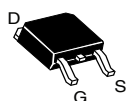


## Power MOSFET

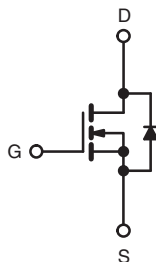
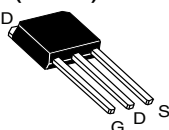
### PRODUCT SUMMARY

|                           |                        |     |
|---------------------------|------------------------|-----|
| $V_{DS}$ (V)              | 200                    |     |
| $R_{DS(on)}$ ( $\Omega$ ) | $V_{GS} = 10\text{ V}$ | 1.5 |
| $Q_g$ (Max.) (nC)         | 8.2                    |     |
| $Q_{gs}$ (nC)             | 1.8                    |     |
| $Q_{gd}$ (nC)             | 4.5                    |     |
| Configuration             | Single                 |     |

DPAK  
(TO-252)



IPAK  
(TO-251)



N-Channel MOSFET

### FEATURES

- Dynamic  $dV/dt$  Rating
- Repetitive Avalanche Rated
- Surface Mount (IRFR210, SiHFR210)
- Straight Lead (IRFU210, SiHFU210)
- 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

### 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 | SiHFR210-GE3  | SiHFR210TRL-GE3 <sup>a</sup> | -                         | SiHFR210TRR-GE3 <sup>a</sup> | SiHFU210-GE3  |
| Lead (Pb)-free                  | IRFR210PbF    | IRFR210TRL-PbF <sup>a</sup>  | IRFR210TRPbF <sup>a</sup> | -                            | IRFU210PbF    |
|                                 | SiHFR210-E3   | SiHFR210TL-E3 <sup>a</sup>   | SiHFR210T-E3 <sup>a</sup> | -                            | SiHFU210-E3   |

#### Note

a. See device orientation.

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

| PARAMETER                                                 | SYMBOL           | LIMIT                             | UNIT                |
|-----------------------------------------------------------|------------------|-----------------------------------|---------------------|
| Drain-Source Voltage                                      | $V_{DS}$         | 200                               | V                   |
| Gate-Source Voltage                                       | $V_{GS}$         | $\pm 20$                          |                     |
| Continuous Drain Current                                  | $V_{GS}$ at 10 V | $T_C = 25\text{ }^\circ\text{C}$  | A                   |
|                                                           |                  | $T_C = 100\text{ }^\circ\text{C}$ |                     |
| Pulsed Drain Current <sup>a</sup>                         | $I_{DM}$         | 10                                | W/ $^\circ\text{C}$ |
| Linear Derating Factor                                    |                  | 0.20                              |                     |
| Linear Derating Factor (PCB Mount) <sup>e</sup>           |                  | 0.020                             |                     |
| Single Pulse Avalanche Energy <sup>b</sup>                | $E_{AS}$         | 95                                | mJ                  |
| Avalanche Current <sup>a</sup>                            | $I_{AR}$         | 2.7                               | A                   |
| Repetitive Avalanche Energy <sup>a</sup>                  | $E_{AR}$         | 2.5                               | mJ                  |
| Maximum Power Dissipation                                 | $P_D$            | $T_C = 25\text{ }^\circ\text{C}$  | W                   |
| Maximum Power Dissipation (PCB Mount) <sup>e</sup>        |                  | $T_A = 25\text{ }^\circ\text{C}$  |                     |
| Peak Diode Recovery $dV/dt$ <sup>c</sup>                  | $dV/dt$          | 5.0                               | V/ns                |
| Operating Junction and Storage Temperature Range          | $T_J, T_{stg}$   | - 55 to + 150                     | $^\circ\text{C}$    |
| Soldering Recommendations (Peak Temperature) <sup>d</sup> | for 10 s         | 260                               |                     |

#### Notes

- Repetitive rating; pulse width limited by maximum junction temperature (see fig. 11).
- $V_{DD} = 50\text{ V}$ , starting  $T_J = 25\text{ }^\circ\text{C}$ ,  $L = 28\text{ mH}$ ,  $R_g = 25\text{ }\Omega$ ,  $I_{AS} = 2.6\text{ A}$  (see fig. 12).
- $I_{SD} \leq 2.6\text{ A}$ ,  $dI/dt \leq 70\text{ A}/\mu\text{s}$ ,  $V_{DD} \leq V_{DS}$ ,  $T_J \leq 150\text{ }^\circ\text{C}$ .
- 1.6 mm from case.
- When mounted on 1" square PCB (FR-4 or G-10 material).

