating & Storage Junction Temperature Range | | $T_J$ & $T_{stg}$ | -55 to +150 | °C |
| Thermal Resistance Junction-to-Case | | $R_{\theta JC}$ | 0.83 | °C/W |
| Total Power Dissipation | @ $T_A$ = +25 °C<br>@ $T_C$ = +25 °C (1) | $P_T$ | 4<br>150 | W |
| Gate-Source Voltage, dc | | $V_{GS}$ | ± 20 | V |
| Drain Current, dc @ $T_C$ = +25 ºC (2) | 2N7224<br>2N7225<br>2N7227<br>2N7228 | $I_{D1}$ | 34.0<br>27.4<br>14.0<br>12.0 | A |
| Drain Current, dc @ $T_C$ = +100 ºC (2) | 2N7224<br>2N7225<br>2N7227<br>2N7228 | $I_{D2}$ | 21<br>17<br>9<br>8 | A |
| Off-State Current (Peak Total Value) (3) | 2N7224<br>2N7225<br>2N7227<br>2N7228 | $I_{DM}$ | 136<br>110<br>56<br>48 | A (pk) |
| Source Current | 2N7224<br>2N7225<br>2N7227<br>2N7228 | $I_S$ | 34.0<br>27.4<br>14.0<br>12.0 | A |

**NOTES:**
1. Derated linearly by 1.2 W/ºC for $T_C$ > +25 ºC.
2. The following formula derives the maximum theoretical ID limit. ID is limited by package and internal wires and may also be limited by pin diameter:

$$I_D = \sqrt{\frac{T_J\,(max) - T_C}{R_{\theta JC} \times R_{DS(on)} @ T_J\,(max)}}$$

3. $I_{DM}$ = 4 x $I_{D1}$ as calculated in note 2.

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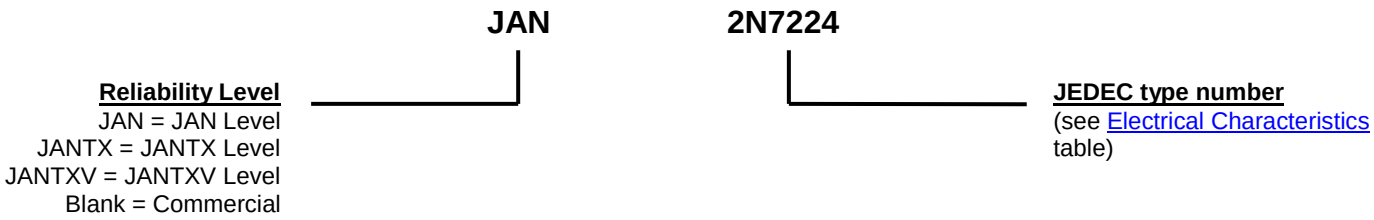
## MECHANICAL and PACKAGING

- CASE: Ceramic and gold over nickel plated steel.
- TERMINALS: Gold over nickel plated tungsten/copper.
- MARKING: Part number, date code, and polarity symbol.
- WEIGHT: 6.5 grams.
- See Package Dimensions on last page.

## PART NOMENCLATURE




## SYMBOLS & DEFINITIONS

| Symbol | Definition |
|---|---|
| di/dt | Rate of change of diode current while in reverse-recovery mode, recorded as maximum value. |
| $I_F$ | Forward current |
| $R_G$ | Gate drive impedance |
| $V_{DD}$ | Drain supply voltage |
| $V_{DS}$ | Drain source voltage, dc |
| $V_{GS}$ | Gate source voltage, dc |

