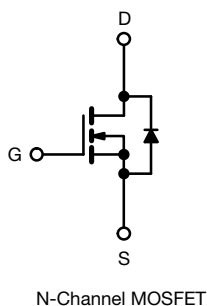
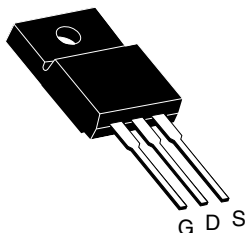


## D Series Power MOSFET

**TO-220 FULLPAK**


### 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
- Material categorization: for definitions of compliance please see [www.vishay.com/doc?99912](http://www.vishay.com/doc?99912)



### PRODUCT SUMMARY

|                                         |                 |      |
|-----------------------------------------|-----------------|------|
| $V_{DS}$ (V) at $T_J$ max.              | 550             |      |
| $R_{DS(on)}$ max. ( $\Omega$ ) at 25 °C | $V_{GS} = 10$ V | 0.85 |
| $Q_g$ max. (nC)                         | 30              |      |
| $Q_{gs}$ (nC)                           | 4               |      |
| $Q_{gd}$ (nC)                           | 7               |      |
| Configuration                           | Single          |      |

### APPLICATIONS

- Consumer electronics
  - Displays (LCD or plasma TV)
- Server and telecom power supplies
  - SMPS
- Industrial
  - Welding
  - Induction heating
  - Motor drives
- Battery chargers

### ORDERING INFORMATION

|                |                |
|----------------|----------------|
| Package        | TO-220 FULLPAK |
| Lead (Pb)-free | SiHF8N50D-E3   |

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

| PARAMETER                                                 | SYMBOL           | LIMIT          | UNIT |
|-----------------------------------------------------------|------------------|----------------|------|
| Drain-Source Voltage                                      | $V_{DS}$         | 500            | V    |
| Gate-Source Voltage                                       | $V_{GS}$         | $\pm 30$       |      |
| Gate-Source Voltage AC ( $f > 1$ Hz)                      |                  | 30             |      |
| Continuous Drain Current ( $T_J = 150$ °C) <sup>a</sup>   | $V_{GS}$ at 10 V | $T_C = 25$ °C  | A    |
|                                                           |                  | $T_C = 100$ °C |      |
| Pulsed Drain Current <sup>a</sup>                         | $I_{DM}$         | 18             |      |
| Linear Derating Factor                                    |                  | 0.26           | W/°C |
| Single Pulse Avalanche Energy <sup>b</sup>                | $E_{AS}$         | 56             | mJ   |
| Maximum Power Dissipation                                 | $P_D$            | 33             | W    |
| Operating Junction and Storage Temperature Range          | $T_J, T_{stg}$   | -55 to +150    | °C   |
| Drain-Source Voltage Slope                                | $dV/dt$          | $T_J = 125$ °C | V/ns |
| Reverse Diode $dV/dt$ <sup>d</sup>                        |                  |                |      |
| Soldering Recommendations (Peak temperature) <sup>c</sup> | For 10 s         | 300            | °C   |
| Mounting Torque                                           | M3 screw         | 0.6            | Nm   |

#### Notes

- Repetitive rating; pulse width limited by maximum junction temperature.
- $V_{DD} = 50$  V, starting  $T_J = 25$  °C,  $L = 2.3$  mH,  $R_g = 25$   $\Omega$ ,  $I_{AS} = 7$  A.
- 1.6 mm from case.
- $I_{SD} \leq I_D$ , starting  $T_J = 25$  °C.
- Limited by maximum junction temperature.

