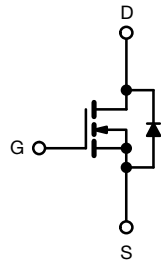
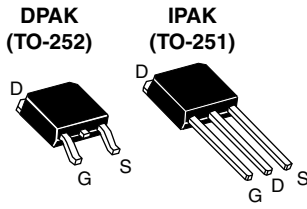


## Power MOSFET



N-Channel MOSFET

### FEATURES

- Dynamic dV/dt rating
- Repetitive avalanche rated
- Surface-mount (IRFR420, SiHFR420)
- Straight lead (IRFU420, SiHFU420)
- Available in tape and reel
- Fast switching
- Ease of paralleling
- Material categorization: for definitions of compliance please see [www.vishay.com/doc?99912](http://www.vishay.com/doc?99912)



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

### PRODUCT SUMMARY

|                          |                        |     |
|--------------------------|------------------------|-----|
| V <sub>DS</sub> (V)      | 500                    |     |
| R <sub>DS(on)</sub> (Ω)  | V <sub>GS</sub> = 10 V | 3.0 |
| Q <sub>g</sub> max. (nC) | 19                     |     |
| Q <sub>gs</sub> (nC)     | 3.3                    |     |
| Q <sub>gd</sub> (nC)     | 13                     |     |
| Configuration            | Single                 |     |

### DESCRIPTION

Third generation power MOSFETs from Vishay provide the designer with the best combination of fast switching, ruggedized device design, low on-resistance and cost-effectiveness.

The DPAK is designed for surface mounting using vapor phase, infrared, or wave soldering techniques. The straight lead version (IRFU, SiHFU series) is for through-hole mounting applications. Power dissipation levels up to 1.5 W are possible in typical surface-mount applications.

### ORDERING INFORMATION

| Package                         | DPAK (TO-252)  | DPAK (TO-252)               | DPAK (TO-252)                | DPAK (TO-252)                | IPAK (TO-251) |
|---------------------------------|----------------|-----------------------------|------------------------------|------------------------------|---------------|
| Lead (Pb)-free and halogen-free | SiHFR420-GE3   | SiHFR420TR-GE3 <sup>a</sup> | SiHFR420TRL-GE3 <sup>a</sup> | SiHFR420TRR-GE3 <sup>a</sup> | SiHFU420-GE3  |
|                                 | IRFR420PbF-BE3 | IRFR420TRPbF-BE3            | IRFR420TRLPbF-BE3            | -                            | -             |
| Lead (Pb)-free                  | IRFR420PbF     | IRFR420TRPbF <sup>a</sup>   | IRFR420TRLPbF <sup>a</sup>   | IRFR420TRRPbF <sup>a</sup>   | IRFU420PbF    |

#### Note

a. See device orientation

### ABSOLUTE MAXIMUM RATINGS (T<sub>C</sub> = 25 °C, unless otherwise noted)

| PARAMETER   | SYMBOL                            | LIMIT                   | UNIT |
|---|-----------------------------------|-------------------------|------|
| Drain-source voltage                                      | V <sub>DS</sub>                   | 500                     | V    |
| Gate-source voltage                                       | V <sub>GS</sub>                   | ± 20                    | V    |
| Continuous drain current                                  | V <sub>GS</sub> at 10 V           | T <sub>C</sub> = 25 °C  | A    |
|   |                                   | T <sub>C</sub> = 100 °C |      |
| Pulsed drain current <sup>a</sup>                         | I <sub>DM</sub>                   | 8.0                     | A    |
| Linear derating factor                                    |                                   | 0.33                    | W/°C |
| Linear derating factor (PCB mount) <sup>e</sup>           |                                   | 0.020                   |      |
| Single pulse avalanche energy <sup>b</sup>                | E <sub>AS</sub>                   | 400                     | mJ   |
| Repetitive avalanche current <sup>a</sup>                 | I <sub>AR</sub>                   | 2.4                     | A    |
| Repetitive avalanche energy <sup>a</sup>                  | E <sub>AR</sub>                   | 4.2                     | mJ   |
| Maximum power dissipation                                 | P <sub>D</sub>                    | T <sub>C</sub> = 25 °C  | W    |
|   |                                   | T <sub>A</sub> = 25 °C  |      |
| Peak diode recovery dV/dt <sup>c</sup>                    | dV/dt                             | 3.5                     | V/ns |
| Operating junction and storage temperature range          | T <sub>J</sub> , T <sub>stg</sub> | -55 to +150             | °C   |
| Soldering recommendations (peak temperature) <sup>d</sup> | For 10 s                          | 260                     |      |

