

## 3N06L13-VB TO220 Datasheet

### N-Channel 60-V (D-S) MOSFET

#### PRODUCT SUMMARY

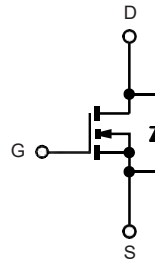
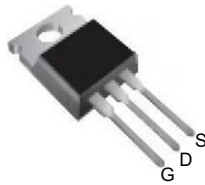
| $V_{DS}$ (V) | $R_{DS(on)}$ ( $\Omega$ ) | $I_D$ (A) <sup>a</sup> |
|--------------|---------------------------|------------------------|
| 60           | 0.011 at $V_{GS} = 10$ V  | 60                     |
|              | 0.013 at $V_{GS} = 4.5$ V | 50                     |

#### FEATURES

- 175 °C Junction Temperature
- Trench Power MOSFET
- Material categorization:



TO-220AB



N-Channel MOSFET

#### ABSOLUTE MAXIMUM RATINGS ( $T_C = 25$ °C, unless otherwise noted)

| Parameter                                               |                | Symbol         | Limit                                | Unit |
|---------------------------------------------------------|----------------|----------------|--------------------------------------|------|
| Gate-Source Voltage                                     |                | $V_{GS}$       | $\pm 20$                             | V    |
| Continuous Drain Current ( $T_J = 175$ °C) <sup>b</sup> | $T_C = 25$ °C  | $I_D$          | 60                                   | A    |
|                                                         | $T_C = 100$ °C |                | 50 <sup>a</sup>                      |      |
| Pulsed Drain Current                                    |                | $I_{DM}$       | 200                                  |      |
| Continuous Source Current (Diode Conduction)            |                | $I_S$          | 50 <sup>a</sup>                      |      |
| Avalanche Current                                       |                | $I_{AS}$       | 50                                   |      |
| Single Avalanche Energy (Duty Cycle $\leq 1$ %)         | $L = 0.1$ mH   | $E_{AS}$       | 125                                  | mJ   |
| Maximum Power Dissipation                               | $T_C = 25$ °C  | $P_D$          | 136                                  | W    |
|                                                         | $T_A = 25$ °C  |                | 3 <sup>b</sup> , 8.3 <sup>b, c</sup> |      |
| Operating Junction and Storage Temperature Range        |                | $T_J, T_{stg}$ | - 55 to 175                          | °C   |

#### THERMAL RESISTANCE RATINGS

| Parameter                                |                 | Symbol     | Typical | Maximum | Unit |
|------------------------------------------|-----------------|------------|---------|---------|------|
| Maximum Junction-to-Ambient <sup>a</sup> | $t \leq 10$ sec | $R_{thJA}$ | 15      | 18      | °C/W |
|                                          | Steady State    |            | 40      | 50      |      |
| Maximum Junction-to-Case                 |                 | $R_{thJC}$ | 0.85    | 1.1     |      |

Notes:

a. Package limited.

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

c.  $t \leq 10$  s.

