

## CEF13N5A-VB Datasheet

**N-Channel 550V (D-S) Power MOSFET****PRODUCT SUMMARY**

|                                    |                        |      |
|------------------------------------|------------------------|------|
| $V_{DS}$ (V)                       | 550                    |      |
| $R_{DS(on)}$ at 25 °C ( $\Omega$ ) | $V_{GS} = 10\text{ V}$ | 0.26 |
| $Q_g$ max. (nC)                    | 150                    |      |
| $Q_{gs}$ (nC)                      | 12                     |      |
| $Q_{gd}$ (nC)                      | 25                     |      |
| Configuration                      | Single                 |      |

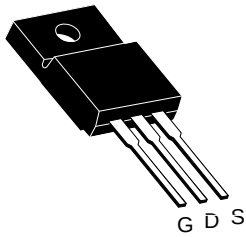
**FEATURES**

- Optimal Design
  - Low Area Specific On-Resistance
  - Low Input Capacitance ( $C_{iss}$ )
  - Reduced Capacitive Switching Losses
  - High Body Diode Ruggedness
  - Avalanche Energy Rated (UIS)
- Optimal Efficiency and Operation
  - Low Cost
  - Simple Gate Drive Circuitry
  - Low Figure-of-Merit (FOM):  $R_{on} \times Q_g$
  - Fast Switching

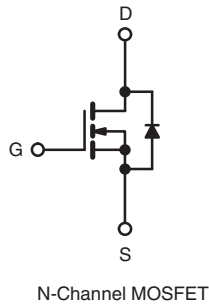


**RoHS\***  
 COMPLIANT  
 HALOGEN  
**FREE**  
 Available

TO-220 FULLPAK



Top View

**APPLICATIONS**

- Consumer Electronics
  - Displays (LCD or Plasma TV)
- Server and Telecom Power Supplies
  - SMPS
- Industrial
  - Welding
  - Induction Heating
  - Motor Drives
- Battery Chargers
- SMPS
  - Power Factor Correction (PFC)

**ABSOLUTE MAXIMUM RATINGS** ( $T_C = 25\text{ }^{\circ}\text{C}$ , unless otherwise noted)

| PARAMETER                                                        | SYMBOL           | LIMIT                               | UNIT                  |
|------------------------------------------------------------------|------------------|-------------------------------------|-----------------------|
| Drain-Source Voltage                                             | $V_{DS}$         | 550                                 | V                     |
| Gate-Source Voltage                                              | $V_{GS}$         | $\pm 20$                            |                       |
| Gate-Source Voltage AC ( $f > 1\text{ Hz}$ )                     |                  | 30                                  |                       |
| Continuous Drain Current ( $T_J = 150\text{ }^{\circ}\text{C}$ ) | $V_{GS}$ at 10 V | $T_C = 25\text{ }^{\circ}\text{C}$  | A                     |
|                                                                  |                  | $T_C = 100\text{ }^{\circ}\text{C}$ |                       |
| Pulsed Drain Current <sup>a</sup>                                | $I_{DM}$         | 56                                  |                       |
| Linear Derating Factor                                           |                  | 2.2                                 | W/ $^{\circ}\text{C}$ |
| Single Pulse Avalanche Energy <sup>b</sup>                       | $E_{AS}$         | 281                                 | mJ                    |
| Maximum Power Dissipation                                        | $P_D$            | 60                                  | W                     |
| Operating Junction and Storage Temperature Range                 | $T_J, T_{stg}$   | - 55 to + 150                       | $^{\circ}\text{C}$    |
| Drain-Source Voltage Slope                                       | $dV/dt$          | $T_J = 125\text{ }^{\circ}\text{C}$ | V/ns                  |
| Reverse Diode $dV/dt$ <sup>d</sup>                               |                  |                                     |                       |
| Soldering Recommendations (Peak Temperature)                     | for 10 s         | 300 $^{\circ}$                      | $^{\circ}\text{C}$    |

**Notes**

- a. Repetitive rating; pulse width limited by maximum junction temperature.  
 b.  $V_{DD} = 50\text{ V}$ , starting  $T_J = 25\text{ }^{\circ}\text{C}$ ,  $L = 10\text{ mH}$ ,  $R_g = 25\text{ }\Omega$ ,  $I_{AS} = 7.5\text{ A}$ .  
 c. 1.6 mm from case.  
 d.  $I_{SD} \leq I_D$ , starting  $T_J = 25\text{ }^{\circ}\text{C}$ .

