

N-Channel 60 V (D-S) MOSFET

| PRODUCT SUMMARY | | | |
|---------------------|----------------------------------|---------------------------------|-----------------------|
| V _{DS} (V) | R _{DS(on)} (Ω) | I _D (A) ^a | Q _g (Typ.) |
| 60 | 0.027 at V _{GS} = 10 V | 55 | 27.5 nC |
| | 0.029 at V _{GS} = 6 V | 55 | |
| | 0.030 at V _{GS} = 4.5 V | 50 | |

FEATURES

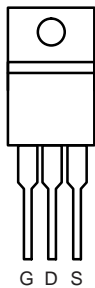
- DT-Trench Power MOSFET
- 100 % R_g and UIS Tested
- Low Q_g for High Efficiency



APPLICATIONS

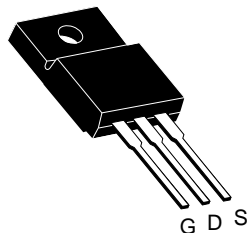
- Primary Side Switch
- POL
- Synchronous Rectifier
- DC/DC Converter
- Amusement System
- Industrial
- LED Backlighting

TO-220AB

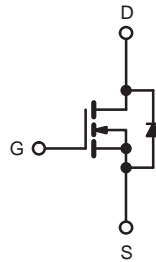


Top View

TO-220 FULLPAK



Top View



N-Channel MOSFET

| ABSOLUTE MAXIMUM RATINGS (T _A = 25 °C, unless otherwise noted) | | | |
|---|-----------------------------------|----------------------|------|
| Parameter | Symbol | Limit | Unit |
| Drain-Source Voltage | V _{DS} | 60 | V |
| Gate-Source Voltage | V _{GS} | ± 20 | |
| Continuous Drain Current (T _J = 150 °C) | T _C = 25 °C | 55 ^a | A |
| | T _C = 70 °C | 55 ^a | |
| | T _A = 25 °C | 35.8 ^{b, c} | |
| | T _A = 70 °C | 28.6 ^{b, c} | |
| Pulsed Drain Current (60 μs Pulse Width) | I _{DM} | 350 | |
| Continuous Source-Drain Diode Current | T _C = 25 °C | 55 ^a | |
| | T _A = 25 °C | 5.6 ^{b, c} | |
| Single Pulse Avalanche Current | I _{AS} | 40 | mJ |
| Single Pulse Avalanche Energy | E _{AS} | 80 | |
| Maximum Power Dissipation | T _C = 25 °C | 104 | W |
| | T _C = 70 °C | 66.6 | |
| | T _A = 25 °C | 6.25 ^{b, c} | |
| | T _A = 70 °C | 4 ^{b, c} | |
| Operating Junction and Storage Temperature Range | T _J , T _{stg} | - 55 to 150 | °C |
| Soldering Recommendations (Peak Temperature) | | 260 | |

| THERMAL RESISTANCE RATINGS | | | | | |
|----------------------------------|--------------|-------------------|---------|---------|------|
| Parameter | | Symbol | Typical | Maximum | Unit |
| Maximum Junction-to-Ambient | t ≤ 10 s | R _{thJA} | 15 | 20 | °C/W |
| Maximum Junction-to-Case (Drain) | Steady State | R _{thJC} | 0.9 | 1.2 | |

Notes:

a. Package limited.

b. Surface mounted on 1" x 1" FR4 board.

c. t = 10 s.