#### Notes

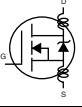

- Repetitive rating; pulse width limited by maximum junction temperature (see fig. 11)
- V<sub>DD</sub> = 50 V, starting T<sub>J</sub> = 25 °C, L = 124 mH, R<sub>g</sub> = 25 Ω, I<sub>AS</sub> = 2.4 A (see fig. 12)
- I<sub>SD</sub> ≤ 2.4 A, dI/dt ≤ 50 A/μs, V<sub>DD</sub> ≤ V<sub>DS</sub>, T<sub>J</sub> ≤ 150 °C
- 1.6 mm from case
- When mounted on 1" square PCB (FR-4 or G-10 material)



| THERMAL RESISTANCE RATINGS                           |            |     |      |      |
|--|------------|-----|------|------|
| PARAMETER  | SYMBOL     | TYP | MAX. | UNIT |
| Maximum junction-to-ambient                          | $R_{thJA}$ | -   | 110  | °C/W |
| Maximum junction-to-ambient (PCB mount) <sup>a</sup> | $R_{thJA}$ | -   | 50   |      |
| Maximum junction-to-case (drain)                     | $R_{thJC}$ | -   | 3.0  |      |

**Note**

a. When mounted on 1" square PCB (FR-4 or G-10 material)

| SPECIFICATIONS ( $T_J = 25\text{ }^\circ\text{C}$ , unless otherwise noted) |                     |  |      |      |           |               |
|---|---------------------|--|------|------|-----------|---------------|
| PARAMETER   | SYMBOL              | TEST CONDITIONS  | MIN. | TYP. | MAX.      | UNIT          |
| <b>Static</b>   |                     |  |      |      |           |               |
| 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 $25\text{ }^\circ\text{C}, I_D = 1\text{ mA}$   | -    | 0.59 | -         | V/°C          |
| Gate-source threshold voltage   | $V_{GS(th)}$        | $V_{DS} = V_{GS}, I_D = 250\text{ }\mu\text{A}$  | 2.0  | -    | 4.0       | V             |
| Gate-source leakage   | $I_{GSS}$           | $V_{GS} = \pm 20\text{ V}$   | -    | -    | $\pm 100$ | nA            |
| Zero gate voltage drain current   | $I_{DSS}$           | $V_{DS} = 500\text{ V}, V_{GS} = 0\text{ V}$   | -    | -    | 25        | $\mu\text{A}$ |
|   |                     | $V_{DS} = 400\text{ V}, V_{GS} = 0\text{ V}, T_J = 125\text{ }^\circ\text{C}$  | -    | -    | 250       |               |
| Drain-source on-state resistance  | $R_{DS(on)}$        | $V_{GS} = 10\text{ V}, I_D = 1.4\text{ A}^b$   | -    | -    | 3.0       | $\Omega$      |
| Forward transconductance  | $g_{fs}$            | $V_{DS} = 50\text{ V}, I_D = 1.4\text{ A}$   | 1.5  | -    | -         | S             |
| <b>Dynamic</b>  |                     |  |      |      |           |               |
| Input capacitance   | $C_{iss}$           | $V_{GS} = 0\text{ V}, V_{DS} = 25\text{ V}, f = 1.0\text{ MHz}, \text{ see fig. 5}$  | -    | 360  | -         | pF            |
| Output capacitance  | $C_{oss}$           |  | -    | 92   | -         |               |
| Reverse transfer capacitance  | $C_{rss}$           |  | -    | 37   | -         |               |
| Total gate charge   | $Q_g$               | $V_{GS} = 10\text{ V}, I_D = 2.1\text{ A}, V_{DS} = 400\text{ V}, \text{ see fig. 6 and 13}^b$   | -    | -    | 19        | nC            |
| Gate-source charge  | $Q_{gs}$            |  | -    | -    | 3.3       |               |
| Gate-drain charge   | $Q_{gd}$            |  | -    | -    | 13        |               |
| Turn-on delay time  | $t_{d(on)}$         | $V_{DD} = 250\text{ V}, I_D = 2.1\text{ A}, R_g = 18\text{ }\Omega, R_D = 120\text{ }\Omega, \text{ see fig. 10}^b$  | -    | 8.0  | -         | ns            |
| Rise time   | $t_r$               |  | -    | 8.6  | -         |               |
| Turn-off delay time   | $t_{d(off)}$        |  | -    | 33   | -         |               |
| Fall time   | $t_f$               |  | -    | 16   | -         |               |
| Gate input resistance   | $R_g$               | $f = 1\text{ MHz}, \text{ open drain}$   | 1.8  | -    | 12.6      | $\Omega$      |
| Internal drain inductance   | $L_D$               | Between lead, 6 mm (0.25") from package and center of die contact<br> | -    | 4.5  | -         | nH            |
| Internal source inductance  | $L_S$               |  | -    | 7.5  | -         |               |
| <b>Drain-Source Body Diode Characteristics</b>                              |                     |  |      |      |           |               |
| Continuous source-drain diode current                                       | $I_S$               | MOSFET symbol showing the integral reverse p - n junction diode<br>   | -    | -    | 2.4       | A             |
| Pulsed diode forward current <sup>a</sup>                                   | $I_{SM}$            |  | -    | -    | 8.0       |               |
| Body diode voltage  | $V_{SD}$            | $T_J = 25\text{ }^\circ\text{C}, I_S = 2.4\text{ A}, V_{GS} = 0\text{ V}^b$  | -    | -    | 1.6       | V             |
| Body diode reverse recovery time  | $t_{rr}$            | $T_J = 25\text{ }^\circ\text{C}, I_F = 2.1\text{ A}, dI/dt = 100\text{ A}/\mu\text{s}^b$   | -    | 260  | 520       | ns            |
| Body diode reverse recovery charge  | $Q_{rr}$            |  | -    | 0.70 | 1.4       | $\mu\text{C}$ |
| Forward turn-on time  | $t_{on}$            | Intrinsic turn-on time is negligible (turn-on is dominated by $L_S$ and $L_D$ )  |      |      |           |               |