**THERMAL RESISTANCE RATINGS**

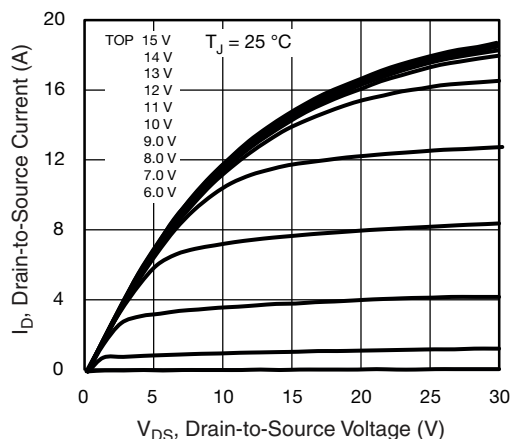
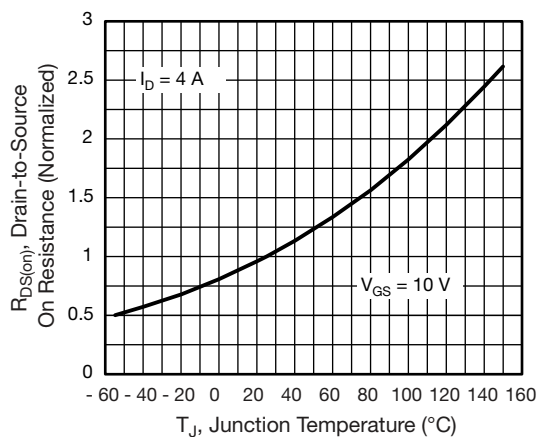
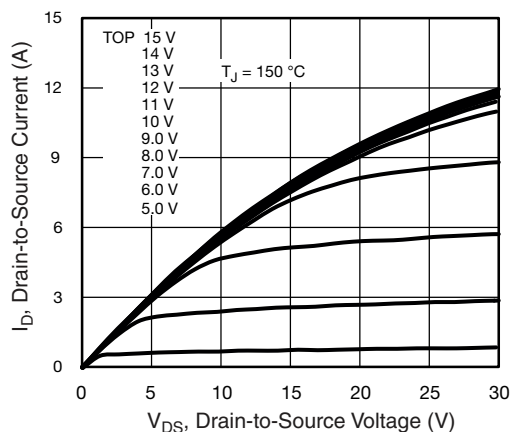
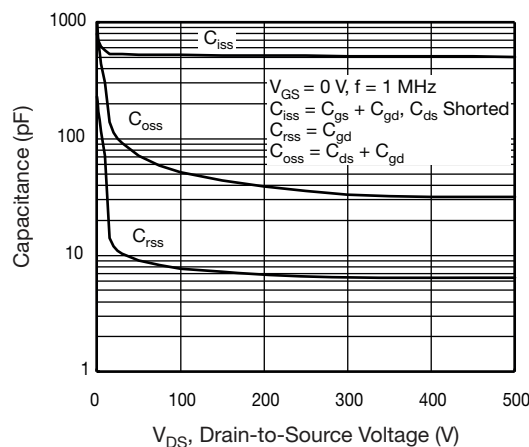
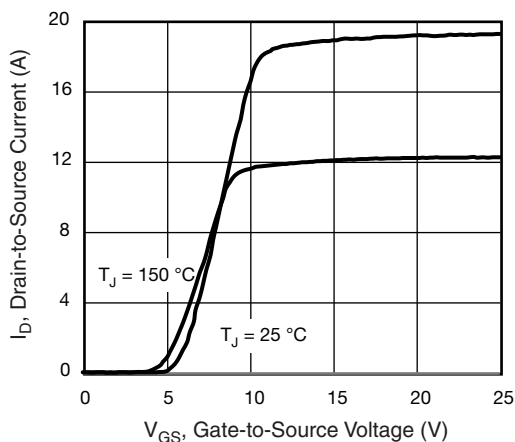
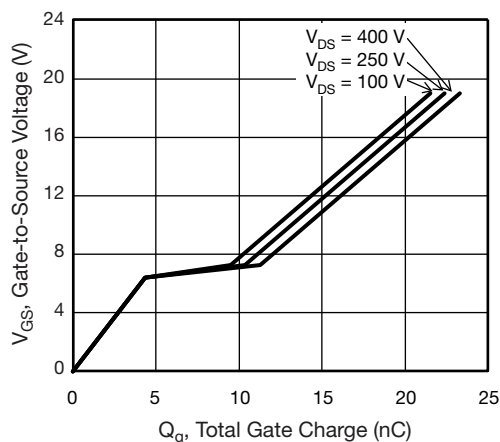
| PARAMETER                        | SYMBOL     | TYP. | MAX. | UNIT |
|----------------------------------|------------|------|------|------|
| Maximum Junction-to-Ambient      | $R_{thJA}$ | -    | 65   | °C/W |
| Maximum Junction-to-Case (Drain) | $R_{thJC}$ | -    | 3.8  |      |

