# NTD20P06L

# Power MOSFET

## −60 V, −15.5 A, Single P−Channel, DPAK

### Features

- Withstands High Energy in Avalanche and Commutation Modes
- Low Gate Charge for Fast Switching
- These are Pb−Free Devices

### Applications

- Bridge Circuits
- Power Supplies, Power Motor Controls
- DC−DC Conversion

**MAXIMUM RATINGS** ($T_J$ = 25°C unless otherwise noted)

| Parameter | | | Symbol | Value | Unit |
|---|---|---|---|---|---|
| Drain−to−Source Voltage | | | $V_{DSS}$ | −60 | V |
| Gate−to−Source Voltage | Continuous | | $V_{GS}$ | ±20 | V |
| | Non−Repetitive | $t_p \le 10$ ms | $V_{GSM}$ | ±30 | |
| Continuous Drain Current (Note 1) | Steady State | $T_A$ = 25°C | $I_D$ | −15.5 | A |
| Power Dissipation (Note 1) | Steady State | $T_A$ = 25°C | $P_D$ | 65 | W |
| Pulsed Drain Current | $t_p$ = 10 μs | | $I_{DM}$ | ±50 | A |
| Operating Junction and Storage Temperature | | | $T_J$, $T_{STG}$ | −55 to 175 | °C |
| Single Pulse Drain−to−Source Avalanche Energy ($V_{DD}$ = 25 V, $V_{GS}$ = 5 V, $I_{PK}$ = 15 A, L = 2.7 mH, $R_G$ = 25 Ω) | | | $E_{AS}$ | 304 | mJ |
| Lead Temperature for Soldering Purposes (1/8" from case for 10 s) | | | $T_L$ | 260 | °C |

**THERMAL RESISTANCE RATINGS**

| Parameter | Symbol | Max | Unit |
|---|---|---|---|
| Junction−to−Case (Drain) | $R_{\theta JC}$ | 2.3 | °C/W |
| Junction−to−Ambient − Steady State (Note 1) | $R_{\theta JA}$ | 80 | |
| Junction−to−Ambient − Steady State (Note 2) | $R_{\theta JA}$ | 110 | |

Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

1. Surface−mounted on FR4 board using 1 in sq. pad size (Cu area = 1.127 in sq. [1 oz] including traces)
2. Surface−mounted on FR4 board using the minimum recommended pad size (Cu area = 0.412 in sq.)

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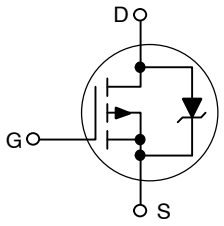
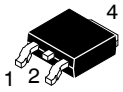
**http://onsemi.com**

| $V_{(BR)DSS}$ | $R_{DS(on)}$ TYP | $I_D$ MAX (Note 1) |
|---|---|---|
| −60 V | 130 mΩ @ −5.0 V | −15.5 A |

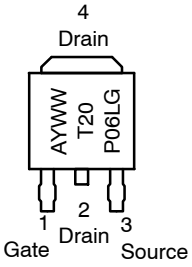
**P−Channel**

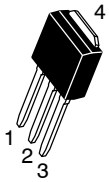



**MARKING DIAGRAMS**

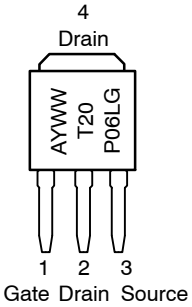



**DPAK**
**CASE 369C**
**STYLE 2**




**IPAK/DPAK**
**CASE 369D**
**STYLE 2**




| | |
|---|---|
| 20P06L | Device Code |
| A | = Assembly Location |
| Y | = Year |
| WW | = Work Week |
| G | = Pb−Free Package |

### ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 6 of this data sheet.

**ELECTRICAL CHARACTERISTICS** ($T_J$ = 25°C unless otherwise noted)

| Parameter | Symbol | Test Condition | | Min | Typ | Max | Units |
|---|---|---|---|---|---|---|---|
| **OFF CHARACTERISTICS** | | | | | | | |
| Drain−to−Source Breakdown Voltage | $V_{(BR)DSS}$ | $V_{GS}$ = 0 V, $I_D$ = −250 μA | | −60 | −74 | | V |
| Drain−to−Source Breakdown Voltage Temperature Coefficient | $V_{(BR)DSS}/T_J$ | | | | −64 | | mV/°C |
| Zero Gate Voltage Drain Current | $I_{DSS}$ | $V_{GS}$ = 0 V, $V_{DS}$ = −60 V | $T_J$ = 25°C | | | −1.0 | μA |
| | | | $T_J$ = 150°C | | | −10 | |
| Gate−to−Source Leakage Current | $I_{GSS}$ | $V_{DS}$ = 0 V, $V_{GS}$ = ±20 V | | | | ±100 | nA |
| **ON CHARACTERISTICS** (Note 3) | | | | | | | |
| Gate Threshold Voltage | $V_{GS(TH)}$ | $V_{GS}$ = $V_{DS}$, $I_D$ = −250 μA | | −1.0 | −1.5 | −2.0 | V |
| Gate Threshold Temperature Coefficient | $V_{GS(TH)}/T_J$ | | | | 3.1 | | mV/°C |
| Drain−to−Source On Resistance | $R_{DS(on)}$ | $V_{GS}$ = −5.0 V, $I_D$ = −7.5 A | | | 0.130 | 0.150 | Ω |
| | | $V_{GS}$ = −5.0 V, $I_D$ = −15 A | | | 0.143 | | |
| Forward Transconductance | $g_{FS}$ | $V_{DS}$ = −10 V, $I_D$ = −7.5 A | | | 11 | | S |
| Drain−to−Source On−Voltage | $V_{DS(on)}$ | $V_{GS}$ = −5.0 V, $I_D$ = −7.5 A | $T_J$ = 25°C | | | −1.2 | V |
| | | | $T_J$ = 150°C | | | −1.9 | |
| **CHARGES AND CAPACITANCES** | | | | | | | |
| Input Capacitance | $C_{ISS}$ | $V_{GS}$ = 0 V, f = 1 MHz, $V_{DS}$ = −25 V | | | 740 | 1190 | pF |
| Output Capacitance | $C_{OSS}$ | | | | 207 | 300 | |
| Reverse Transfer Capacitance | $C_{RSS}$ | | | | 66 | 120 | |
| Total Gate Charge | $Q_{G(TOT)}$ | $V_{GS}$ = −5.0 V, $V_{DS}$ = −48 V, $I_D$ = −18 A | | | 15 | 26 | nC |
| Gate−to−Source Charge | $Q_{GS}$ | | | | 4.0 | | |
| Gate−to−Drain Charge | $Q_{GD}$ | | | | 7.0 | | |
| **SWITCHING CHARACTERISTICS** (Note 4) | | | | | | | |
| Turn−On Delay Time | $t_{d(ON)}$ | $V_{GS}$ = −5.0 V, $V_{DD}$ = −30 V, $I_D$ = −15 A, $R_G$ = 9.1 Ω | | | 11 | 20 | ns |
| Rise Time | $t_r$ | | | | 90 | 180 | |
| Turn−Off Delay Time | $t_{d(OFF)}$ | | | | 28 | 50 | |
| Fall Time | $t_f$ | | | | 70 | 135 | |
| **DRAIN−SOURCE DIODE CHARACTERISTICS** | | | | | | | |
| Forward Diode Voltage | $V_{SD}$ | $V_{GS}$ = 0 V, $I_S$ = −15 A | $T_J$ = 25°C | | 1.5 | 2.5 | V |
| | | | $T_J$ = 150°C | | 1.3 | | |
| Reverse Recovery Time | $t_{RR}$ | $V_{GS}$ = 0 V, $d_{IS}/d_t$ = 100 A/μs, $I_S$ = −12 A | | | 60 | | ns |
| Charge Time | $t_a$ | | | | 39 | | |
| Discharge Time | $t_b$ | | | | 21 | | |
| Reverse Recovery Charge | $Q_{RR}$ | | | | 0.13 | | nC |