## ELECTRICAL CHARACTERISTICS @ $T_A$ = +25 °C, unless otherwise noted

| Parameters / Test Conditions | | Symbol | Min. | Max. | Unit |
|---|---|---|---|---|---|
| **OFF CHARACTERISTICS** | | | | | |
| Drain-Source Breakdown Voltage | | | | | |
| $V_{GS}$ = 0 V, $I_D$ = 1.0 mA | 2N7224 | $V_{(BR)DSS}$ | 100 | | V |
| | 2N7225 | | 200 | | |
| | 2N7227 | | 400 | | |
| | 2N7228 | | 500 | | |
| Gate-Source Voltage (Threshold) | | | | | |
| $V_{DS} \geq V_{GS}$, $I_D$ = 0.25 mA | | $V_{GS(th)1}$ | 2.0 | 4.0 | V |
| $V_{DS} \geq V_{GS}$, $I_D$ = 0.25 mA, $T_J$ = +125°C | | $V_{GS(th)2}$ | 1.0 | | |
| $V_{DS} \geq V_{GS}$, $I_D$ = 0.25 mA, $T_J$ = -55°C | | $V_{GS(th)3}$ | | 5.0 | |
| Gate Current | | | | | |
| $V_{GS}$ = ± 20 V, $V_{DS}$ = 0 V | | $I_{GSS1}$ | | ±100 | nA |
| $V_{GS}$ = ± 20 V, $V_{DS}$ = 0 V, $T_J$ = +125°C | | $I_{GSS2}$ | | ±200 | |
| Drain Current | | | | | |
| $V_{GS}$ = 0 V, $V_{DS}$ = 80 V | 2N7224 | $I_{DSS1}$ | | 25 | µA |
| $V_{GS}$ = 0 V, $V_{DS}$ = 160 V | 2N7225 | | | | |
| $V_{GS}$ = 0 V, $V_{DS}$ = 320 V | 2N7227 | | | | |
| $V_{GS}$ = 0 V, $V_{DS}$ = 400 V | 2N7228 | | | | |
| Drain Current | | | | | |
| $V_{GS}$ = 0 V, $V_{DS}$ = 80 V, $T_J$ = +125 °C | 2N7224 | $I_{DSS2}$ | | 0.25 | mA |
| $V_{GS}$ = 0 V, $V_{DS}$ = 160 V, $T_J$ = +125 °C | 2N7225 | | | | |
| $V_{GS}$ = 0 V, $V_{DS}$ = 320 V, $T_J$ = +125 °C | 2N7227 | | | | |
| $V_{GS}$ = 0 V, $V_{DS}$ = 400 V, $T_J$ = +125 °C | 2N7228 | | | | |
| Static Drain-Source On-State Resistance | | | | | |
| $V_{GS}$ = 10 V, $I_D$ = 21.0 A pulsed | 2N7224 | $r_{DS(on)1}$ | | 0.070 | Ω |
| $V_{GS}$ = 10 V, $I_D$ = 17.0 A pulsed | 2N7225 | | | 0.100 | |
| $V_{GS}$ = 10 V, $I_D$ = 9.0 A pulsed | 2N7227 | | | 0.315 | |
| $V_{GS}$ = 10 V, $I_D$ = 8.0 A pulsed | 2N7228 | | | 0.415 | |
| Static Drain-Source On-State Resistance | | | | | |
| $V_{GS}$ = 10 V, $I_D$ = 34.0 A pulsed | 2N7224 | $r_{DS(on)2}$ | | 0.081 | Ω |
| $V_{GS}$ = 10 V, $I_D$ = 27.4 A pulsed | 2N7225 | | | 0.105 | |
| $V_{GS}$ = 10 V, $I_D$ = 14.0 A pulsed | 2N7227 | | | 0.415 | |
| $V_{GS}$ = 10 V, $I_D$ = 12.0 A pulsed | 2N7228 | | | 0.515 | |
| Static Drain-Source On-State Resistance | | | | | |
| $T_J$ = +125°C | | | | | |
| $V_{GS}$ = 10 V, $I_D$ = 21.0 A pulsed | 2N7224 | $r_{DS(on)3}$ | | 0.11 | Ω |
| $V_{GS}$ = 10 V, $I_D$ = 17.0 A pulsed | 2N7225 | | | 0.17 | |
| $V_{GS}$ = 10 V, $I_D$ = 9.0 A pulsed | 2N7227 | | | 0.68 | |
| $V_{GS}$ = 10 V, $I_D$ = 8.0 A pulsed | 2N7228 | | | 0.90 | |
| Diode Forward Voltage | | | | | |
| $V_{GS}$ = 0 V, $I_D$ = 34.0 A pulsed | 2N7224 | $V_{SD}$ | | 1.8 | V |
| $V_{GS}$ = 0 V, $I_D$ = 27.4 A pulsed | 2N7225 | | | 1.9 | |
| $V_{GS}$ = 0 V, $I_D$ = 14.0 A pulsed | 2N7227 | | | 1.7 | |
| $V_{GS}$ = 0 V, $I_D$ = 12.0 A pulsed | 2N7228 | | | 1.7 | |