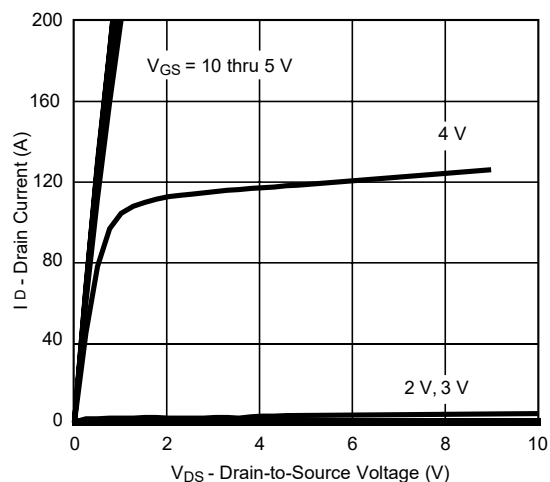
| SPECIFICATIONS (T <sub>J</sub> = 25 °C, unless otherwise noted)         |                     |                                                                                                                          |      |                   |       |      |
|-------------------------------------------------------------------------|---------------------|--------------------------------------------------------------------------------------------------------------------------|------|-------------------|-------|------|
| Parameter                                                               | Symbol              | Test Conditions                                                                                                          | Min. | Typ. <sup>a</sup> | Max.  | Unit |
| Static                                                                  |                     |                                                                                                                          |      |                   |       |      |
| Drain-Source Breakdown Voltage                                          | V <sub>DS</sub>     | V <sub>GS</sub> = 0 V, I <sub>D</sub> = 250 μA                                                                           | 60   |                   |       | V    |
| Gate Threshold Voltage                                                  | V <sub>GS(th)</sub> | V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = 250 μA                                                              | 1    |                   | 3     |      |
| Gate-Body Leakage                                                       | I <sub>GSS</sub>    | V <sub>DS</sub> = 0 V, V <sub>GS</sub> = ± 20 V                                                                          |      |                   | ± 100 | nA   |
| Zero Gate Voltage Drain Current                                         | I <sub>DSS</sub>    | V <sub>DS</sub> = 60 V, V <sub>GS</sub> = 0 V                                                                            |      |                   | 1     | μA   |
|                                                                         |                     | V <sub>DS</sub> = 60 V, V <sub>GS</sub> = 0 V, T <sub>J</sub> = 125 °C                                                   |      |                   | 50    |      |
|                                                                         |                     | V <sub>DS</sub> = 60 V, V <sub>GS</sub> = 0 V, T <sub>J</sub> = 175 °C                                                   |      |                   | 250   |      |
| On-State Drain Current <sup>b</sup>                                     | I <sub>D(on)</sub>  | V <sub>DS</sub> = 5 V, V <sub>GS</sub> = 10 V                                                                            | 60   |                   |       | A    |
| Drain-Source On-State Resistance <sup>b</sup>                           | R <sub>DS(on)</sub> | V <sub>GS</sub> = 10 V, I <sub>D</sub> = 20 A                                                                            |      | 0.011             |       | Ω    |
|                                                                         |                     | V <sub>GS</sub> = 10 V, I <sub>D</sub> = 20 A, T <sub>J</sub> = 125 °C                                                   |      | 0.014             |       |      |
|                                                                         |                     | V <sub>GS</sub> = 10 V, I <sub>D</sub> = 20 A, T <sub>J</sub> = 175 °C                                                   |      | 0.018             |       |      |
|                                                                         |                     | V <sub>GS</sub> = 4.5 V, I <sub>D</sub> = 15 A                                                                           |      | 0.013             |       |      |
| Forward Transconductance <sup>b</sup>                                   | g <sub>fs</sub>     | V <sub>DS</sub> = 15 V, I <sub>D</sub> = 20 A                                                                            |      | 60                |       | S    |
| Dynamic                                                                 |                     |                                                                                                                          |      |                   |       |      |
| Input Capacitance                                                       | C <sub>iss</sub>    | V <sub>GS</sub> = 0 V, V <sub>DS</sub> = 25 V, f = 1 MHz                                                                 |      | 4200              |       | pF   |
| Output Capacitance                                                      | C <sub>oss</sub>    |                                                                                                                          |      | 570               |       |      |
| Reverse Transfer Capacitance                                            | C <sub>rss</sub>    |                                                                                                                          |      | 325               |       |      |
| Total Gate Charge <sup>c</sup>                                          | Q <sub>g</sub>      | V <sub>DS</sub> = 30 V, V <sub>GS</sub> = 10 V, I <sub>D</sub> = 50 A                                                    |      | 47                |       | nC   |
| Gate-Source Charge <sup>c</sup>                                         | Q <sub>gs</sub>     |                                                                                                                          |      | 10                |       |      |
| Gate-Drain Charge <sup>c</sup>                                          | Q <sub>gd</sub>     |                                                                                                                          |      | 12                |       |      |
| Turn-On Delay Time <sup>c</sup>                                         | t <sub>d(on)</sub>  | V <sub>DD</sub> = 30 V, R <sub>L</sub> = 0.6 Ω<br>I <sub>D</sub> ≅ 50 A, V <sub>GEN</sub> = 10 V, R <sub>g</sub> = 2.5 Ω |      | 10                | 20    | ns   |
| Rise Time <sup>c</sup>                                                  | t <sub>r</sub>      |                                                                                                                          |      | 15                | 25    |      |
| Turn-Off Delay Time <sup>c</sup>                                        | t <sub>d(off)</sub> |                                                                                                                          |      | 35                | 50    |      |
| Fall Time <sup>c</sup>                                                  | t <sub>f</sub>      |                                                                                                                          |      | 20                | 30    |      |
| Source-Drain Diode Ratings and Characteristics (T <sub>C</sub> = 25 °C) |                     |                                                                                                                          |      |                   |       |      |
| Pulsed Current                                                          | I <sub>SM</sub>     |                                                                                                                          |      |                   | 60    | A    |
| Diode Forward Voltage                                                   | V <sub>SD</sub>     | I <sub>F</sub> = 20 A, V <sub>GS</sub> = 0 V                                                                             |      | 1                 | 1.5   | V    |
| Reverse Recovery Time                                                   | t <sub>rr</sub>     | I <sub>F</sub> = 20 A, di/dt = 100 A/μs                                                                                  |      | 45                | 100   | ns   |