3. Pulse Test: pulse width ≤ 300 μs, duty cycle ≤ 2%
4. Switching characteristics are independent of operating junction temperatures

## TYPICAL PERFORMANCE CURVES

($T_J$ = 25°C unless otherwise noted)

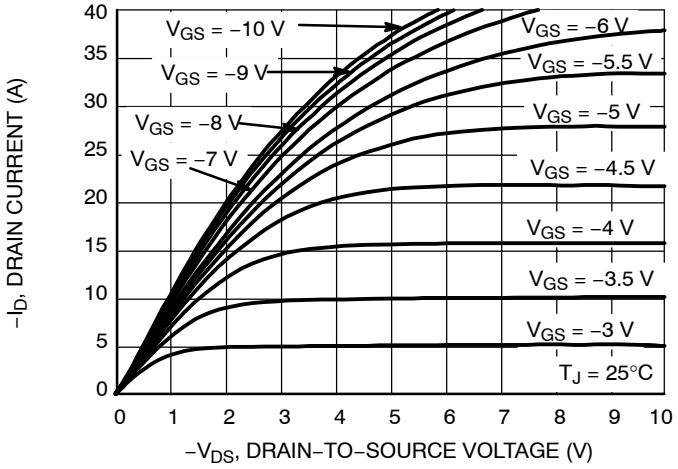



**Figure 1. On−Region Characteristics**

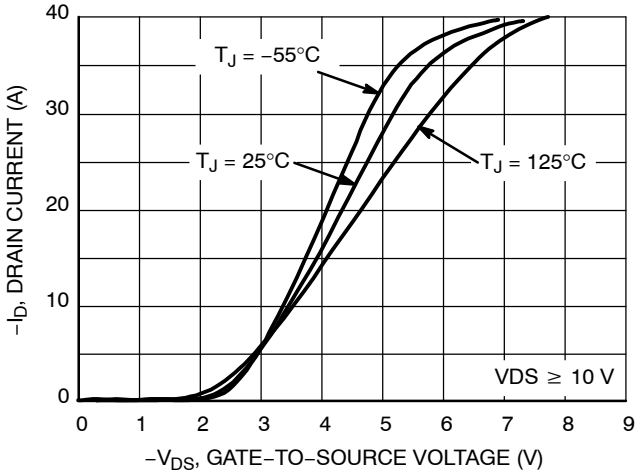



**Figure 2. Transfer Characteristics**

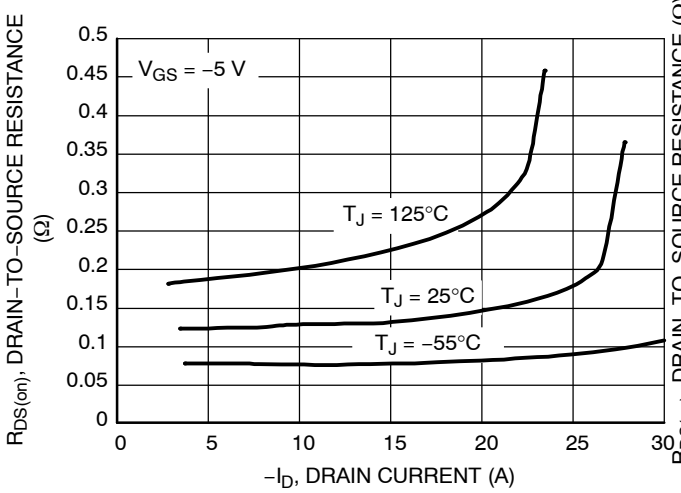