**ELECTRICAL CHARACTERISTICS** @ $T_A$ = +25 °C, unless otherwise noted (continued)

## DYNAMIC CHARACTERISTICS

| Parameters / Test Conditions | | Symbol | Min. | Max. | Unit |
|---|---|---|---|---|---|
| Gate Charge: | | | | | |
| On-State Gate Charge | | $Q_{g(on)}$ | | | nC |
| $V_{GS}$ = 10 V, $I_D$ = 34.0 A, $V_{DS}$ = 50 V | 2N7224 | | | 125 | |
| $V_{GS}$ = 10 V, $I_D$ = 27.4 A, $V_{DS}$ = 50 V | 2N7225 | | | 115 | |
| $V_{GS}$ = 10 V, $I_D$ = 14.0 A, $V_{DS}$ = 50 V | 2N7227 | | | 110 | |
| $V_{GS}$ = 10 V, $I_D$ = 12.0 A, $V_{DS}$ = 50 V | 2N7228 | | | 120 | |
| Gate to Source Charge | | $Q_{gs}$ | | | nC |
| $V_{GS}$ = 10 V, $I_D$ = 34.0 A, $V_{DS}$ = 50 V | 2N7224 | | | 22 | |
| $V_{GS}$ = 10 V, $I_D$ = 27.4 A, $V_{DS}$ = 50 V | 2N7225 | | | 22 | |
| $V_{GS}$ = 10 V, $I_D$ = 14.0 A, $V_{DS}$ = 50 V | 2N7227 | | | 18 | |
| $V_{GS}$ = 10 V, $I_D$ = 12.0 A, $V_{DS}$ = 50 V | 2N7228 | | | 19 | |
| Gate to Drain Charge | | $Q_{gd}$ | | | nC |
| $V_{GS}$ = 10 V, $I_D$ = 34.0 A, $V_{DS}$ = 50 V | 2N7224 | | | 65 | |
| $V_{GS}$ = 10 V, $I_D$ = 27.4 A, $V_{DS}$ = 50 V | 2N7225 | | | 60 | |
| $V_{GS}$ = 10 V, $I_D$ = 14.0 A, $V_{DS}$ = 50 V | 2N7227 | | | 65 | |
| $V_{GS}$ = 10 V, $I_D$ = 12.0 A, $V_{DS}$ = 50 V | 2N7228 | | | 70 | |