**Notes**

- a. Repetitive rating; pulse width limited by maximum junction temperature (see fig. 11)
- b. Pulse width  $\leq 300\text{ }\mu\text{s}$ ; duty cycle  $\leq 2\%$



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

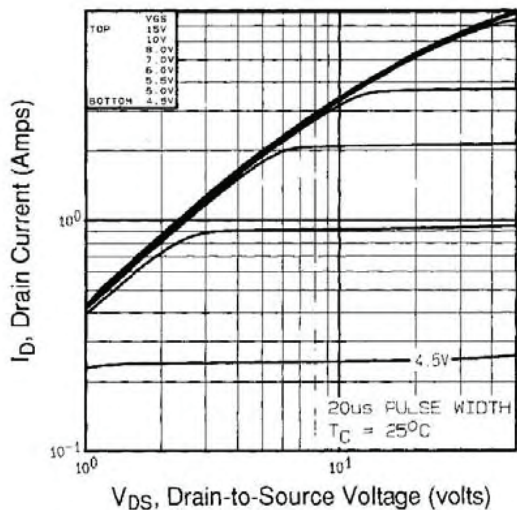


Fig. 1 - Typical Output Characteristics,  $T_C = 25\text{ }^\circ\text{C}$

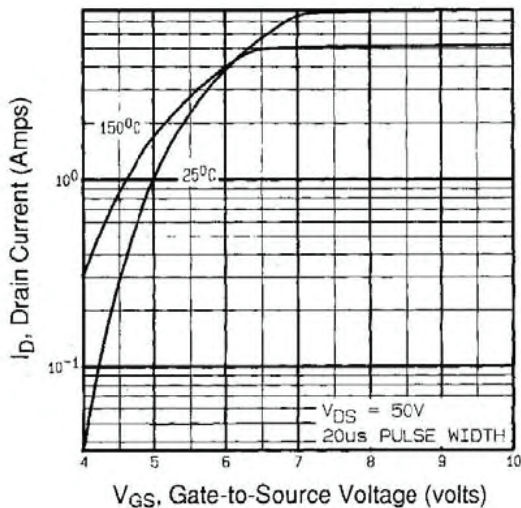


Fig. 3 - Typical Transfer Characteristics