**Figure 3. On−Resistance versus Drain Current and Temperature**

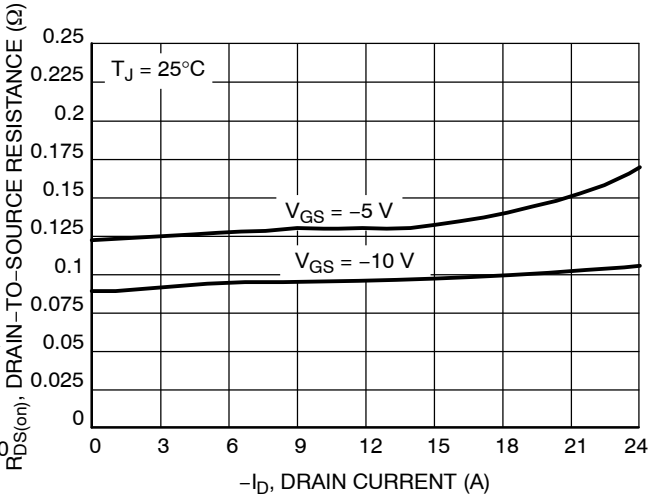



**Figure 4. On−Resistance versus Drain Current and Gate Voltage**

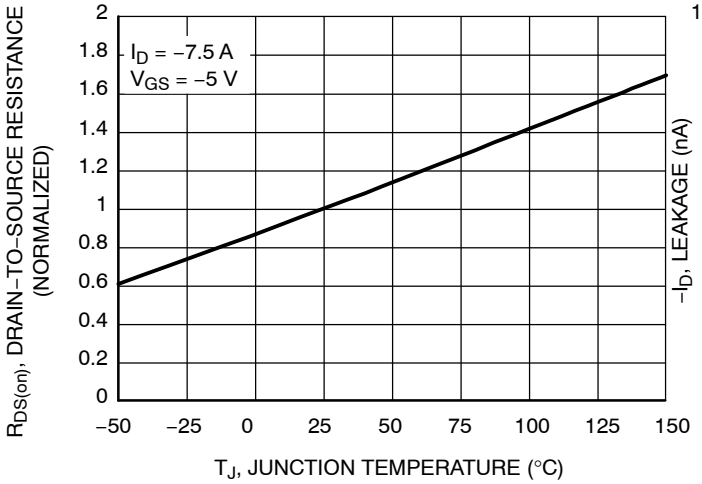



**Figure 5. On−Resistance Variation with Temperature**

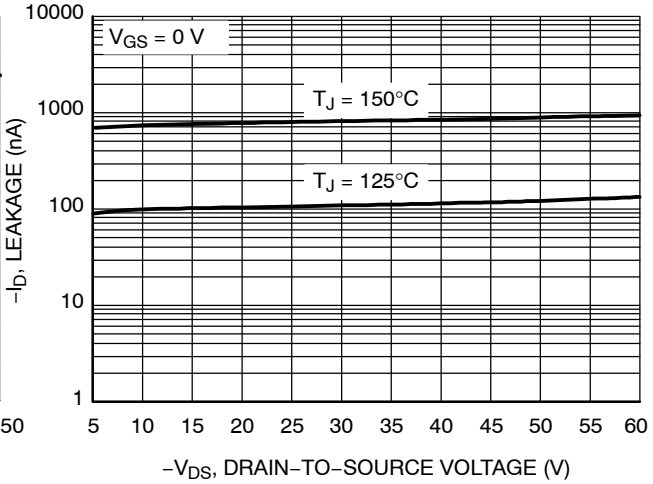



**Figure 6. Drain−to−Source Leakage Current versus Voltage**

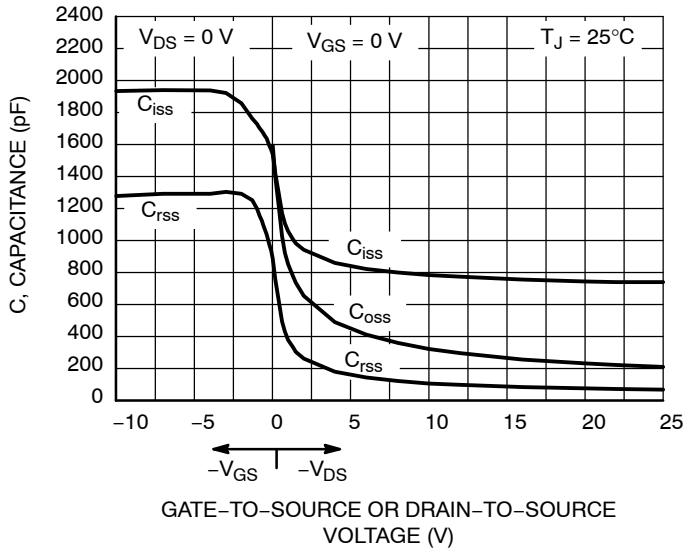



**Figure 7. Capacitance Variation**

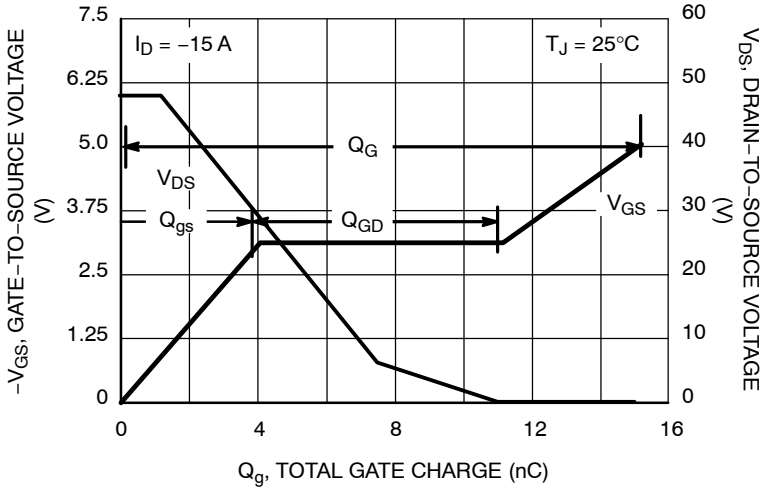