## SWITCHING CHARACTERISTICS

| Parameters / Test Conditions | | Symbol | Min. | Max. | Unit |
|---|---|---|---|---|---|
| Turn-on delay time | | $t_{d(on)}$ | | 35 | ns |
| $I_D$ = 34.0 A, $V_{GS}$ = 10 V, $R_G$ = 2.35 Ω, $V_{DD}$ = 50 V | 2N7224 | | | | |
| $I_D$ = 27.4 A, $V_{GS}$ = 10 V, $R_G$ = 2.35 Ω, $V_{DD}$ = 100 V | 2N7225 | | | | |
| $I_D$ = 14.0 A, $V_{GS}$ = 10 V, $R_G$ = 2.35 Ω, $V_{DD}$ = 200 V | 2N7227 | | | | |
| $I_D$ = 12.0 A, $V_{GS}$ = 10 V, $R_G$ = 2.35 Ω, $V_{DD}$ = 250 V | 2N7228 | | | | |
| Rinse time | | $t_r$ | | 190 | ns |
| $I_D$ = 34.0 A, $V_{GS}$ = 10 V, $R_G$ = 2.35 Ω, $V_{DD}$ = 50 V | 2N7224 | | | | |
| $I_D$ = 27.4 A, $V_{GS}$ = 10 V, $R_G$ = 2.35 Ω, $V_{DD}$ = 100 V | 2N7225 | | | | |
| $I_D$ = 14.0 A, $V_{GS}$ = 10 V, $R_G$ = 2.35 Ω, $V_{DD}$ = 200 V | 2N7227 | | | | |
| $I_D$ = 12.0 A, $V_{GS}$ = 10 V, $R_G$ = 2.35 Ω, $V_{DD}$ = 250 V | 2N7228 | | | | |
| Turn-off delay time | | $t_{d(off)}$ | | 170 | ns |
| $I_D$ = 34.0 A, $V_{GS}$ = 10 V, $R_G$ = 2.35 Ω, $V_{DD}$ = 50 V | 2N7224 | | | | |
| $I_D$ = 27.4 A, $V_{GS}$ = 10 V, $R_G$ = 2.35 Ω, $V_{DD}$ = 100 V | 2N7225 | | | | |
| $I_D$ = 14.0 A, $V_{GS}$ = 10 V, $R_G$ = 2.35 Ω, $V_{DD}$ = 200 V | 2N7227 | | | | |
| $I_D$ = 12.0 A, $V_{GS}$ = 10 V, $R_G$ = 2.35 Ω, $V_{DD}$ = 250 V | 2N7228 | | | | |
| Fall time | | $t_f$ | | 130 | ns |
| $I_D$ = 34.0 A, $V_{GS}$ = 10 V, $R_G$ = 2.35 Ω, $V_{DD}$ = 50 V | 2N7224 | | | | |
| $I_D$ = 27.4 A, $V_{GS}$ = 10 V, $R_G$ = 2.35 Ω, $V_{DD}$ = 100 V | 2N7225 | | | | |
| $I_D$ = 14.0 A, $V_{GS}$ = 10 V, $R_G$ = 2.35 Ω, $V_{DD}$ = 200 V | 2N7227 | | | | |
| $I_D$ = 12.0 A, $V_{GS}$ = 10 V, $R_G$ = 2.35 Ω, $V_{DD}$ = 250 V | 2N7228 | | | | |
| Diode Reverse Recovery Time | | $t_{rr}$ | | | ns |
| di/dt ≤ 100 A/µs, $V_{DD}$ ≤ 30 V, $I_F$ = 34.0 A | 2N7224 | | | 500 | |
| di/dt ≤ 100 A/µs, $V_{DD}$ ≤ 30 V, $I_F$ = 27.4 A | 2N7225 | | | 950 | |
| di/dt ≤ 100 A/µs, $V_{DD}$ ≤ 30 V, $I_F$ = 14.0 A | 2N7227 | | | 1200 | |
| di/dt ≤ 100 A/µs, $V_{DD}$ ≤ 30 V, $I_F$ = 12.0 A | 2N7228 | | | 1600 | |