Notes:

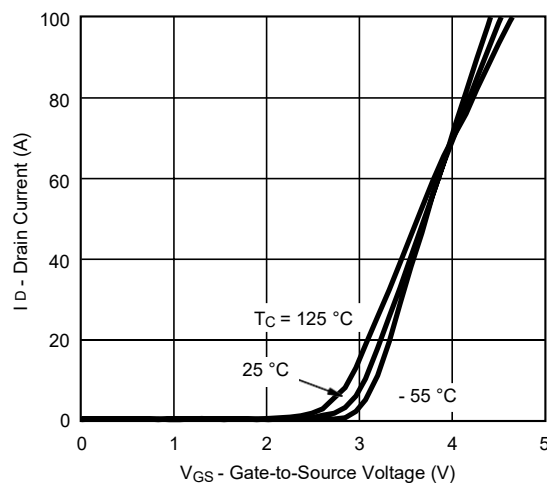
- a. For design aid only; not subject to production testing.  
 b. Pulse test; pulse width  $\leq 300\text{ }\mu\text{s}$ , duty cycle  $\leq 2\%$ .  
 c. Independent of operating temperature.

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.

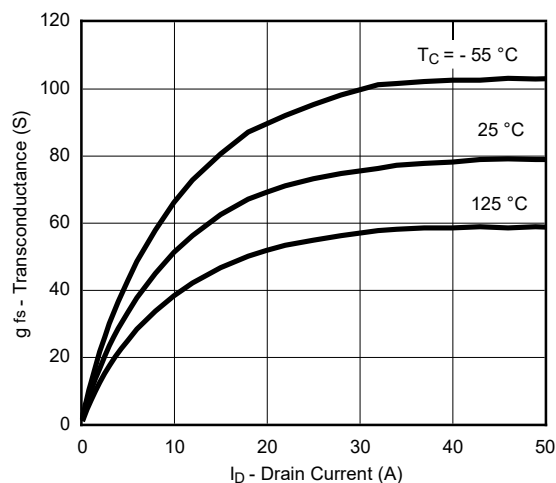
## TYPICAL CHARACTERISTICS (25 °C unless noted)