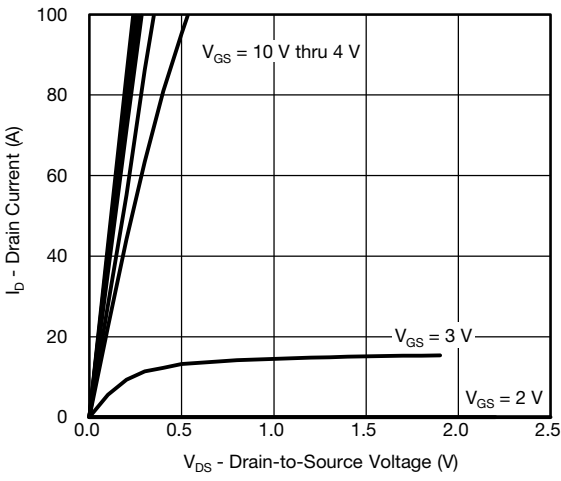
| SPECIFICATIONS ($T_J = 25\text{ }^\circ\text{C}$, unless otherwise noted) | | | | | | |
|--|-------------------------|---|--------------------|-------|-----------|---------------|
| Parameter | Symbol | Test Conditions | Min. | Typ. | Max. | Unit |
| Static | | | | | | |
| Drain-Source Breakdown Voltage | V_{DS} | $V_{GS} = 0\text{ V}, I_D = 250\text{ }\mu\text{A}$ | 60 | | | V |
| $V_{GS(th)}$ Temperature Coefficient | $\Delta V_{GS(th)}/T_J$ | $I_D = 250\text{ }\mu\text{A}$ | | - 6 | | mV/°C |
| Gate-Source Threshold Voltage | $V_{GS(th)}$ | $V_{DS} = V_{GS}, I_D = 250\text{ }\mu\text{A}$ | 1 | | 3 | V |
| Gate-Source Leakage | I_{GSS} | $V_{DS} = 0\text{ V}, V_{GS} = \pm 20\text{ V}$ | | | ± 100 | nA |
| Zero Gate Voltage Drain Current | I_{DSS} | $V_{DS} = 60\text{ V}, V_{GS} = 0\text{ V}$ | | | 1 | μA |
| | | $V_{DS} = 60\text{ V}, V_{GS} = 0\text{ V}, T_J = 55\text{ }^\circ\text{C}$ | | | 10 | |
| On-State Drain Current ^a | $I_{D(on)}$ | $V_{DS} \geq 5\text{ V}, V_{GS} = 10\text{ V}$ | 30 | | | A |
| Drain-Source On-State Resistance ^a | $R_{DS(on)}$ | $V_{GS} = 10\text{ V}, I_D = 20\text{ A}$ | | 0.027 | 0.030 | Ω |
| | | $V_{GS} = 6\text{ V}, I_D = 20\text{ A}$ | | 0.029 | 0.032 | |
| | | $V_{GS} = 4.5\text{ V}, I_D = 20\text{ A}$ | | 0.030 | 0.034 | |
| Forward Transconductance ^a | g_{fs} | $V_{DS} = 15\text{ V}, I_D = 20\text{ A}$ | | 82 | | S |
| Dynamic^b | | | | | | |
| Input Capacitance | C_{iss} | $V_{DS} = 30\text{ V}, V_{GS} = 0\text{ V}, f = 1\text{ MHz}$ | | 1475 | | μF |
| Output Capacitance | C_{oss} | | | 305 | | |
| Reverse Transfer Capacitance | C_{rss} | | | 77 | | |
| Total Gate Charge | Q_g | $V_{DS} = 30\text{ V}, V_{GS} = 10\text{ V}, I_D = 20\text{ A}$ | | 63.5 | 96 | nC |
| | | | | 27.5 | 42 | |
| Gate-Source Charge | Q_{gs} | $V_{DS} = 30\text{ V}, V_{GS} = 4.5\text{ V}, I_D = 20\text{ A}$ | | 12 | | nC |
| Gate-Drain Charge | Q_{gd} | | | 5.9 | | |
| Gate Resistance | R_g | | $f = 1\text{ MHz}$ | 0.4 | 1.2 | |
| Turn-On Delay Time | $t_{d(on)}$ | $V_{DD} = 30\text{ V}, R_L = 3\text{ }\Omega$ $I_D \cong 10\text{ A}, V_{GEN} = 10\text{ V}, R_g = 1\text{ }\Omega$ | | 14 | 28 | ns |
| Rise Time | t_r | | | 11 | 22 | |
| Turn-Off Delay Time | $t_{d(off)}$ | | | 33 | 60 | |
| Fall Time | t_f | | | 11 | 22 | |
| Turn-On Delay Time | $t_{d(on)}$ | $V_{DD} = 30\text{ V}, R_L = 3\text{ }\Omega$ $I_D \cong 10\text{ A}, V_{GEN} = 4.5\text{ V}, R_g = 1\text{ }\Omega$ | | 47 | 90 | ns |
| Rise Time | t_r | | | 97 | 180 | |
| Turn-Off Delay Time | $t_{d(off)}$ | | | 32 | 60 | |
| Fall Time | t_f | | | 13 | 26 | |
| Drain-Source Body Diode Characteristics | | | | | | |
| Continuous Source-Drain Diode Current | I_S | $T_C = 25\text{ }^\circ\text{C}$ | | | 60 | A |
| Pulse Diode Forward Current ^a | I_{SM} | | | | 100 | |
| Body Diode Voltage | V_{SD} | $I_S = 5\text{ A}$ | | 0.73 | 1.1 | V |
| Body Diode Reverse Recovery Time | t_{rr} | $I_F = 10\text{ A}, di/dt = 100\text{ A}/\mu\text{s}, T_J = 25\text{ }^\circ\text{C}$ | | 79 | 120 | ns |
| Body Diode Reverse Recovery Charge | Q_{rr} | | | 88 | 135 | nC |
| Reverse Recovery Fall Time | t_a | | | 32 | | ns |
| Reverse Recovery Rise Time | t_b | | | 47 | | |