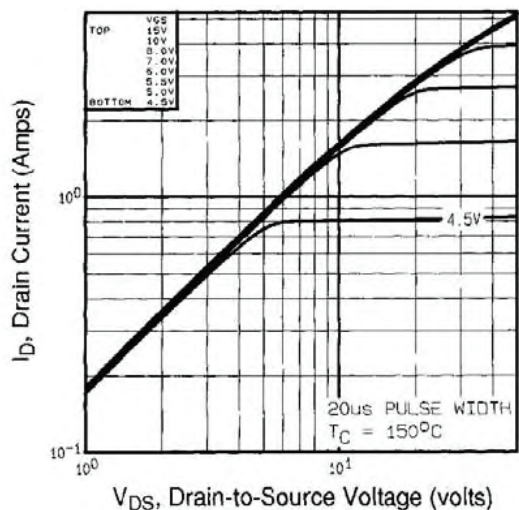


Fig. 2 - Typical Output Characteristics,  $T_C = 150\text{ }^\circ\text{C}$

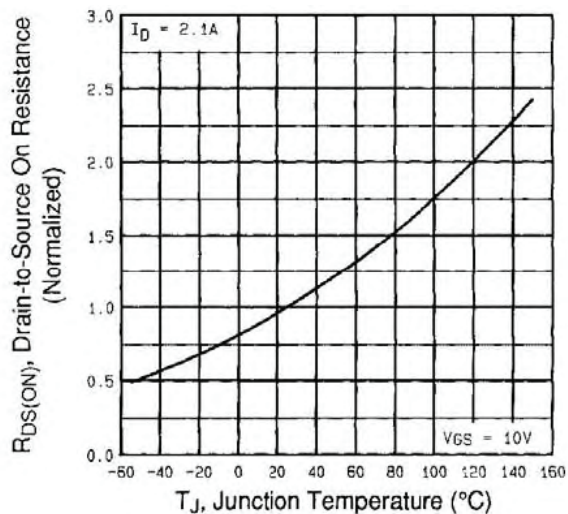


Fig. 4 - Normalized On-Resistance vs. Temperature

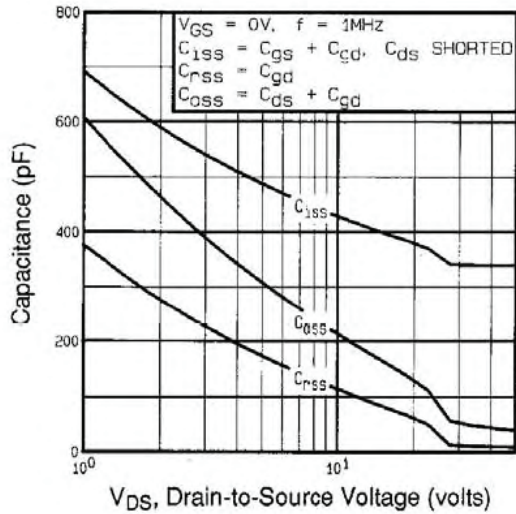


Fig. 5 - Typical Capacitance vs. Drain-to-Source Voltage



Fig. 7 - Typical Source-Drain Diode Forward Voltage

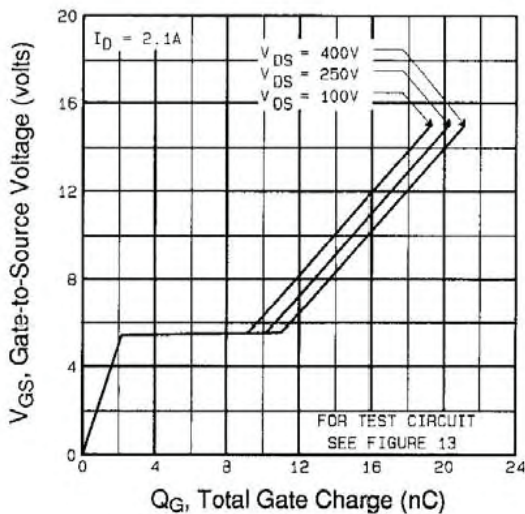


Fig. 6 - Typical Gate Charge vs. Gate-to-Source Voltage