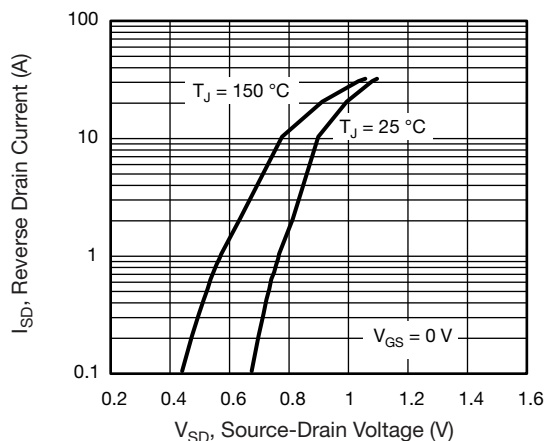
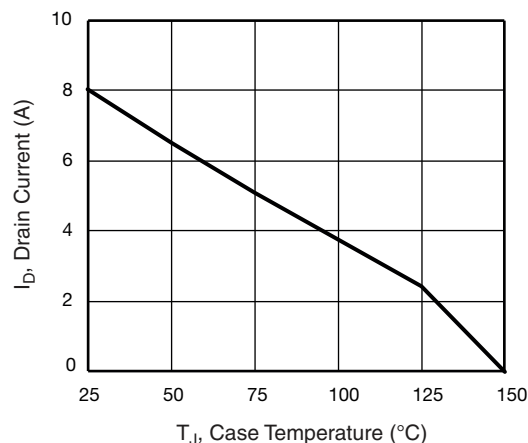
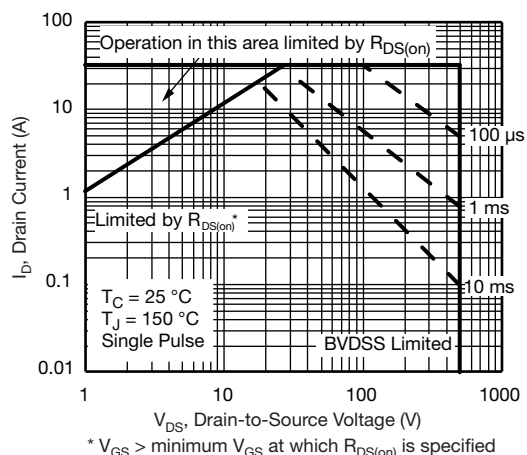
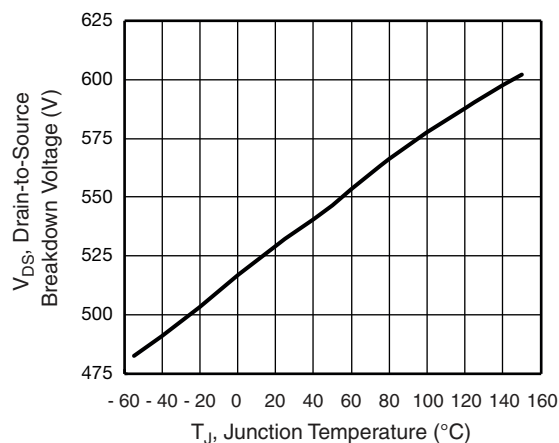
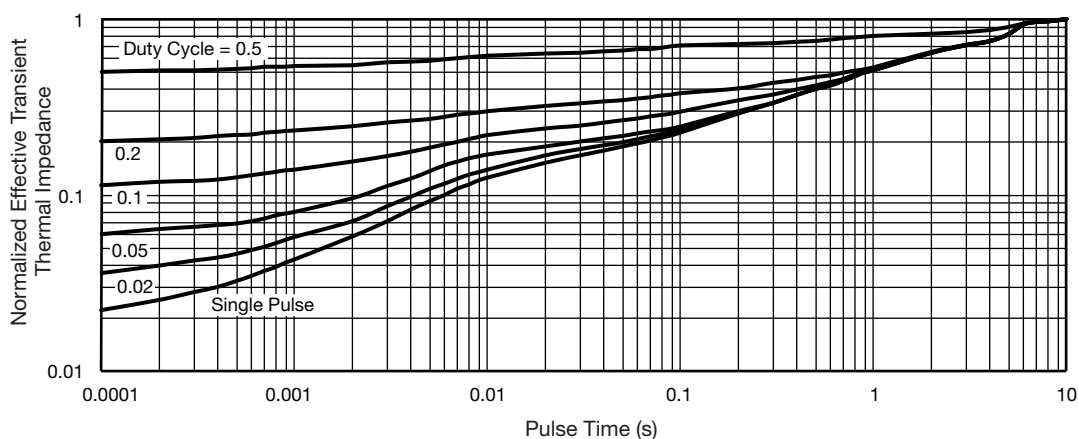
**SPECIFICATIONS** ( $T_J = 25\text{ }^{\circ}\text{C}$ , unless otherwise noted)