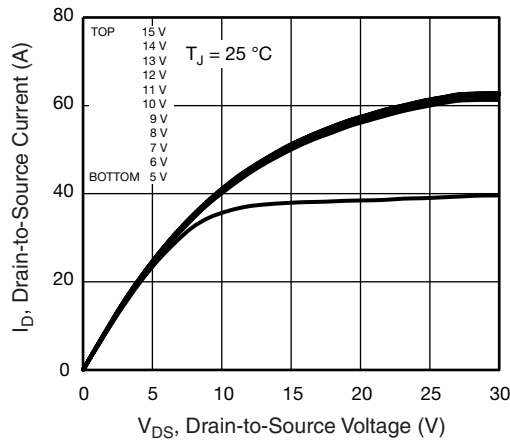
| THERMAL RESISTANCE RATINGS       |            |      |      |      |
|----------------------------------|------------|------|------|------|
| PARAMETER                        | SYMBOL     | TYP. | MAX. | UNIT |
| Maximum Junction-to-Ambient      | $R_{thJA}$ | -    | 40   | °C/W |
| Maximum Junction-to-Case (Drain) | $R_{thJC}$ | -    | 0.45 |      |

| SPECIFICATIONS (T <sub>J</sub> = 25 °C, unless otherwise noted) |                                  |                                                                                                                                                          |                                                |      |      |       |      |
|-----------------------------------------------------------------|----------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------|------|------|-------|------|
| PARAMETER                                                       | SYMBOL                           | TEST CONDITIONS                                                                                                                                          |                                                | MIN. | TYP. | MAX.  | UNIT |
| Static                                                          |                                  |                                                                                                                                                          |                                                |      |      |       |      |
| Drain-Source Breakdown Voltage                                  | V <sub>DS</sub>                  | V <sub>GS</sub> = 0 V, I <sub>D</sub> = 250 μA                                                                                                           |                                                | 550  | -    | -     | V    |
| V <sub>DS</sub> Temperature Coefficient                         | ΔV <sub>DS</sub> /T <sub>J</sub> | Reference to 25 °C, I <sub>D</sub> = 250 μA                                                                                                              |                                                | -    | 0.56 | -     | V/°C |
| Gate-Source Threshold Voltage (N)                               | V <sub>GS(th)</sub>              | V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = 250 μA                                                                                              |                                                | 2    | -    | 4     | V    |
| Gate-Source Leakage                                             | I <sub>GSS</sub>                 | V <sub>GS</sub> = ± 20 V                                                                                                                                 |                                                | -    | -    | ± 100 | nA   |
| Zero Gate Voltage Drain Current                                 | I <sub>DSS</sub>                 | V <sub>DS</sub> = 500 V, V <sub>GS</sub> = 0 V                                                                                                           |                                                | -    | -    | 1     | μA   |
|                                                                 |                                  | V <sub>DS</sub> = 400 V, V <sub>GS</sub> = 0 V, T <sub>J</sub> = 125 °C                                                                                  |                                                | -    | -    | 10    |      |
| Drain-Source On-State Resistance                                | R <sub>DS(on)</sub>              | V <sub>GS</sub> = 10 V                                                                                                                                   | I <sub>D</sub> = 10 A                          | -    | 0.26 | -     | Ω    |
| Forward Transconductance                                        | g <sub>fs</sub>                  | V <sub>DS</sub> = 50 V, I <sub>D</sub> = 10 A                                                                                                            |                                                | -    | 12   | -     | S    |
| Dynamic                                                         |                                  |                                                                                                                                                          |                                                |      |      |       |      |
| Input Capacitance                                               | C <sub>iss</sub>                 | V <sub>GS</sub> = 0 V,<br>V <sub>DS</sub> = 100 V,<br>f = 1 MHz                                                                                          |                                                | -    | 3094 | -     | pF   |
| Output Capacitance                                              | C <sub>oss</sub>                 |                                                                                                                                                          |                                                | -    | 152  | -     |      |
| Reverse Transfer Capacitance                                    | C <sub>rss</sub>                 |                                                                                                                                                          |                                                | -    | 13   | -     |      |
| Effective output capacitance, energy related <sup>a</sup>       | C <sub>o(er)</sub>               | V <sub>GS</sub> = 0 V,<br>V <sub>DS</sub> = 0 V to 400 V                                                                                                 |                                                | -    | 131  | -     | pF   |