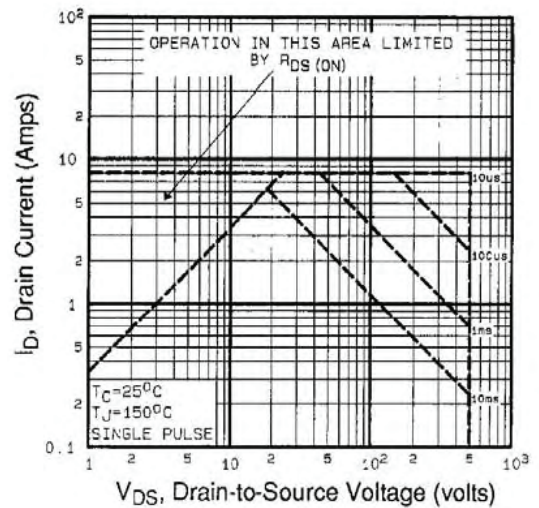


Fig. 8 - Maximum Safe Operating Area

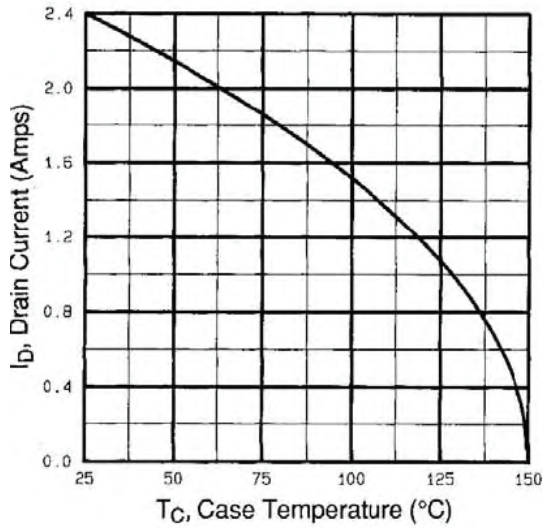


Fig. 9 - Maximum Drain Current vs. Case Temperature

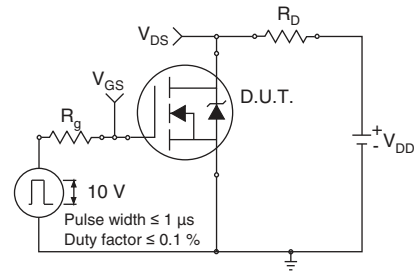


Fig. 10a - Switching Time Test Circuit



Fig. 10b - Switching Time Waveforms

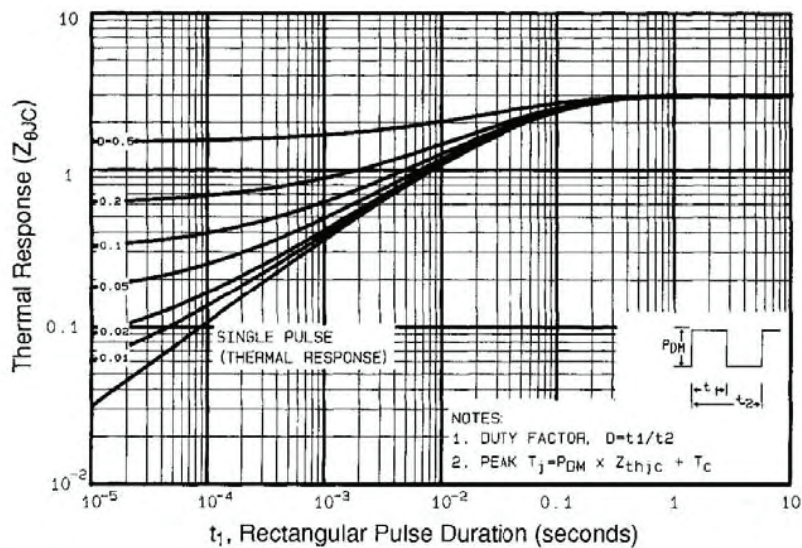


Fig. 11 - Maximum Effective Transient Thermal Impedance, Junction-to-Case