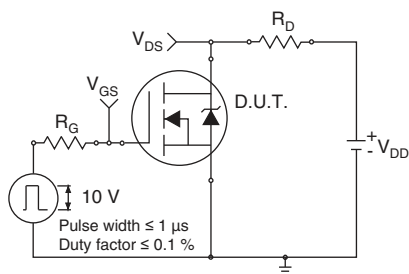
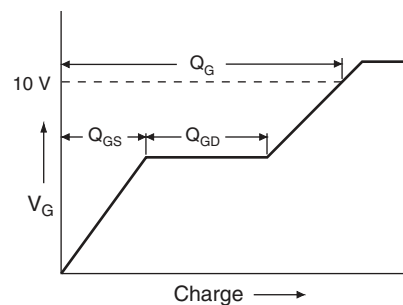
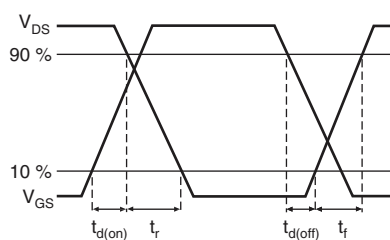
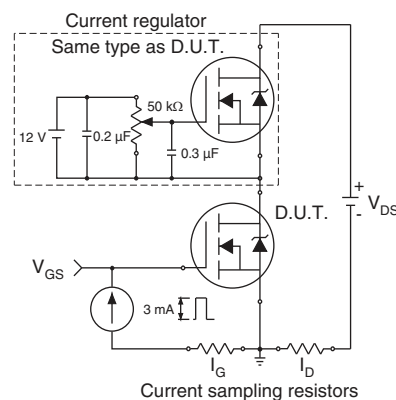
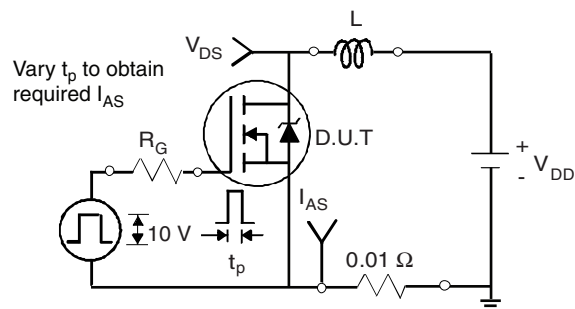
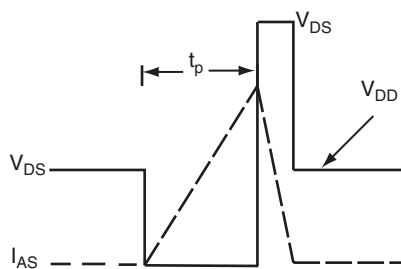
| PARAMETER                                                 | SYMBOL              | TEST CONDITIONS                                                                                                                                          |                                              | MIN. | TYP. | MAX.      | UNIT                  |
|-----------------------------------------------------------|---------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------|------|------|-----------|-----------------------|
| Static                                                    |                     |                                                                                                                                                          |                                              |      |      |           |                       |
| Drain-Source Breakdown Voltage                            | $V_{DS}$            | $V_{GS} = 0\text{ V}$ , $I_D = 250\text{ }\mu\text{A}$                                                                                                   |                                              | 500  | -    | -         | V                     |
| $V_{DS}$ Temperature Coefficient                          | $\Delta V_{DS}/T_J$ | Reference to $25\text{ }^{\circ}\text{C}$ , $I_D = 250\text{ }\mu\text{A}$                                                                               |                                              | -    | 0.58 | -         | V/ $^{\circ}\text{C}$ |
| Gate-Source Threshold Voltage (N)                         | $V_{GS(th)}$        | $V_{DS} = V_{GS}$ , $I_D = 250\text{ }\mu\text{A}$                                                                                                       |                                              | 3    | -    | 5         | V                     |
| Gate-Source Leakage                                       | $I_{GSS}$           | $V_{GS} = \pm 30\text{ V}$                                                                                                                               |                                              | -    | -    | $\pm 100$ | nA                    |
| Zero Gate Voltage Drain Current                           | $I_{DSS}$           | $V_{DS} = 500\text{ V}$ , $V_{GS} = 0\text{ V}$                                                                                                          |                                              | -    | -    | 1         | $\mu\text{A}$         |
|                                                           |                     | $V_{DS} = 400\text{ V}$ , $V_{GS} = 0\text{ V}$ , $T_J = 125\text{ }^{\circ}\text{C}$                                                                    |                                              | -    | -    | 10        |                       |
| Drain-Source On-State Resistance                          | $R_{DS(on)}$        | $V_{GS} = 10\text{ V}$                                                                                                                                   | $I_D = 4\text{ A}$                           | -    | 0.70 | 0.85      | $\Omega$              |
| Forward Transconductance <sup>a</sup>                     | $g_{fs}$            | $V_{DS} = 20\text{ V}$ , $I_D = 4\text{ A}$                                                                                                              |                                              | -    | 3    | -         | S                     |
| Dynamic                                                   |                     |                                                                                                                                                          |                                              |      |      |           |                       |
| Input Capacitance                                         | $C_{iss}$           | $V_{GS} = 0\text{ V}$ ,<br>$V_{DS} = 100\text{ V}$ ,<br>$f = 1\text{ MHz}$                                                                               |                                              | -    | 527  | -         | pF                    |
| Output Capacitance                                        | $C_{oss}$           |                                                                                                                                                          |                                              | -    | 52   | -         |                       |
| Reverse Transfer Capacitance                              | $C_{rss}$           |                                                                                                                                                          |                                              | -    | 8    | -         |                       |
| Effective Output Capacitance, Energy Related <sup>b</sup> | $C_{o(er)}$         | $V_{DS} = 0\text{ V to } 400\text{ V}$ , $V_{GS} = 0\text{ V}$                                                                                           |                                              | -    | 46   | -         |                       |