## GRAPHS

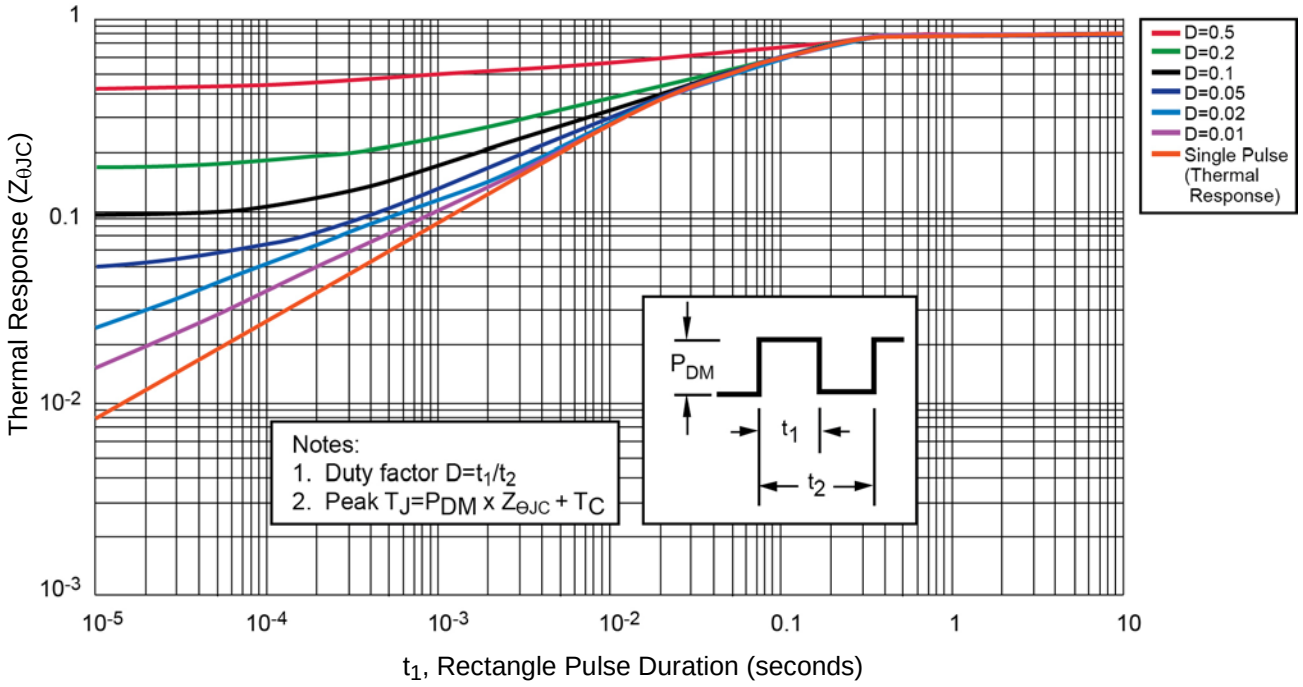
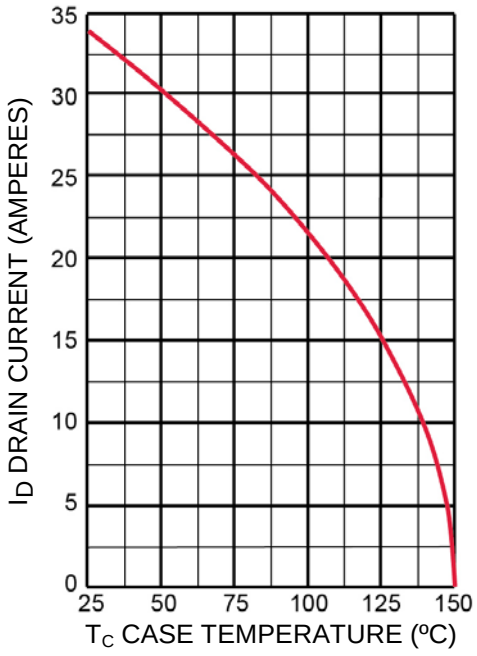