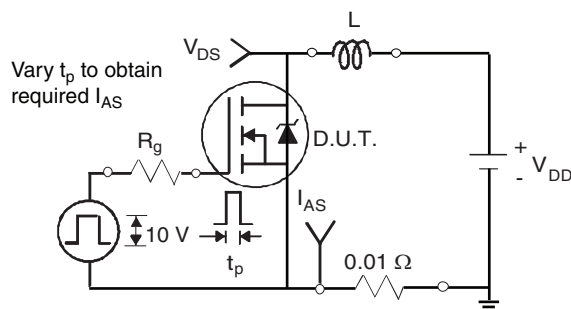


Fig. 12a - Unclamped Inductive Test Circuit

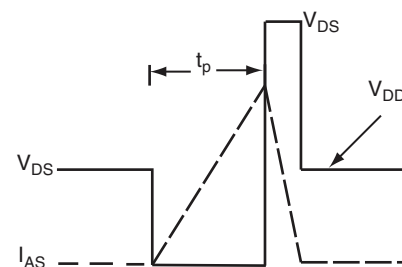


Fig. 12b - Unclamped Inductive Waveforms

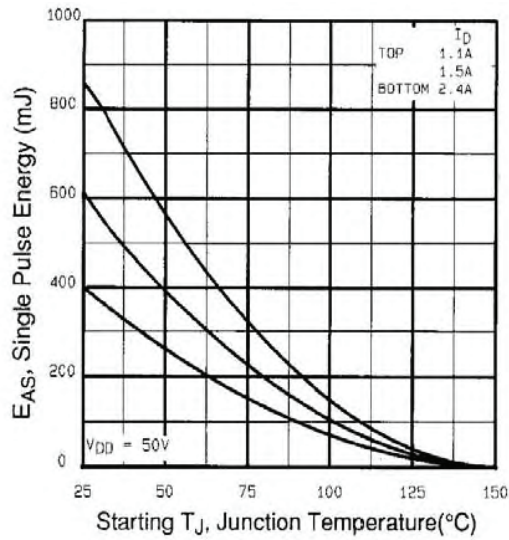


Fig. 12c - Maximum Avalanche Energy vs. Drain Current

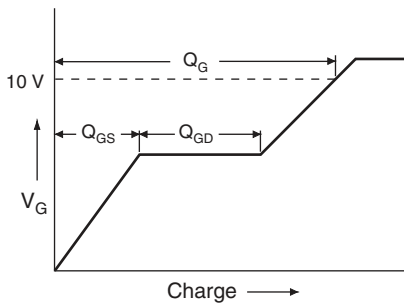


Fig. 13a - Basic Gate Charge Waveform

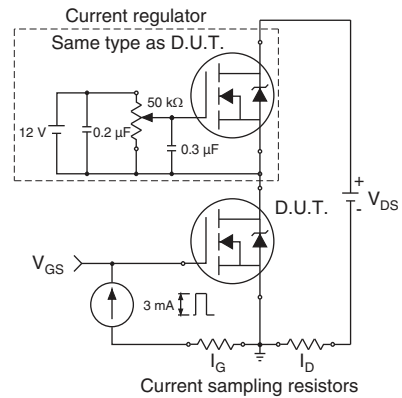
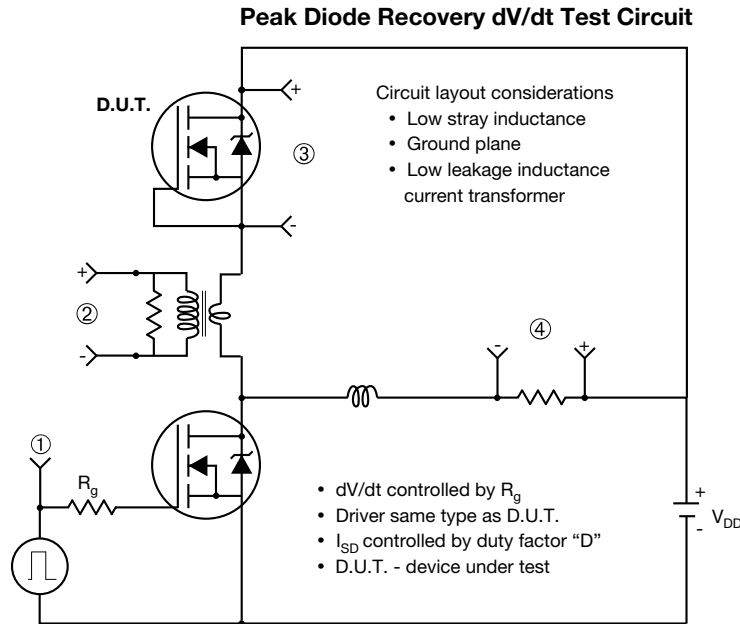