| Effective Output Capacitance, Time Related <sup>c</sup>   | $C_{o(tr)}$         |                                                                                                                                                          |                                              | -    | 64   | -         |                       |
| Total Gate Charge                                         | $Q_g$               | $V_{GS} = 10\text{ V}$                                                                                                                                   | $I_D = 4\text{ A}$ , $V_{DS} = 400\text{ V}$ | -    | 15   | 30        | nC                    |
| Gate-Source Charge                                        | $Q_{gs}$            |                                                                                                                                                          |                                              | -    | 4    | -         |                       |
| Gate-Drain Charge                                         | $Q_{gd}$            |                                                                                                                                                          |                                              | -    | 7    | -         |                       |
| Turn-On Delay Time                                        | $t_{d(on)}$         | $V_{DD} = 400\text{ V}$ , $I_D = 4\text{ A}$<br>$R_g = 9.1\text{ }\Omega$ , $V_{GS} = 10\text{ V}$                                                       |                                              | -    | 13   | 26        | ns                    |
| Rise Time                                                 | $t_r$               |                                                                                                                                                          |                                              | -    | 16   | 32        |                       |
| Turn-Off Delay Time                                       | $t_{d(off)}$        |                                                                                                                                                          |                                              | -    | 17   | 34        |                       |
| Fall Time                                                 | $t_f$               |                                                                                                                                                          |                                              | -    | 11   | 22        |                       |
| Gate Input Resistance                                     | $R_g$               | $f = 1\text{ MHz}$ , open drain                                                                                                                          |                                              | -    | 1.8  | -         | $\Omega$              |
| Drain-Source Body Diode Characteristics                   |                     |                                                                                                                                                          |                                              |      |      |           |                       |
| Continuous Source-Drain Diode Current                     | $I_S$               | MOSFET symbol showing the integral reverse p - n junction diode<br> |                                              | -    | -    | 8         | A                     |
| Pulsed Diode Forward Current                              | $I_{SM}$            |                                                                                                                                                          |                                              | -    | -    | 32        |                       |
| Diode Forward Voltage                                     | $V_{SD}$            | $T_J = 25\text{ }^{\circ}\text{C}$ , $I_S = 4\text{ A}$ , $V_{GS} = 0\text{ V}$                                                                          |                                              | -    | -    | 1.2       | V                     |
| Reverse Recovery Time                                     | $t_{rr}$            | $T_J = 25\text{ }^{\circ}\text{C}$ , $I_F = I_S = 4\text{ A}$ ,<br>$di/dt = 100\text{ A}/\mu\text{s}$ , $V_R = 20\text{ V}$                              |                                              | -    | 308  | -         | ns                    |
| Reverse Recovery Charge                                   | $Q_{rr}$            |                                                                                                                                                          |                                              | -    | 1.8  | -         | $\mu\text{C}$         |
| Reverse Recovery Current                                  | $I_{RRM}$           |                                                                                                                                                          |                                              | -    | 11   | -         | A                     |