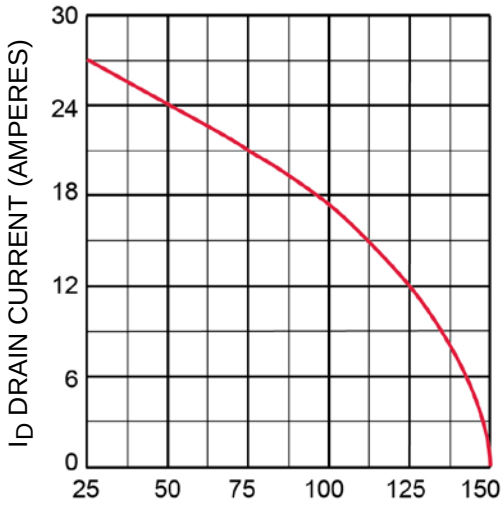

**FIGURE 1**
Thermal Impedance Curves

## GRAPHS (continued)

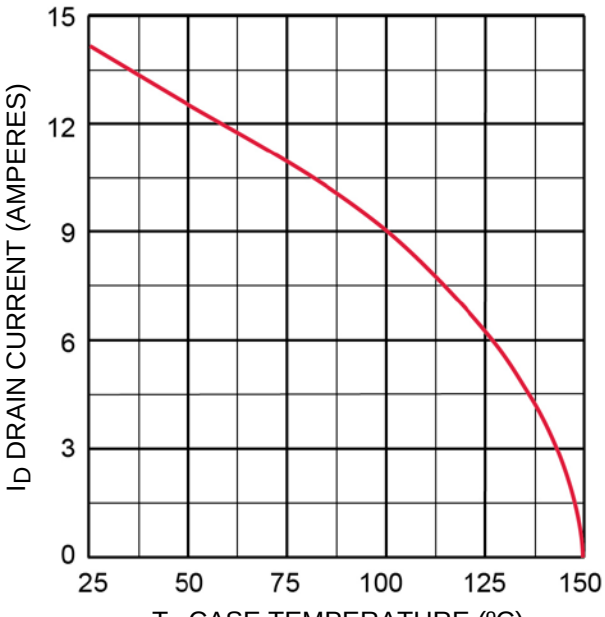
**FIGURE 2** – Maximum Drain Current vs Case Temperature Graphs