**THERMAL RESISTANCE RATINGS**

| PARAMETER                                            | SYMBOL     | MIN. | 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)                     | $R_{thJC}$ | -    | -    | 5.0  |      |

**Note**

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

**SPECIFICATIONS** ( $T_J = 25\text{ °C}$ , 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                                                                             |                                                                                    | 200  | -    | -     | V    |
| V <sub>DS</sub> Temperature Coefficient   | ΔV <sub>DS</sub> /T <sub>J</sub> | Reference to 25 °C, I <sub>D</sub> = 1 mA                                                                                  |                                                                                    | -    | 0.30 | -     | V/°C |
| Gate-Source Threshold Voltage             | V <sub>GS(th)</sub>              | V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = 250 μA                                                                |                                                                                    | 2.0  | -    | 4.0   | 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> = 200 V, V <sub>GS</sub> = 0 V                                                                             |                                                                                    | -    | -    | 25    | μA   |
|                                           |                                  | V <sub>DS</sub> = 160 V, V <sub>GS</sub> = 0 V, T <sub>J</sub> = 125 °C                                                    |                                                                                    | -    | -    | 250   |      |
| Drain-Source On-State Resistance          | R <sub>DS(on)</sub>              | V <sub>GS</sub> = 10 V                                                                                                     | I <sub>D</sub> = 1.6 A <sup>b</sup>                                                | -    | -    | 1.5   | Ω    |
| Forward Transconductance                  | g <sub>fs</sub>                  | V <sub>DS</sub> = 50 V, I <sub>D</sub> = 1.6 A <sup>b</sup>                                                                |                                                                                    | 0.80 | -    | -     | S    |
| Dynamic                                   |                                  |                                                                                                                            |                                                                                    |      |      |       |      |
| Input Capacitance                         | C <sub>iss</sub>                 | V <sub>GS</sub> = 0 V,<br>V <sub>DS</sub> = 25 V,<br>f = 1.0 MHz, see fig. 5                                               |                                                                                    | -    | 140  | -     | pF   |
| Output Capacitance                        | C <sub>oss</sub>                 |                                                                                                                            |                                                                                    | -    | 53   | -     |      |
| Reverse Transfer Capacitance              | C <sub>rss</sub>                 |                                                                                                                            |                                                                                    | -    | 15   | -     |      |
| Total Gate Charge                         | Q <sub>g</sub>                   | V <sub>GS</sub> = 10 V                                                                                                     | I <sub>D</sub> = 3.3 A, V <sub>DS</sub> = 160 V,<br>see fig. 6 and 13 <sup>b</sup> | -    | -    | 8.2   | nC   |
| Gate-Source Charge                        | Q <sub>gs</sub>                  |                                                                                                                            |                                                                                    | -    | -    | 1.8   |      |
| Gate-Drain Charge                         | Q <sub>gd</sub>                  |                                                                                                                            |                                                                                    | -    | -    | 4.5   |      |
| Turn-On Delay Time                        | t <sub>d(on)</sub>               | V <sub>DD</sub> = 100 V, I <sub>D</sub> = 3.3 A,<br>R <sub>g</sub> = 24 Ω, R <sub>D</sub> = 30 Ω, see fig. 10 <sup>b</sup> |                                                                                    | -    | 8.2  | -     | ns   |
| Rise Time                                 | t <sub>r</sub>                   |                                                                                                                            |                                                                                    | -    | 17   | -     |      |
| Turn-Off Delay Time                       | t <sub>d(off)</sub>              |                                                                                                                            |                                                                                    | -    | 14   | -     |      |
| Fall Time                                 | t <sub>f</sub>                   |                                                                                                                            |                                                                                    | -    | 8.9  | -     |      |
| Internal Drain Inductance                 | L <sub>D</sub>                   | Between lead,<br>6 mm (0.25") from<br>package and center of<br>die contact                                                 |                                                                                    | -    | 4.5  | -     | nH   |
| Internal Source Inductance                | L <sub>S</sub>                   |                                                                                                                            |                                                                                    | -    | 7.5  | -     |      |
| Drain-Source Body Diode Characteristics   |                                  |                                                                                                                            |                                                                                    |      |      |       |      |
| Continuous Source-Drain Diode Current     | I <sub>S</sub>                   | MOSFET symbol<br>showing the<br>integral reverse<br>p - n junction diode                                                   |                                                                                    | -    | -    | 2.6   | A    |
| Pulsed Diode Forward Current <sup>a</sup> | I <sub>SM</sub>                  |                                                                                                                            |                                                                                    | -    | -    | 10    |      |
| Body Diode Voltage                        | V <sub>SD</sub>                  | T <sub>J</sub> = 25 °C, I <sub>S</sub> = 2.6 A, V <sub>GS</sub> = 0 V <sup>b</sup>                                         |                                                                                    | -    | -    | 2.0   | V    |
| Body Diode Reverse Recovery Time          | t <sub>rr</sub>                  | T <sub>J</sub> = 25 °C, I <sub>F</sub> = 3.3 A, dI/dt = 100 A/μs <sup>b</sup>                                              |                                                                                    | -    | 150  | 310   | ns   |
| Body Diode Reverse Recovery Charge        | Q <sub>rr</sub>                  |                                                                                                                            |                                                                                    | -    | 0.60 | 1.4   | μC   |
| Forward Turn-On Time                      | t <sub>on</sub>                  | Intrinsic turn-on time is negligible (turn-on is dominated by L <sub>S</sub> and L <sub>D</sub> )                          |                                                                                    |      |      |       |      |