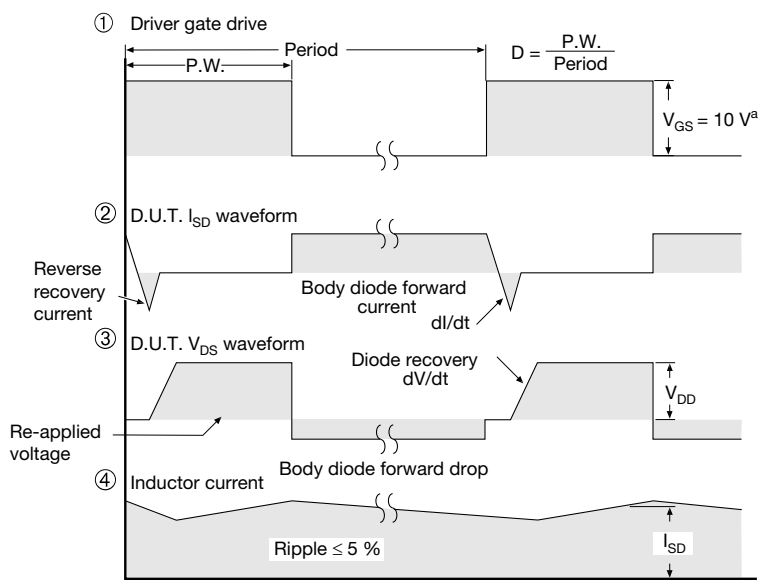
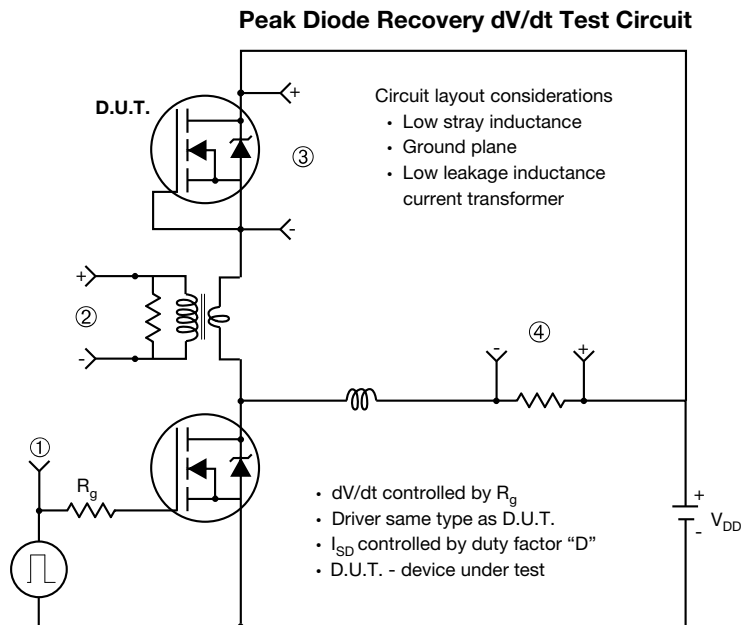
**Note**