Notes:

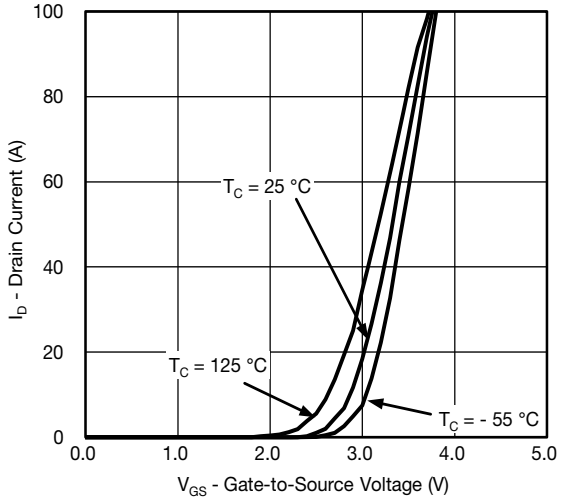
- Pulse test; pulse width $\leq 300\text{ }\mu\text{s}$, duty cycle $\leq 2\%$.
- Guaranteed by design, not subject to production testing.

Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

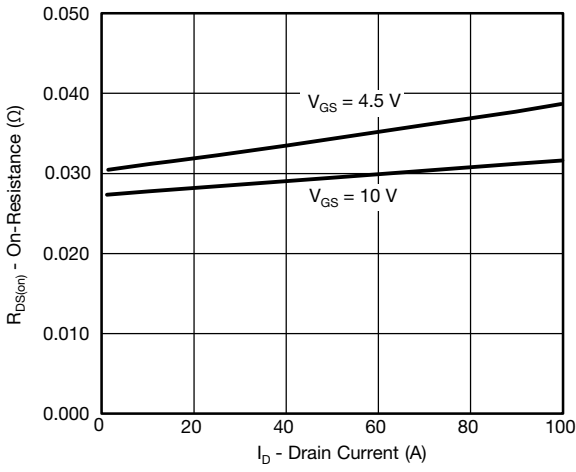
TYPICAL CHARACTERISTICS (25 °C, unless otherwise noted)