| Effective output capacitance, time related <sup>b</sup>         | C <sub>o(tr)</sub>               |                                                                                                                                                          |                                                | -    | 189  | -     |      |
| Total Gate Charge                                               | Q <sub>g</sub>                   | V <sub>GS</sub> = 10 V                                                                                                                                   | I <sub>D</sub> = 10 A, V <sub>DS</sub> = 400 V | -    | 80   | 150   | nC   |
| Gate-Source Charge                                              | Q <sub>gs</sub>                  |                                                                                                                                                          |                                                | -    | 12   | -     |      |
| Gate-Drain Charge                                               | Q <sub>gd</sub>                  |                                                                                                                                                          |                                                | -    | 25   | -     |      |
| Turn-On Delay Time                                              | t <sub>d(on)</sub>               | V <sub>DD</sub> = 400 V, I <sub>D</sub> = 10 A,<br>V <sub>GS</sub> = 10 V, R <sub>g</sub> = 9.1 Ω                                                        |                                                | -    | 24   | 50    | ns   |
| Rise Time                                                       | t <sub>r</sub>                   |                                                                                                                                                          |                                                | -    | 31   | 62    |      |
| Turn-Off Delay Time                                             | t <sub>d(off)</sub>              |                                                                                                                                                          |                                                | -    | 117  | 176   |      |
| Fall Time                                                       | t <sub>f</sub>                   |                                                                                                                                                          |                                                | -    | 56   | 112   |      |
| Gate Input Resistance                                           | R <sub>g</sub>                   | f = 1 MHz, open drain                                                                                                                                    |                                                | -    | 1.8  | -     | Ω    |
| Drain-Source Body Diode Characteristics                         |                                  |                                                                                                                                                          |                                                |      |      |       |      |
| Continuous Source-Drain Diode Current                           | I <sub>S</sub>                   | MOSFET symbol showing the integral reverse p - n junction diode<br> |                                                | -    | -    | 20    | A    |
| Pulsed Diode Forward Current                                    | I <sub>SM</sub>                  |                                                                                                                                                          |                                                | -    | -    | 80    |      |
| Diode Forward Voltage                                           | V <sub>SD</sub>                  | T <sub>J</sub> = 25 °C, I <sub>S</sub> = 10 A, V <sub>GS</sub> = 0 V                                                                                     |                                                | -    | -    | 1.2   | V    |
| Reverse Recovery Time                                           | t <sub>rr</sub>                  | T <sub>J</sub> = 25 °C, I <sub>F</sub> = I <sub>S</sub> = 10 A,<br>di/dt = 100 A/μs, V <sub>R</sub> = 20 V                                               |                                                | -    | 437  | -     | ns   |
| Reverse Recovery Charge                                         | Q <sub>rr</sub>                  |                                                                                                                                                          |                                                | -    | 5.9  | -     | μC   |
| Reverse Recovery Current                                        | I <sub>RRM</sub>                 |                                                                                                                                                          |                                                | -    | 25   | -     | A    |

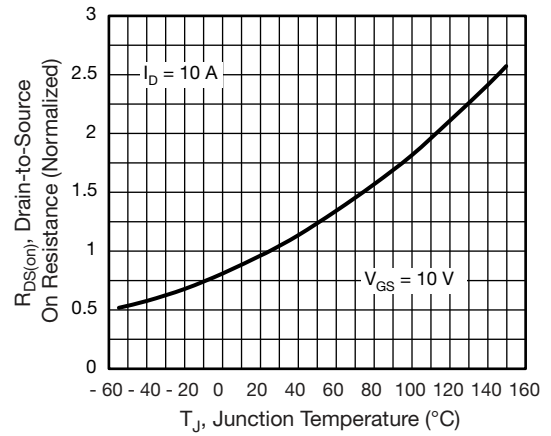
**Notes**

- a.  $C_{oss(er)}$  is a fixed capacitance that gives the same energy as  $C_{oss}$  while  $V_{DS}$  is rising from 0 % to 80 %  $V_{DS}$ .  
b.  $C_{oss(tr)}$  is a fixed capacitance that gives the same charging time as  $C_{oss}$  while  $V_{DS}$  is rising from 0 % to 80 %  $V_{DS}$ .