**Figure 8. Gate−to−Source and Drain−to−Source Voltage versus Total Charge**

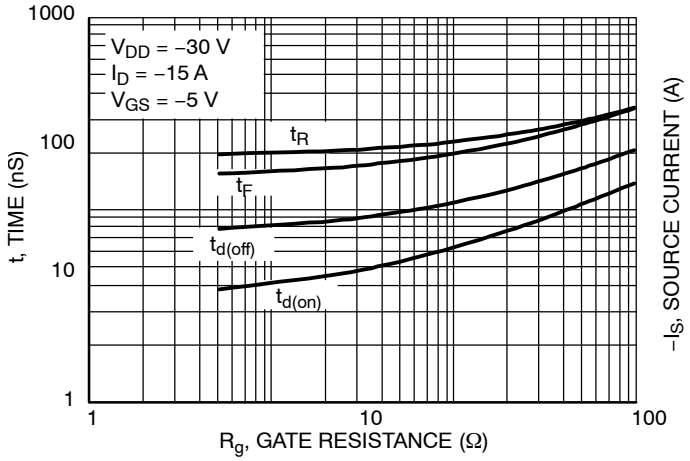



**Figure 9. Resistive Switching Time Variation versus Gate Resistance**

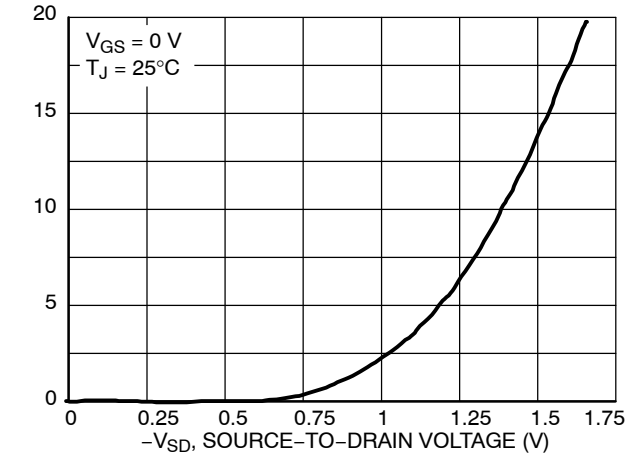



**Figure 10. Diode Forward Voltage versus Current**

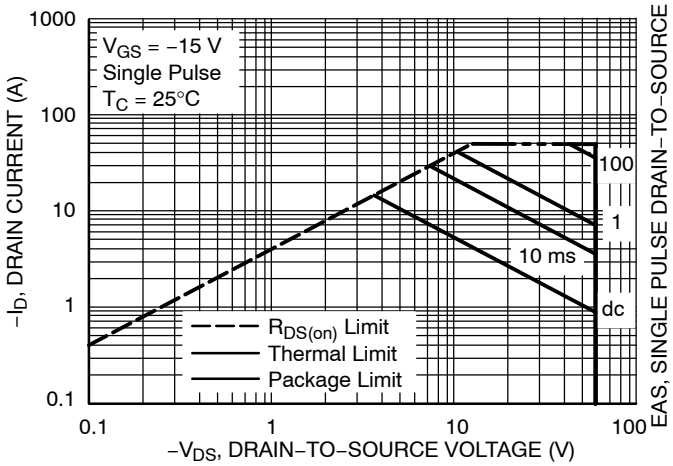



**Figure 11. Maximum Rated Forward Biased Safe Operating Area**

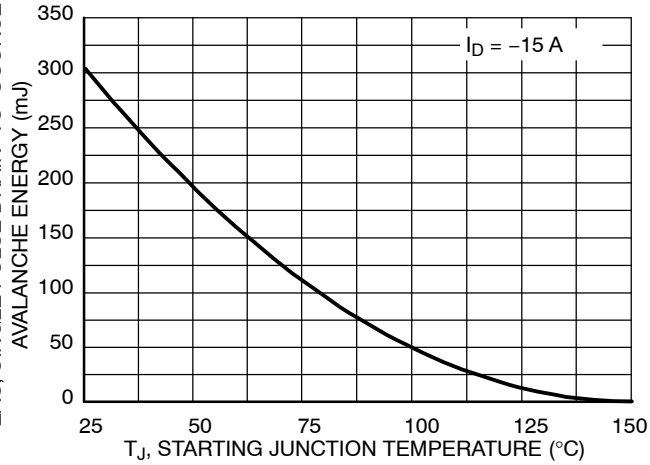