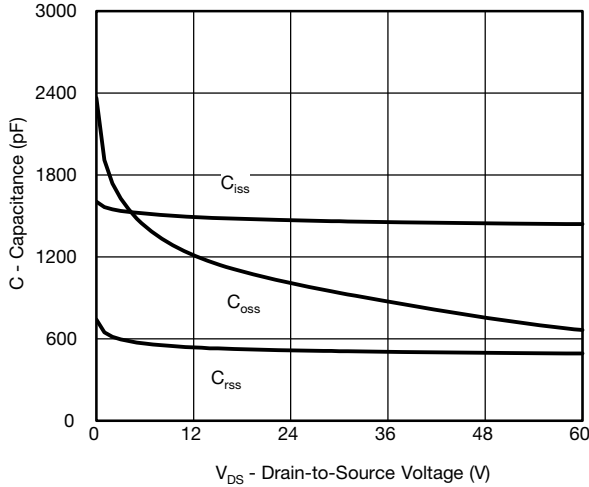
Output Characteristics



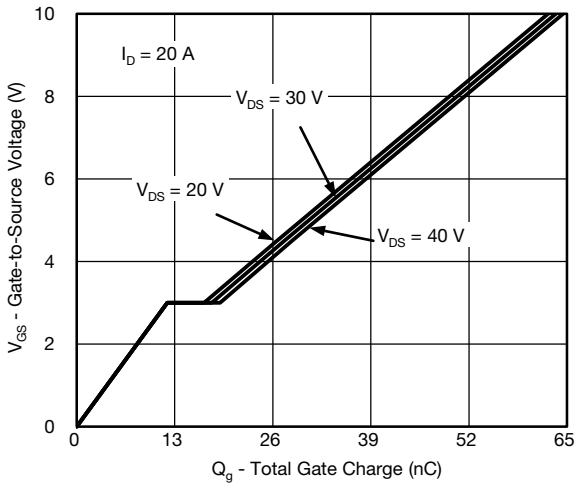
Transfer Characteristics



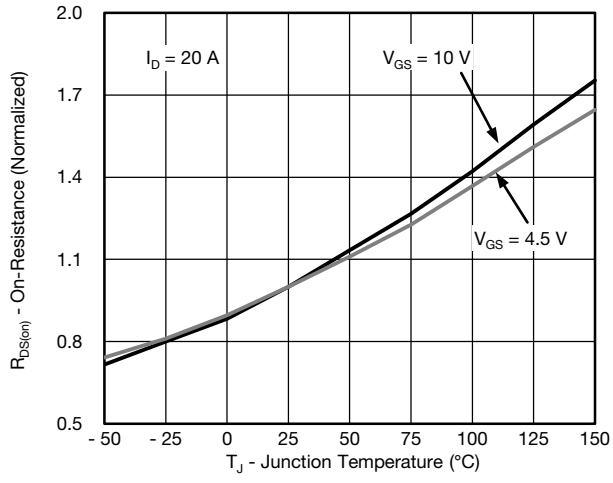
On-Resistance vs. Drain Current and Gate Voltage