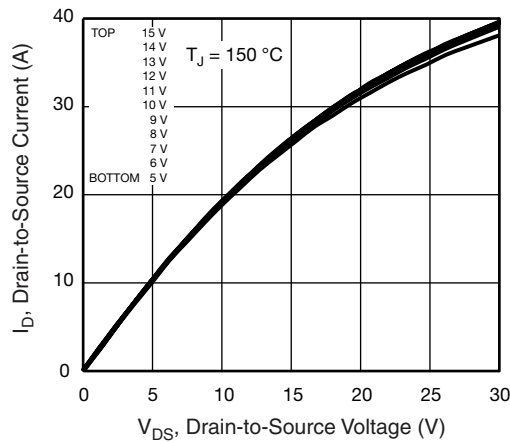
**TYPICAL CHARACTERISTICS** (25 °C, unless otherwise noted)



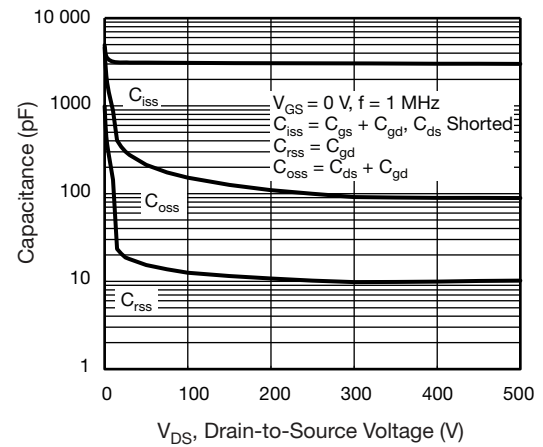
**Fig. 1 - Typical Output Characteristics**



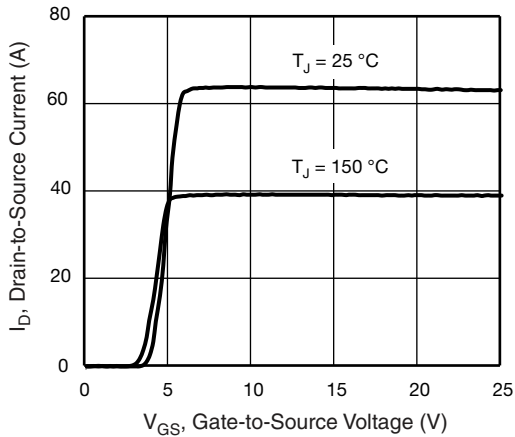
**Fig. 4 - Normalized On-Resistance vs. Temperature**



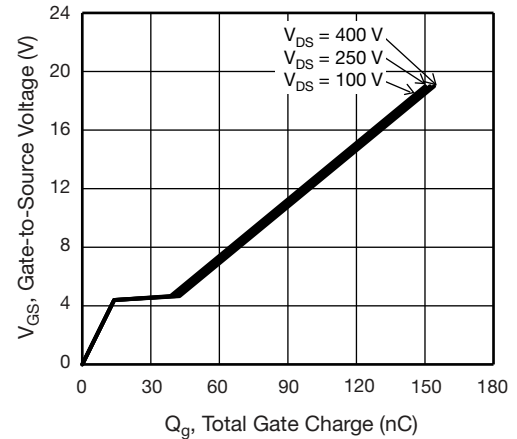
**Fig. 2 - Typical Output Characteristics**