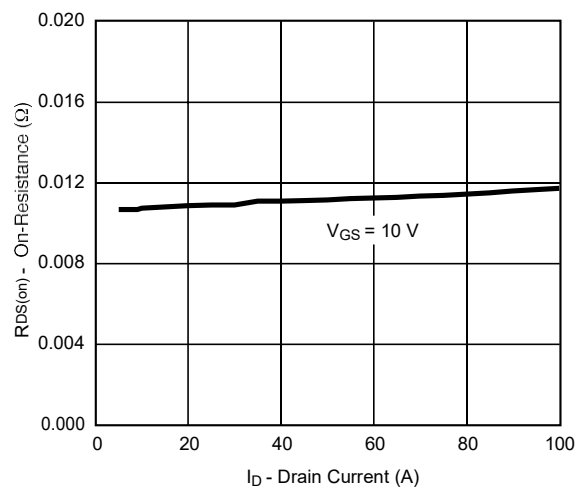
**Output Characteristics**



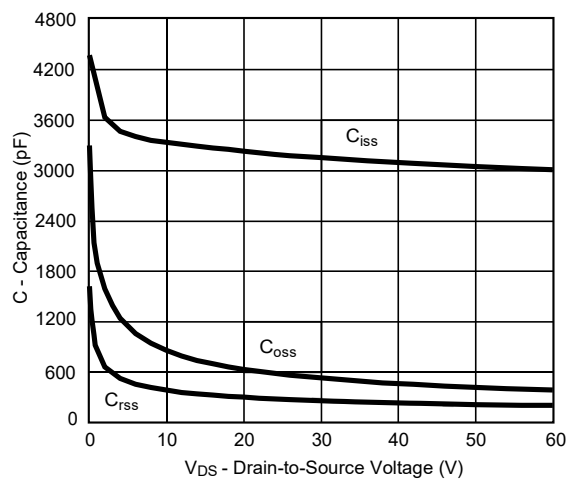
**Transfer Characteristics**



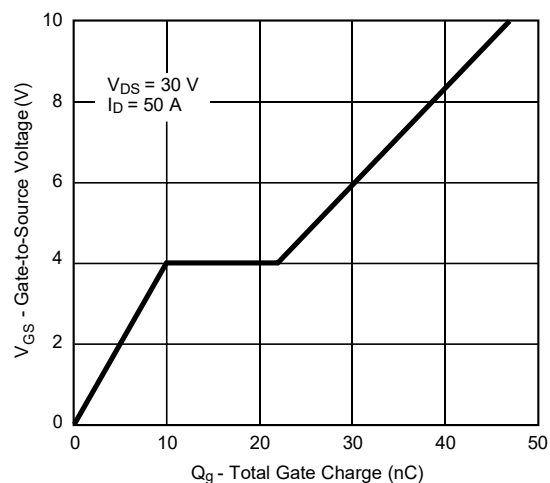
**Transconductance**



**On-Resistance vs. Drain Current**

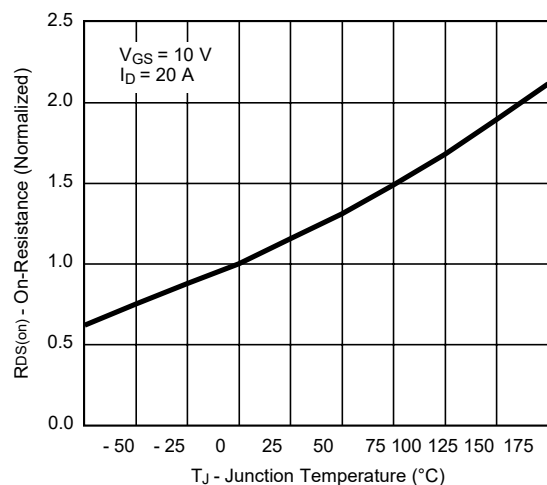


**Capacitance**

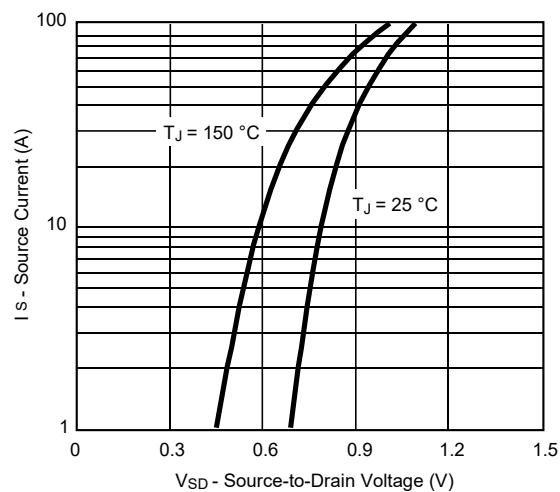


**Gate Charge**

## TYPICAL CHARACTERISTICS (25 °C unless noted)

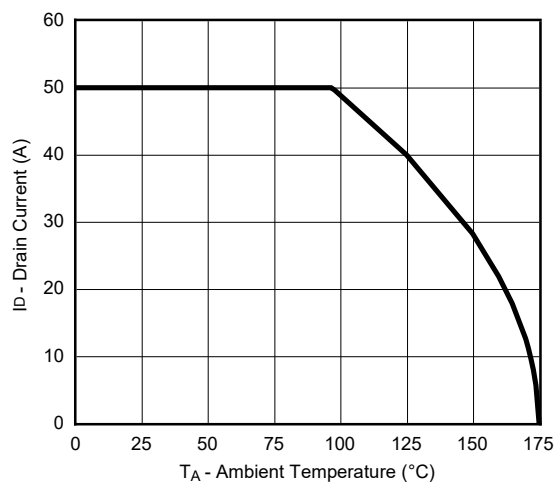


On-Resistance vs. Junction Temperature

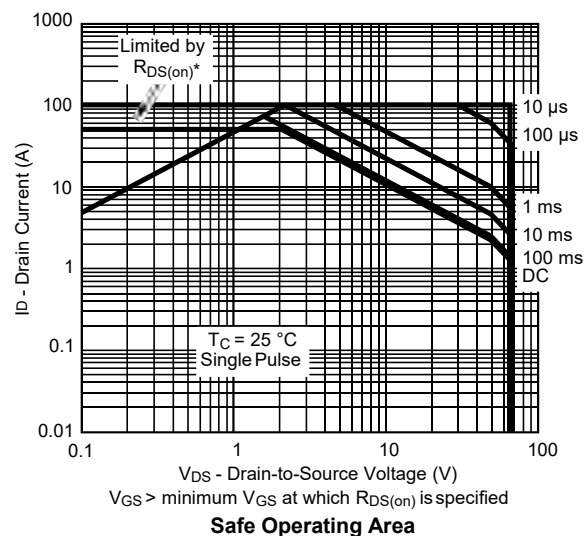


Source-Drain Diode Forward Voltage

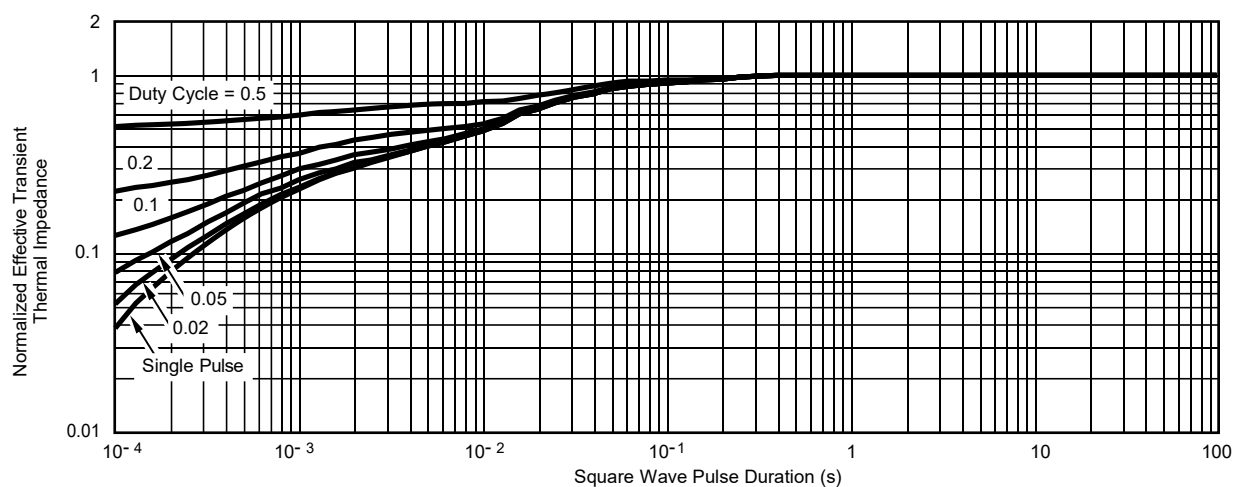
## THERMAL RATINGS



Maximum Drain Current vs. Ambient Temperature