Capacitance

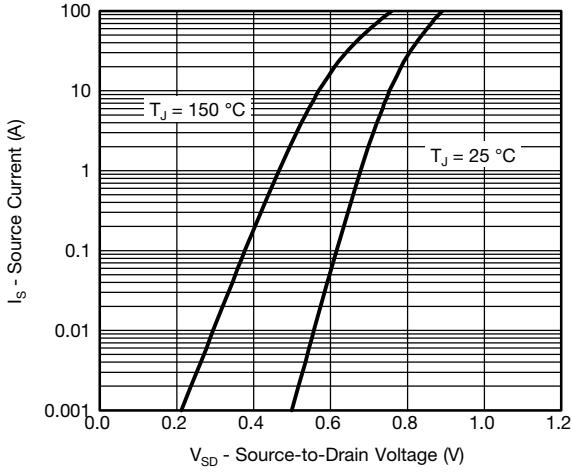


Gate Charge

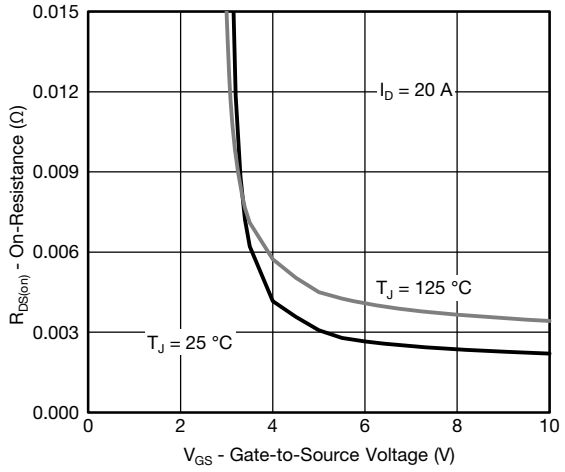


On-Resistance vs. Junction Temperature

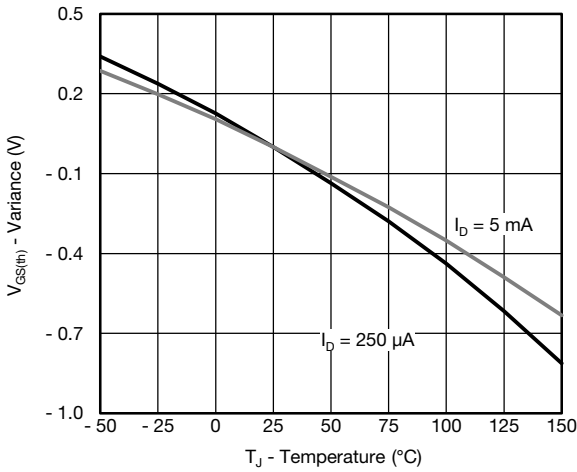
TYPICAL CHARACTERISTICS (25 °C, unless otherwise noted)



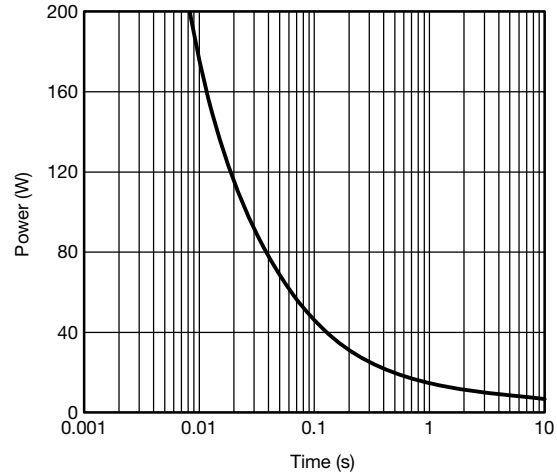
Source-Drain Diode Forward Voltage



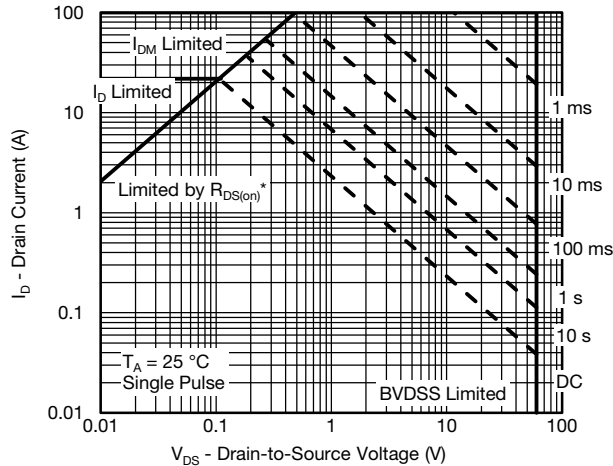
On-Resistance vs. Gate-to-Source Voltage