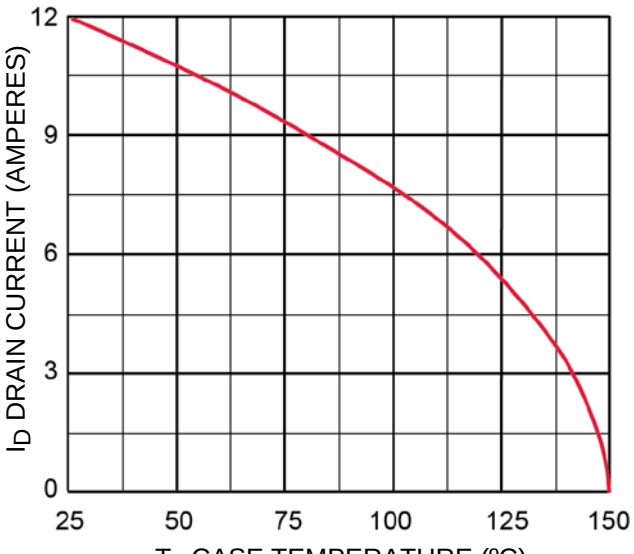

For 2N7224




For 2N7225



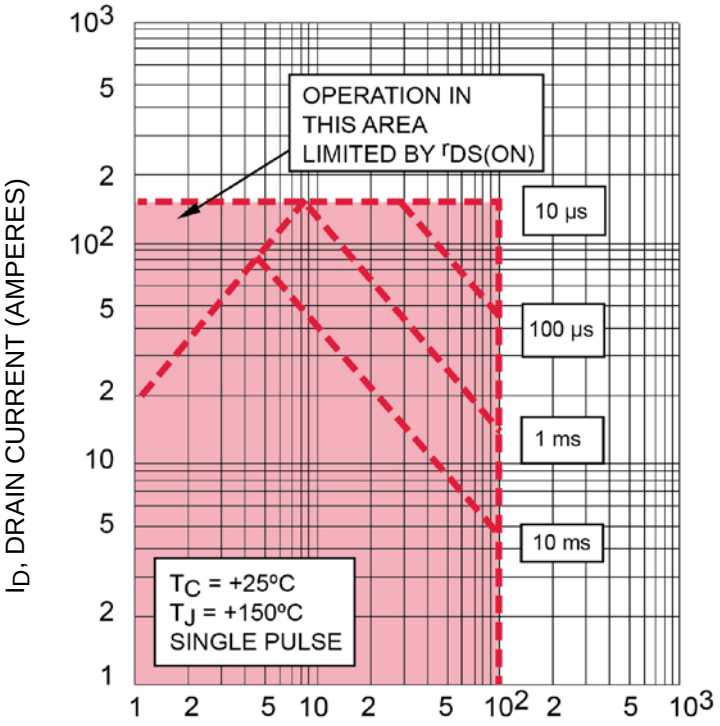

For 2N7227

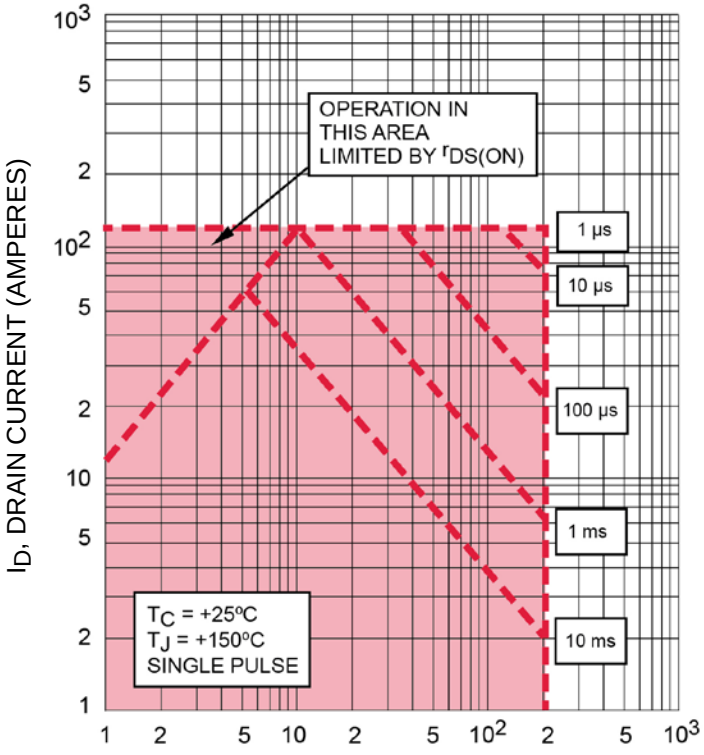



For 2N7228

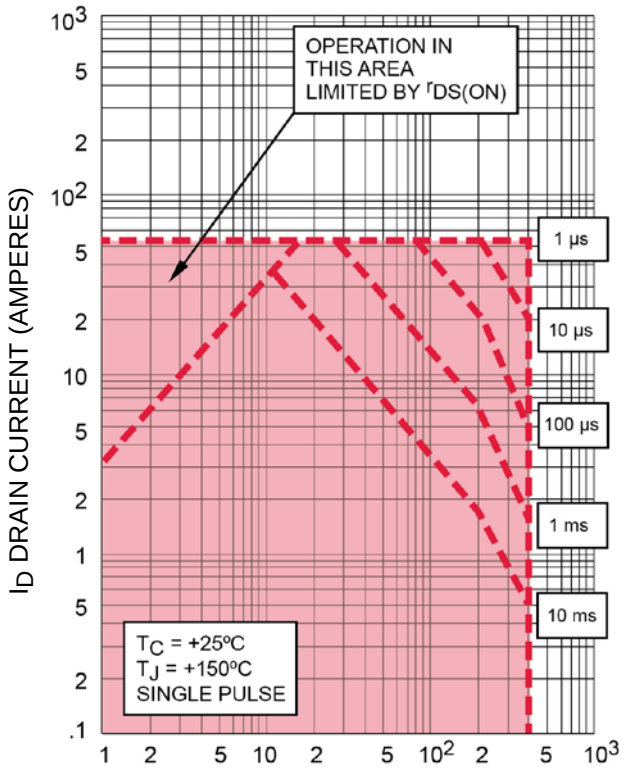
## GRAPHS (continued)