Fig. 13b - Gate Charge Test Circuit



**Note**

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

**Fig. 14 - For N-Channel**

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# TO-252AA Case Outline

## VERSION 1: FACILITY CODE = Y



| MILLIMETERS |          |       |
|-------------|----------|-------|
| DIM.        | MIN.     | MAX.  |
| A           | 2.18     | 2.38  |
| A1          | -        | 0.127 |
| b           | 0.64     | 0.88  |
| b2          | 0.76     | 1.14  |
| b3          | 4.95     | 5.46  |
| C           | 0.46     | 0.61  |
| C2          | 0.46     | 0.89  |
| D           | 5.97     | 6.22  |
| D1          | 4.10     | -     |
| E           | 6.35     | 6.73  |
| E1          | 4.32     | -     |
| H           | 9.40     | 10.41 |
| e           | 2.28 BSC |       |
| e1          | 4.56 BSC |       |
| L           | 1.40     | 1.78  |
| L3          | 0.89     | 1.27  |
| L4          | -        | 1.02  |
| L5          | 1.01     | 1.52  |

### Note

- Dimension L3 is for reference only





VERSION 2: FACILITY CODE = N



| MILLIMETERS |          |       |
|-------------|----------|-------|
| DIM.        | MIN.     | MAX.  |
| A           | 2.18     | 2.39  |
| A1          | -        | 0.13  |
| b           | 0.65     | 0.89  |
| b1          | 0.64     | 0.79  |
| b2          | 0.76     | 1.13  |
| b3          | 4.95     | 5.46  |
| c           | 0.46     | 0.61  |
| c1          | 0.41     | 0.56  |
| c2          | 0.46     | 0.60  |
| D           | 5.97     | 6.22  |
| D1          | 5.21     | -     |
| E           | 6.35     | 6.73  |
| E1          | 4.32     | -     |
| e           | 2.29 BSC |       |
| H           | 9.94     | 10.34 |

| MILLIMETERS |           |      |
|-------------|-----------|------|
| DIM.        | MIN.      | MAX. |
| L           | 1.50      | 1.78 |
| L1          | 2.74 ref. |      |
| L2          | 0.51 BSC  |      |
| L3          | 0.89      | 1.27 |
| L4          | -         | 1.02 |
| L5          | 1.14      | 1.49 |
| L6          | 0.65      | 0.85 |
| θ           | 0°        | 10°  |
| θ1          | 0°        | 15°  |
| θ2          | 25°       | 35°  |

Notes

- Dimensioning and tolerance confirm to ASME Y14.5M-1994
- All dimensions are in millimeters. Angles are in degrees
- Heat sink side flash is max. 0.8 mm
- Radius on terminal is optional