Threshold Voltage

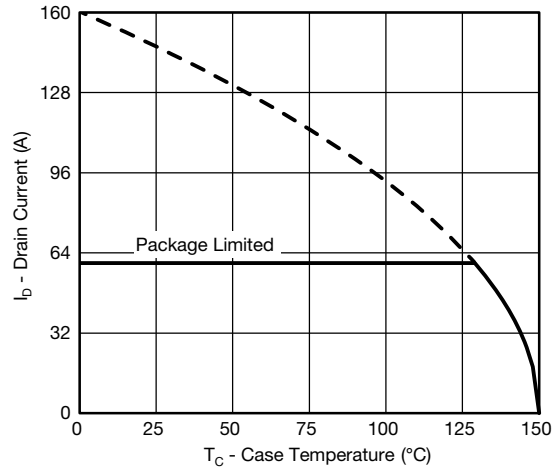


Single Pulse Power, Junction-to-Ambient

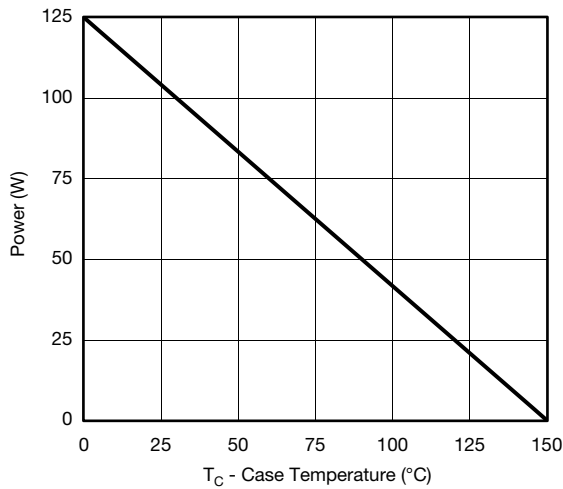


Safe Operating Area, Junction-to-Ambient
* $V_{GS} >$ minimum V_{GS} at which $R_{DS(on)}$ is specified

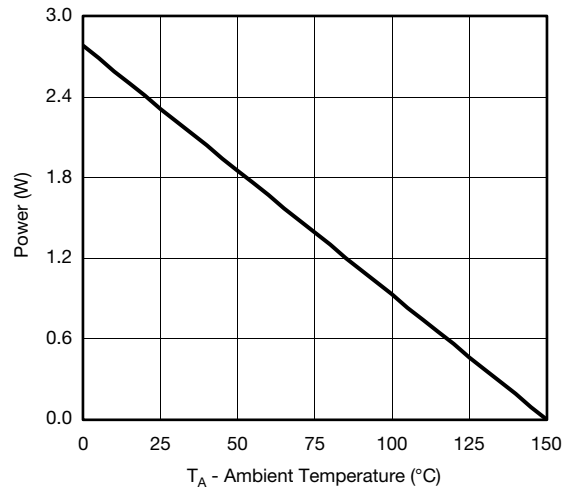
TYPICAL CHARACTERISTICS (25 °C, unless otherwise noted)