**FIGURE 3** – Maximum Safe Operating Area

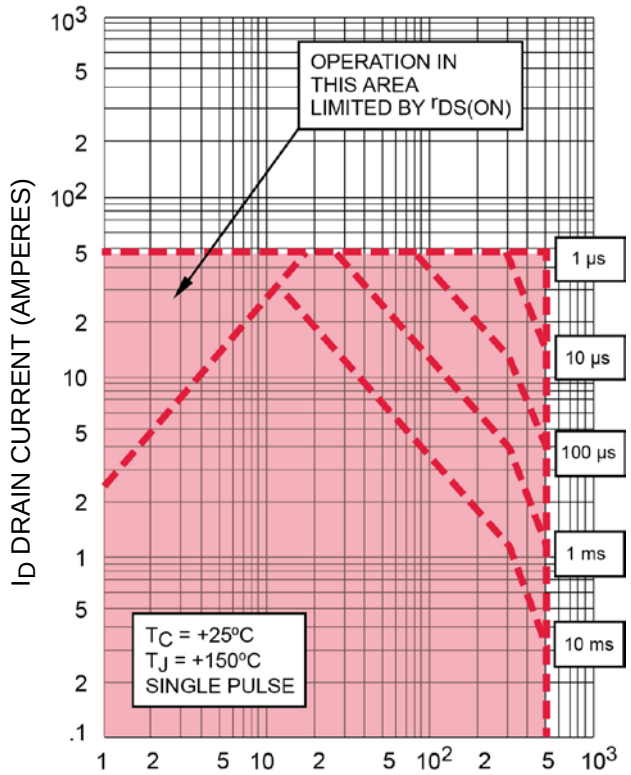


## GRAPHS (continued)

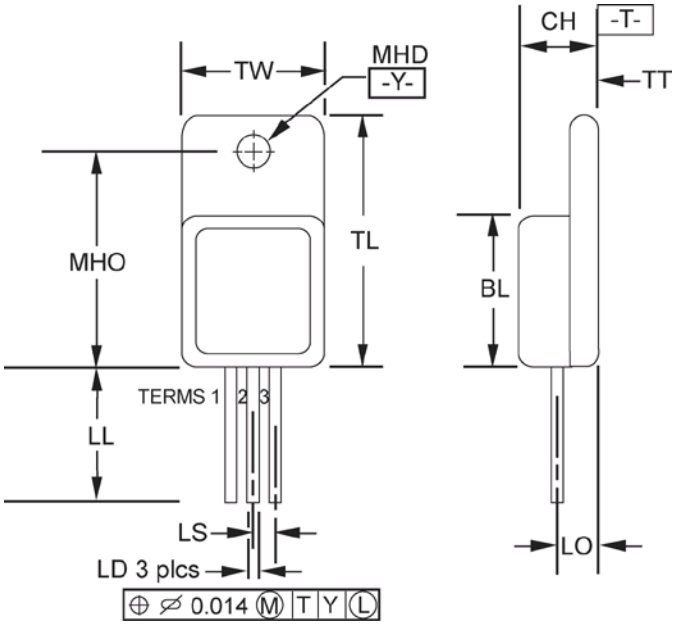



$V_{DS}$, DRAIN-TO-SOURCE VOLTAGE (VOLTS) for 2N7227




$V_{DS}$, DRAIN-TO-SOURCE VOLTAGE (VOLTS) for 2N7228

## PACKAGE DIMENSIONS




**NOTES:**

1. Dimensions are in inches.
2. Millimeters are given for general information only.
3. Glass meniscus included in dimension D and E.
4. All terminals are isolated from case.
5. In accordance with ASME Y14.5M, diameters are equivalent to Φx symbology.

| Ltr | Dimensions | | | | Notes |
|---|---|---|---|---|---|
| | Inch | | Millimeters | | |
| | Min | Max | Min | Max | |
| **BL** | .535 | .545 | 13.59 | 13.84 | |
| **CH** | .249 | .260 | 6.32 | 6.60 | |
| **LD** | .035 | .045 | 0.89 | 1.14 | |
| **LL** | .510 | .570 | 12.95 | 14.48 | |
| **LO** | .150 BSC | | 3.81 BSC | | |
| **LS** | .150 BSC | | 3.81 BSC | | |
| **MHD** | .139 | .149 | 3.53 | 3.78 | |
| **MHO** | .665 | .685 | 16.89 | 17.40 | |
| **TL** | .790 | .800 | 20.07 | 20.32 | 3, 4 |
| **TT** | .040 | .050 | 1.02 | 1.27 | |
| **TW** | .535 | .545 | 13.59 | 13.84 | 3, 4 |
| **Term 1** | Drain | | | | |
| **Term 2** | Source | | | | |
| **Term 3** | Gate | | | | |