**Fig. 5 - Typical Capacitance vs. Drain-to-Source Voltage**



**Fig. 3 - Typical Transfer Characteristics**



**Fig. 6 - Typical Gate Charge vs. Gate-to-Source Voltage**

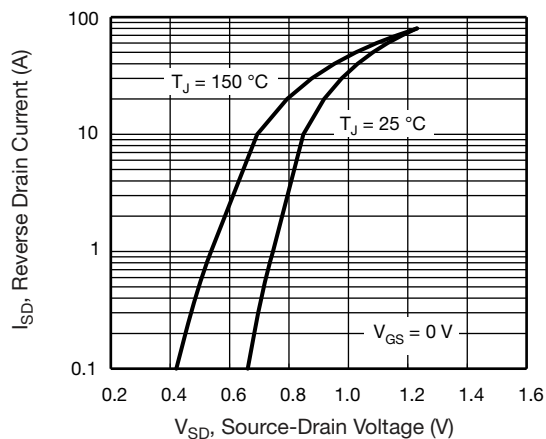


Fig. 7 - Typical Source-Drain Diode Forward Voltage

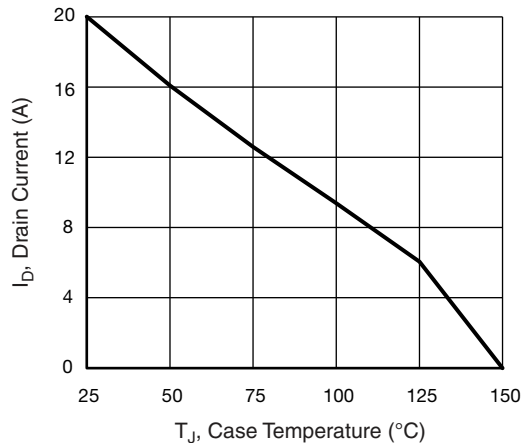


Fig. 9 - Maximum Drain Current vs. Case Temperature

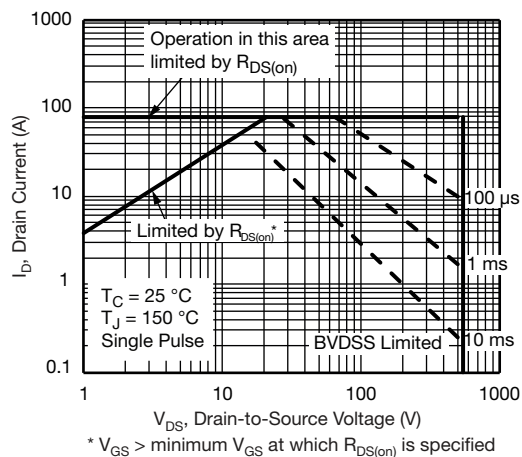


Fig. 8 - Maximum Safe Operating Area

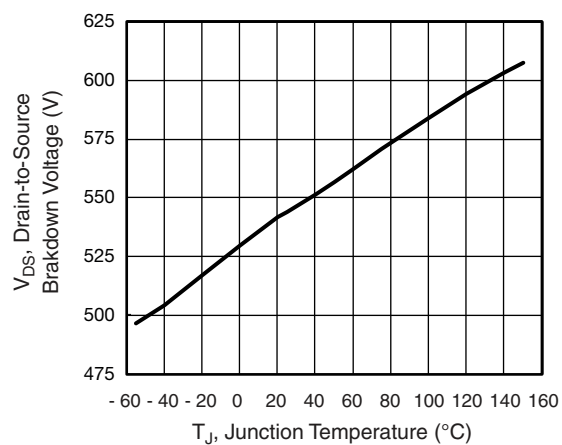