Current Derating*



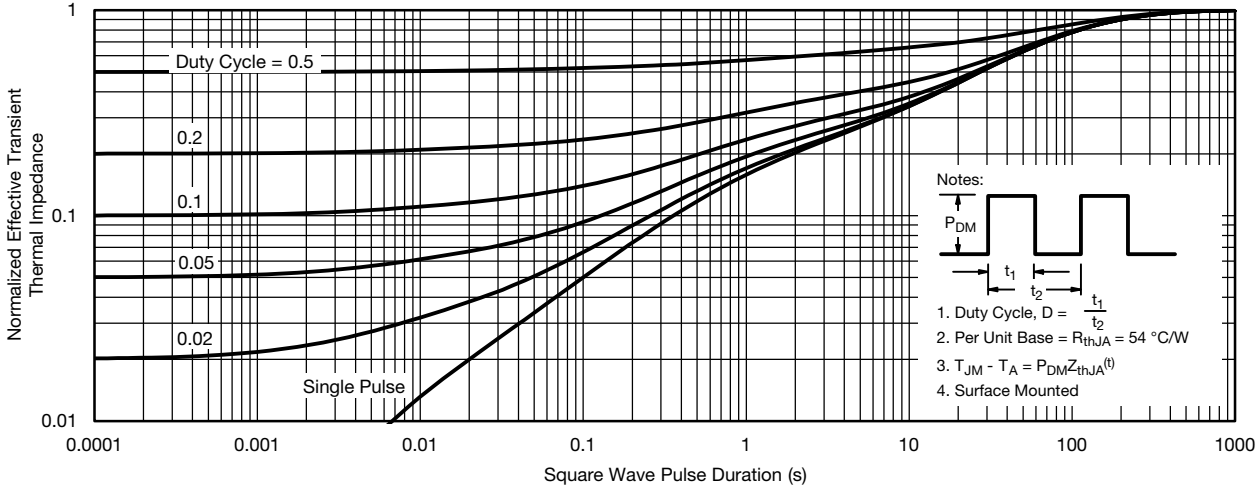
Power, Junction-to-Case



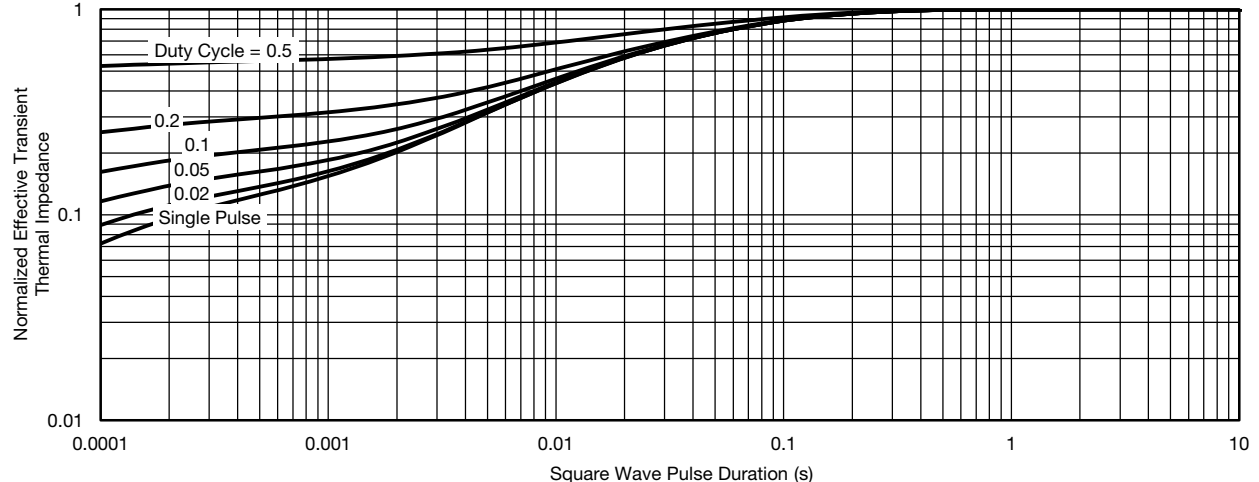
Power, Junction-to-Ambient

* The power dissipation P_D is based on T_{J(max.)} = 150 °C, using junction-to-case thermal resistance, and is more useful in settling the upper dissipation limit for cases where additional heatsinking is used. It is used to determine the current rating, when this rating falls below the package limit.

TYPICAL CHARACTERISTICS (25 °C, unless otherwise noted)