**Figure 12. Maximum Avalanche Energy versus Starting Junction Temperature**

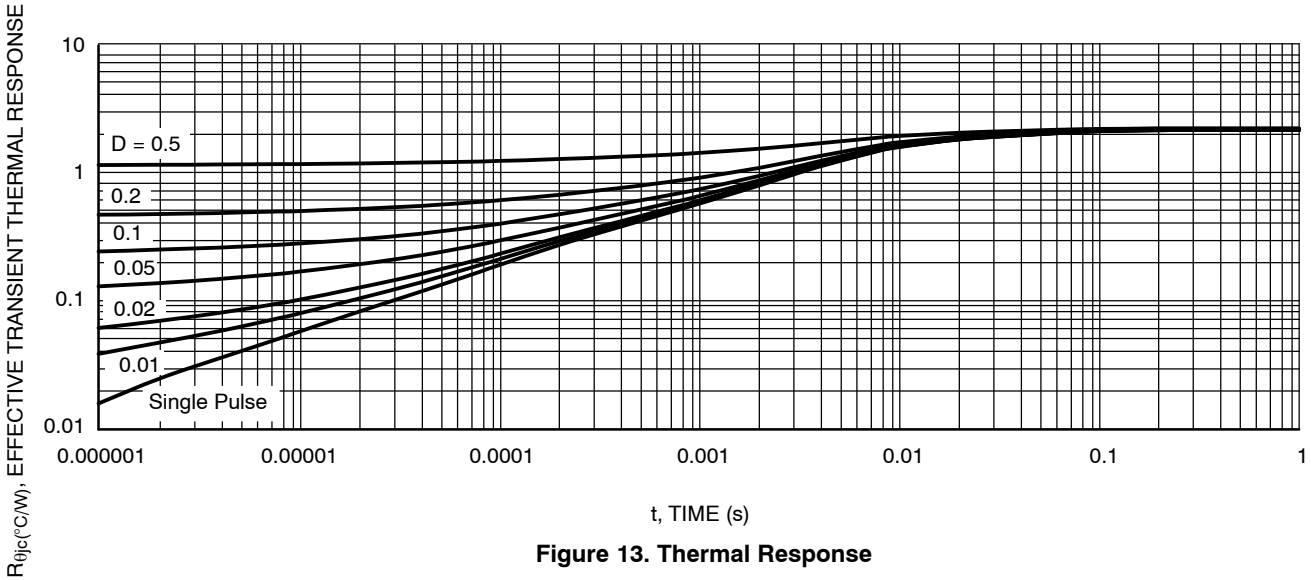



**Figure 13. Thermal Response**

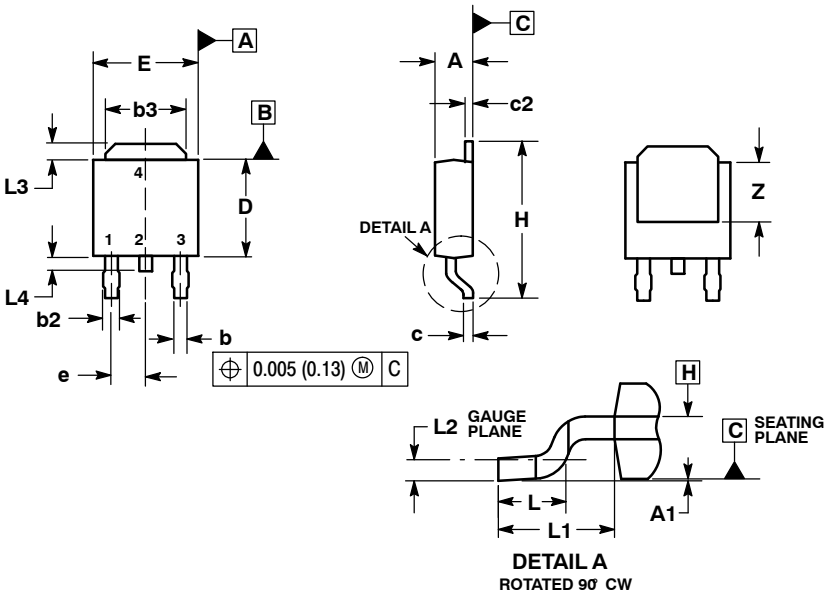
## ORDERING INFORMATION

| Device | Package | Shipping† |
|---|---|---|
| NTD20P06L−1G | DPAK (Pb−Free) | 75 Units / Rail |
| NTD20P06LG | | 75 Units / Rail |
| NTD20P06LT4G | | 2500 / Tape & Reel |

†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.

## PACKAGE DIMENSIONS

**DPAK (SINGLE GAUGE)**
CASE 369C−01
ISSUE D

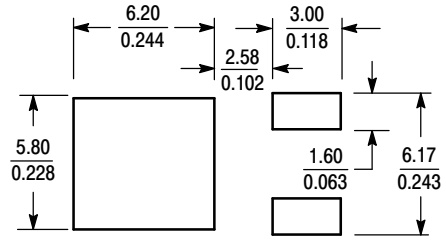



NOTES:
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: INCHES.
3. THERMAL PAD CONTOUR OPTIONAL WITHIN DIMENSIONS b3, L3 and Z.
4. DIMENSIONS D AND E DO NOT INCLUDE MOLD FLASH, PROTRUSIONS, OR BURRS. MOLD FLASH, PROTRUSIONS, OR GATE BURRS SHALL NOT EXCEED 0.006 INCHES PER SIDE.
5. DIMENSIONS D AND E ARE DETERMINED AT THE OUTERMOST EXTREMES OF THE PLASTIC BODY.
6. DATUMS A AND B ARE DETERMINED AT DATUM PLANE H.