ECN: E22-0399-Rev. R, 03-Oct-2022  
 DWG: 5347

## Case Outline for TO-251AA (High Voltage)

### OPTION 1:



| DIM. | MILLIMETERS |      | INCHES |       |
|------|-------------|------|--------|-------|
|      | MIN.        | MAX. | MIN.   | MAX.  |
| A    | 2.18        | 2.39 | 0.086  | 0.094 |
| A1   | 0.89        | 1.14 | 0.035  | 0.045 |
| b    | 0.64        | 0.89 | 0.025  | 0.035 |
| b1   | 0.65        | 0.79 | 0.026  | 0.031 |
| b2   | 0.76        | 1.14 | 0.030  | 0.045 |
| b3   | 0.76        | 1.04 | 0.030  | 0.041 |
| b4   | 4.95        | 5.46 | 0.195  | 0.215 |
| c    | 0.46        | 0.61 | 0.018  | 0.024 |
| c1   | 0.41        | 0.56 | 0.016  | 0.022 |
| c2   | 0.46        | 0.86 | 0.018  | 0.034 |
| D    | 5.97        | 6.22 | 0.235  | 0.245 |

| DIM. | MILLIMETERS |      | INCHES   |       |
|------|-------------|------|----------|-------|
|      | MIN.        | MAX. | MIN.     | MAX.  |
| D1   | 5.21        | -    | 0.205    | -     |
| E    | 6.35        | 6.73 | 0.250    | 0.265 |
| E1   | 4.32        | -    | 0.170    | -     |
| e    | 2.29 BSC    |      | 2.29 BSC |       |
| L    | 8.89        | 9.65 | 0.350    | 0.380 |
| L1   | 1.91        | 2.29 | 0.075    | 0.090 |
| L2   | 0.89        | 1.27 | 0.035    | 0.050 |
| L3   | 1.14        | 1.52 | 0.045    | 0.060 |
| θ1   | 0'          | 15'  | 0'       | 15'   |
| θ2   | 25'         | 35'  | 25'      | 35'   |

ECN: E21-0682-Rev. C, 27-Dec-2021  
 DWG: 5968

#### Notes

- Dimensioning and tolerancing per ASME Y14.5M-1994
- Dimension are shown in inches and millimeters
- Dimension D and E do not include mold flash. Mold flash shall not exceed 0.13 mm (0.005") per side. These dimensions are measured at the outermost extremes of the plastic body
- Thermal pad contour optional with dimensions b4, L2, E1 and D1
- Lead dimension uncontrolled in L3
- Dimension b1, b3 and c1 apply to base metal only
- Outline conforms to JEDEC® outline TO-251AA



**OPTION 2: FACILITY CODE = N**



| DIM. | MIN.  | NOM.  | MAX.  |
|------|-------|-------|-------|
| A    | 2.180 | 2.285 | 2.390 |
| A1   | 0.890 | 1.015 | 1.140 |
| b    | 0.640 | 0.765 | 0.890 |
| b1   | 0.640 | 0.715 | 0.790 |
| b2   | 0.760 | 0.950 | 1.140 |
| b3   | 0.760 | 0.900 | 1.040 |
| b4   | 4.950 | 5.205 | 5.460 |
| c    | 0.460 | -     | 0.610 |
| c1   | 0.410 | -     | 0.560 |
| c2   | 0.460 | -     | 0.610 |
| D    | 5.970 | 6.095 | 6.220 |
| D1   | 4.300 | -     | -     |

| DIM.    | MIN.     | NOM.  | MAX.  |
|---------|----------|-------|-------|
| D2      | 5.380    | -     | -     |
| E       | 6.350    | 6.540 | 6.730 |
| E1      | 4.32     | -     | -     |
| e       | 2.29 BSC |       |       |
| L       | 8.890    | 9.270 | 9.650 |
| L1      | 1.910    | 2.100 | 2.290 |
| L2      | 0.890    | 1.080 | 1.270 |
| L3      | 1.140    | 1.330 | 1.520 |
| L4      | 1.300    | 1.400 | 1.500 |
| theta 1 | 0°       | 7.5°  | 15°   |
| theta 2 | 4°       | -     | -     |

ECN: E21-0682-Rev. C, 27-Dec-2021  
 DWG: 5968

**Notes**

- Dimensioning and tolerancing per ASME Y14.5M-1994
- All dimension are in millimeters, angles are in degrees
- Heat sink side flash is max. 0.8 mm

## RECOMMENDED MINIMUM PADS FOR DPAK (TO-252)



Recommended Minimum Pads  
Dimensions in Inches/(mm)

[Return to Index](#)



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