Normalized Thermal Transient Impedance, Junction-to-Ambient



Normalized Thermal Transient Impedance, Junction-to-Case

TO-220AB



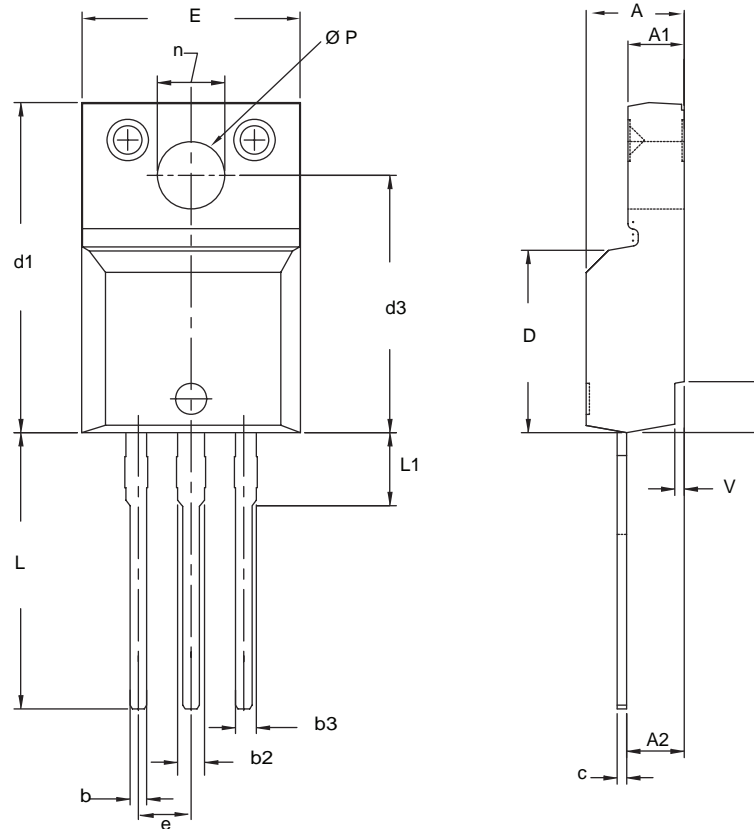
| DIM. | MILLIMETERS | | INCHES | |
|------|-------------|-------|--------|-------|
| | MIN. | MAX. | MIN. | MAX. |
| A | 4.25 | 4.65 | 0.167 | 0.183 |
| b | 0.69 | 1.01 | 0.027 | 0.040 |
| b(1) | 1.20 | 1.73 | 0.047 | 0.068 |
| c | 0.36 | 0.61 | 0.014 | 0.024 |
| D | 14.85 | 15.49 | 0.585 | 0.610 |
| E | 10.04 | 10.51 | 0.395 | 0.414 |
| e | 2.41 | 2.67 | 0.095 | 0.105 |
| e(1) | 4.88 | 5.28 | 0.192 | 0.208 |
| F | 1.14 | 1.40 | 0.045 | 0.055 |
| H(1) | 6.09 | 6.48 | 0.240 | 0.255 |
| J(1) | 2.41 | 2.92 | 0.095 | 0.115 |
| L | 13.35 | 14.02 | 0.526 | 0.552 |
| L(1) | 3.32 | 3.82 | 0.131 | 0.150 |
| Ø P | 3.54 | 3.94 | 0.139 | 0.155 |
| Q | 2.60 | 3.00 | 0.102 | 0.118 |

ECN: X12-0208-Rev. N, 08-Oct-12
DWG: 5471

Notes

* M = 1.32 mm to 1.62 mm (dimension including protrusion)
Heatsink hole for HVM

TO-220 FULLPAK (HIGH VOLTAGE)



| DIM. | MILLIMETERS | | INCHES | |
|-----------------|-------------|--------|-----------|-------|
| | MIN. | MAX. | MIN. | MAX. |
| A | 4.570 | 4.830 | 0.180 | 0.190 |
| A1 | 2.570 | 2.830 | 0.101 | 0.111 |
| A2 | 2.510 | 2.850 | 0.099 | 0.112 |
| b | 0.622 | 0.890 | 0.024 | 0.035 |
| 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 |
| D | 8.650 | 9.800 | 0.341 | 0.386 |
| d1 | 15.88 | 16.120 | 0.622 | 0.635 |
| d3 | 12.300 | 12.920 | 0.484 | 0.509 |
| E | 10.360 | 10.630 | 0.408 | 0.419 |
| e | 2.54 BSC | | 0.100 BSC | |
| L | 13.200 | 13.730 | 0.520 | 0.541 |
| L1 | 3.100 | 3.500 | 0.122 | 0.138 |
| n | 6.050 | 6.150 | 0.238 | 0.242 |
| $\varnothing P$ | 3.050 | 3.450 | 0.120 | 0.136 |
| u | 2.400 | 2.500 | 0.094 | 0.098 |
| v | 0.400 | 0.500 | 0.016 | 0.020 |

ECN: X09-0126-Rev. B, 26-Oct-09
DWG: 5972

Notes

1. To be used only for process drawing.
2. These dimensions apply to all TO-220, FULLPAK leadframe versions 3 leads.
3. All critical dimensions should C meet $C_{pk} > 1.33$.
4. All dimensions include burrs and plating thickness.
5. No chipping or package damage.

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