| | INCHES | | MILLIMETERS | |
|---|---|---|---|---|
| DIM | MIN | MAX | MIN | MAX |
| A | 0.086 | 0.094 | 2.18 | 2.38 |
| A1 | 0.000 | 0.005 | 0.00 | 0.13 |
| b | 0.025 | 0.035 | 0.63 | 0.89 |
| b2 | 0.030 | 0.045 | 0.76 | 1.14 |
| b3 | 0.180 | 0.215 | 4.57 | 5.46 |
| c | 0.018 | 0.024 | 0.46 | 0.61 |
| c2 | 0.018 | 0.024 | 0.46 | 0.61 |
| D | 0.235 | 0.245 | 5.97 | 6.22 |
| E | 0.250 | 0.265 | 6.35 | 6.73 |
| e | 0.090 BSC | | 2.29 BSC | |
| H | 0.370 | 0.410 | 9.40 | 10.41 |
| L | 0.055 | 0.070 | 1.40 | 1.78 |
| L1 | 0.108 REF | | 2.74 REF | |
| L2 | 0.020 BSC | | 0.51 BSC | |
| L3 | 0.035 | 0.050 | 0.89 | 1.27 |
| L4 | −−− | 0.040 | −−− | 1.01 |
| Z | 0.155 | −−− | 3.93 | −−− |

STYLE 2:
PIN 1. GATE
2. DRAIN
3. SOURCE
4. DRAIN

### SOLDERING FOOTPRINT*

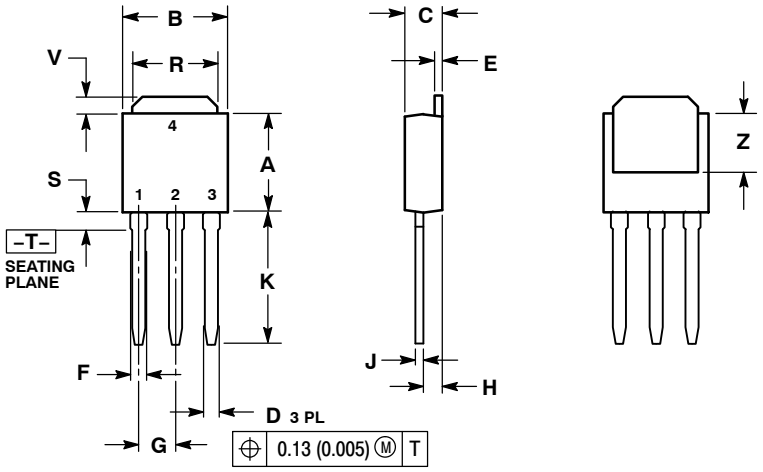



SCALE 3:1 (mm / inches)

*For additional information on our Pb−Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

## PACKAGE DIMENSIONS

**IPAK**
CASE 369D−01
ISSUE C




NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

| | INCHES | | MILLIMETERS | |
|---|---|---|---|---|
| DIM | MIN | MAX | MIN | MAX |
| A | 0.235 | 0.245 | 5.97 | 6.35 |
| B | 0.250 | 0.265 | 6.35 | 6.73 |
| C | 0.086 | 0.094 | 2.19 | 2.38 |
| D | 0.027 | 0.035 | 0.69 | 0.88 |
| E | 0.018 | 0.023 | 0.46 | 0.58 |
| F | 0.037 | 0.045 | 0.94 | 1.14 |
| G | 0.090 BSC | | 2.29 BSC | |
| H | 0.034 | 0.040 | 0.87 | 1.01 |
| J | 0.018 | 0.023 | 0.46 | 0.58 |
| K | 0.350 | 0.380 | 8.89 | 9.65 |
| R | 0.180 | 0.215 | 4.45 | 5.45 |
| S | 0.025 | 0.040 | 0.63 | 1.01 |
| V | 0.035 | 0.050 | 0.89 | 1.27 |
| Z | 0.155 | −−− | 3.93 | −−− |

STYLE 2:
PIN 1. GATE
2. DRAIN
3. SOURCE
4. DRAIN



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