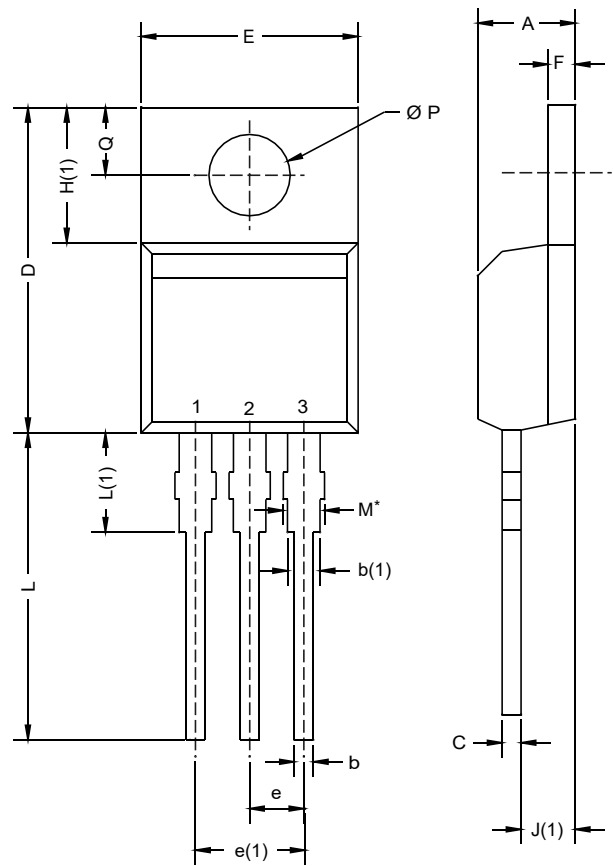


Safe Operating Area



Normalized Thermal Transient Impedance, Junction-to-Case

TO-220AB



| DIM.            | MILLIMETERS |       | INCHES |       |
|-----------------|-------------|-------|--------|-------|
|                 | MIN.        | MAX.  | MIN.   | MAX.  |
| A               | 4.24        | 4.65  | 0.167  | 0.183 |
| b               | 0.69        | 1.02  | 0.027  | 0.040 |
| b(1)            | 1.14        | 1.78  | 0.045  | 0.070 |
| c               | 0.36        | 0.61  | 0.014  | 0.024 |
| D               | 14.33       | 15.85 | 0.564  | 0.624 |
| E               | 9.96        | 10.52 | 0.392  | 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)            | 6.10        | 6.71  | 0.240  | 0.264 |
| J(1)            | 2.41        | 2.92  | 0.095  | 0.115 |
| L               | 13.36       | 14.40 | 0.526  | 0.567 |
| L(1)            | 3.33        | 4.04  | 0.131  | 0.159 |
| $\varnothing P$ | 3.53        | 3.94  | 0.139  | 0.155 |
| Q               | 2.54        | 3.00  | 0.100  | 0.118 |

ECN: X15-0364-Rev. C, 14-Dec-15  
DWG: 6031

**Note**

- $M^* = 0.052$  inches to  $0.064$  inches (dimension including protrusion), heatsink hole for HVM

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