Fig. 10 - Temperature vs. Drain-to-Source Voltage

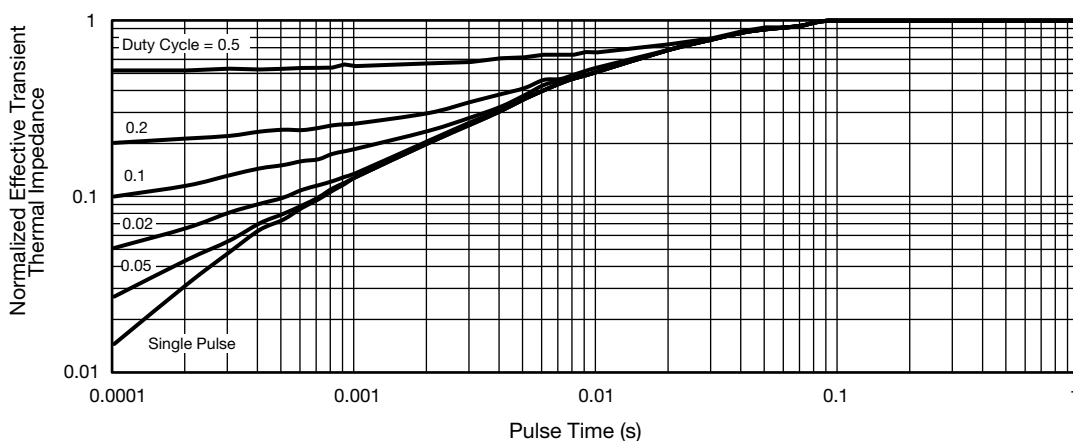


Fig. 11 - Normalized Thermal Transient Impedance, Junction-to-Case

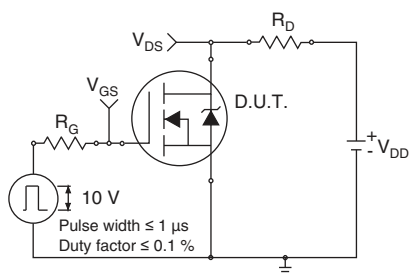


Fig. 12 - Switching Time Test Circuit

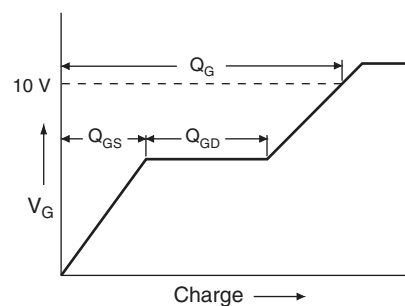


Fig. 16 - Basic Gate Charge Waveform

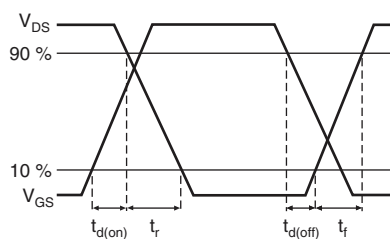


Fig. 13 - Switching Time Waveforms

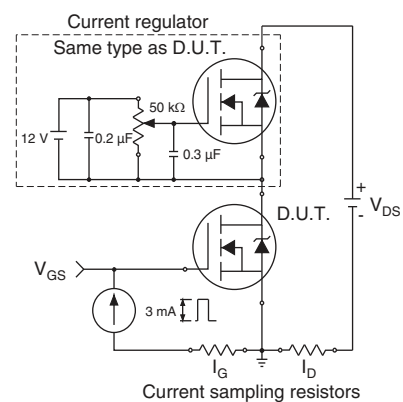


Fig. 17 - Gate Charge Test Circuit

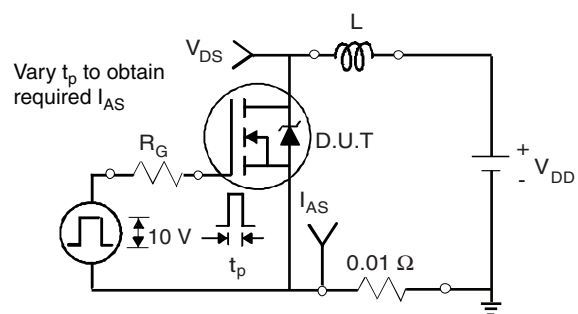