- a. Repetitive rating; pulse width limited by maximum junction temperature.  
b.  $C_{oss(er)}$  is a fixed capacitance that gives the same energy as  $C_{oss}$  while  $V_{DS}$  is rising from 0 % to 80 %  $V_{DSS}$ .  
c.  $C_{oss(tr)}$  is a fixed capacitance that gives the same charging time as  $C_{oss}$  while  $V_{DS}$  is rising from 0 % to 80 %  $V_{DSS}$ .

**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 - Typical Drain-to-Source Voltage vs. Temperature**

**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

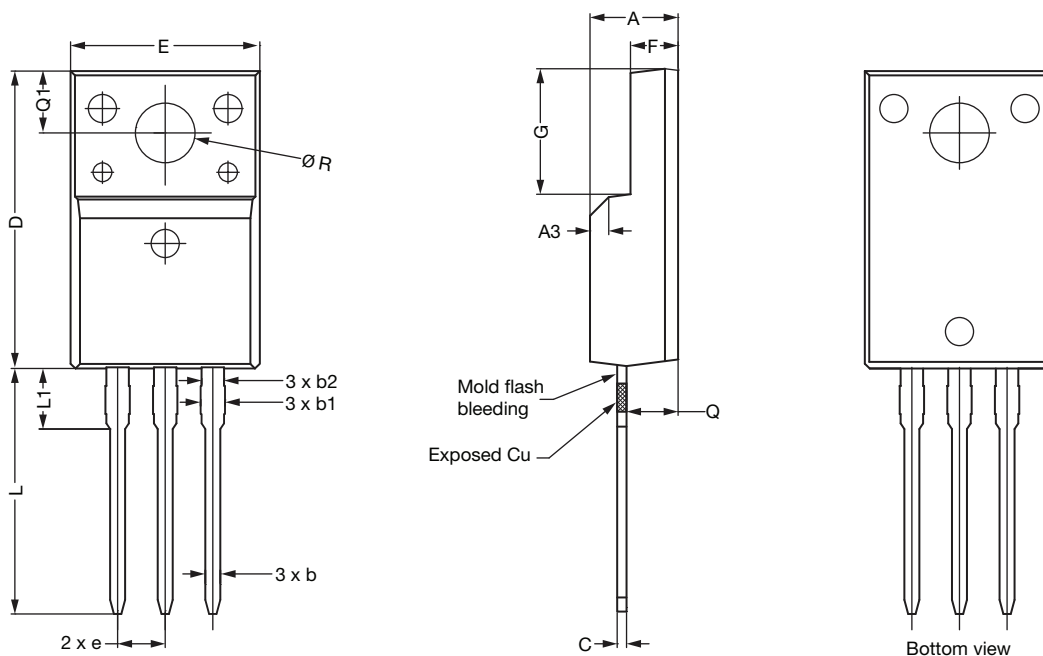
**Fig. 18 - For N-Channel**

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## TO-220 FULLPAK (High Voltage)

### OPTION 1: FACILITY CODE = 9



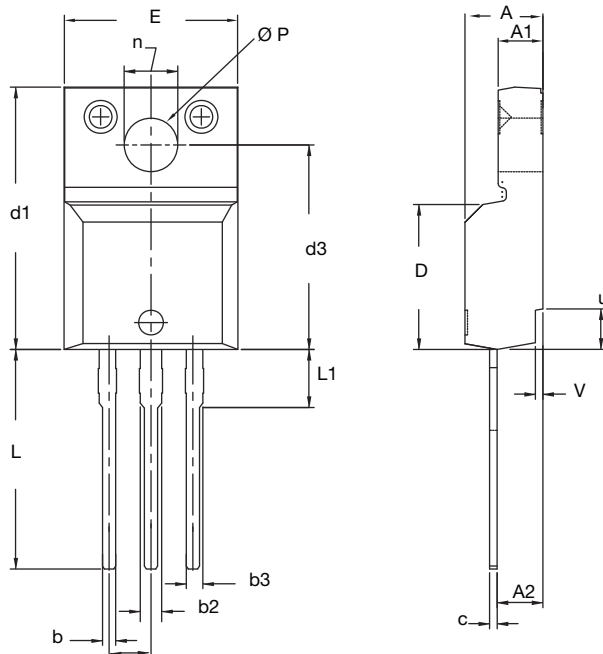
| DIM. | MILLIMETERS |       |       |
|------|-------------|-------|-------|
|      | MIN.        | NOM.  | MAX.  |
| A    | 4.60        | 4.70  | 4.80  |
| b    | 0.70        | 0.80  | 0.91  |
| b1   | 1.20        | 1.30  | 1.47  |
| b2   | 1.10        | 1.20  | 1.30  |
| C    | 0.45        | 0.50  | 0.63  |
| D    | 15.80       | 15.87 | 15.97 |
| e    | 2.54 BSC    |       |       |
| E    | 10.00       | 10.10 | 10.30 |
| F    | 2.44        | 2.54  | 2.64  |
| G    | 6.50        | 6.70  | 6.90  |
| L    | 12.90       | 13.10 | 13.30 |
| L1   | 3.13        | 3.23  | 3.33  |
| Q    | 2.65        | 2.75  | 2.85  |
| Q1   | 3.20        | 3.30  | 3.40  |
| Ø R  | 3.08        | 3.18  | 3.28  |

#### 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
6. Facility code will be the 1<sup>st</sup> character located at the 2<sup>nd</sup> row of the unit marking



## OPTION 2: FACILITY CODE = Y



| 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: E19-0180-Rev. D, 08-Apr-2019  
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
6. Facility code will be the 1<sup>st</sup> character located at the 2<sup>nd</sup> row of the unit marking



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