Fig. 14 - Unclamped Inductive Test Circuit

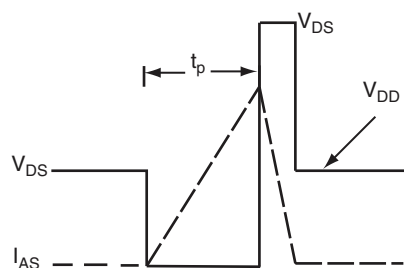
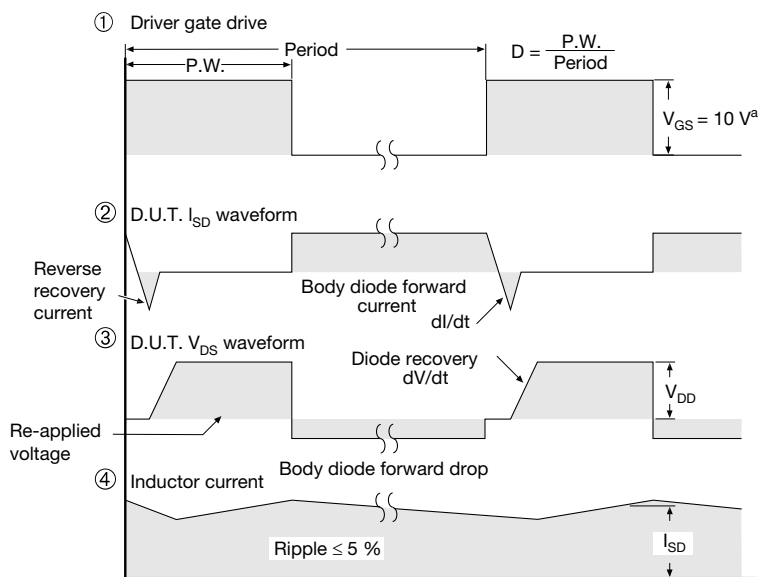
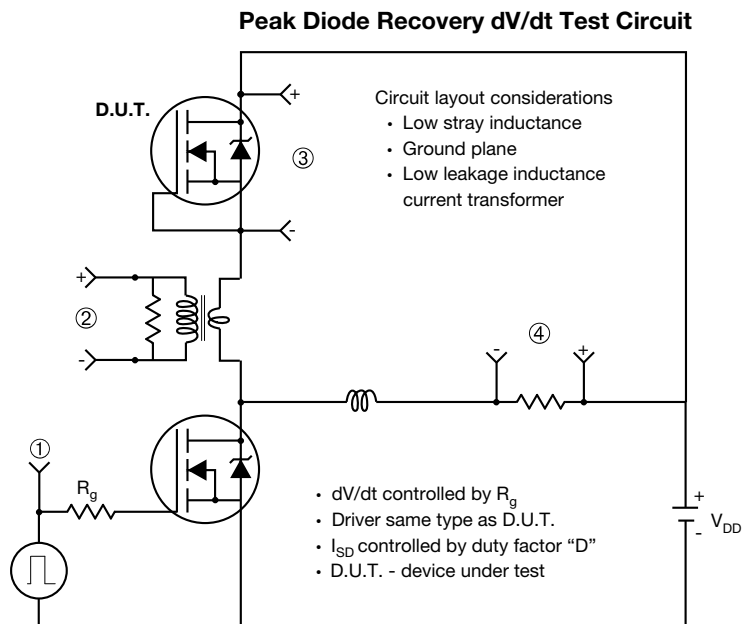


Fig. 15 - Unclamped Inductive Waveforms

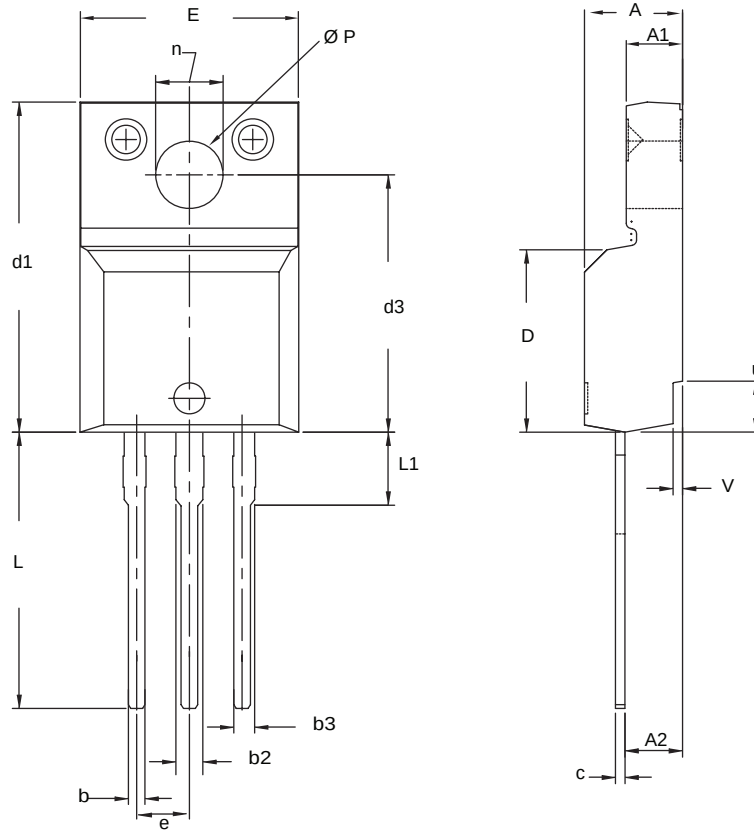


**Note**

a.  $V_{GS} = 5\text{ V}$  for logic level devices

**Fig. 18 - For N-Channel**

**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 |
| Ø 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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