**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)

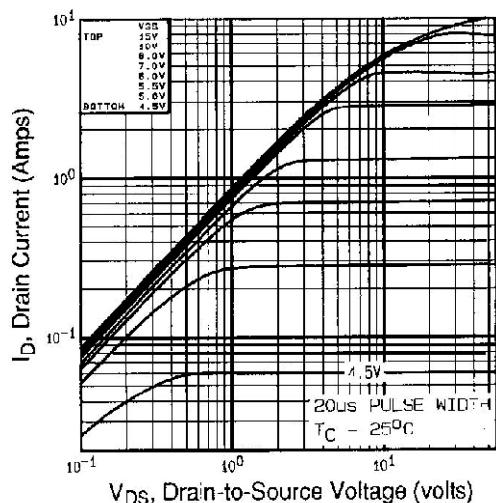


Fig. 1 - Typical Output Characteristics,  $T_C = 25^\circ C$

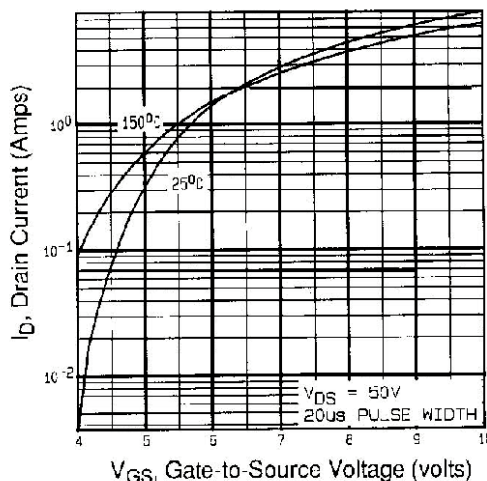


Fig. 3 - Typical Transfer Characteristics

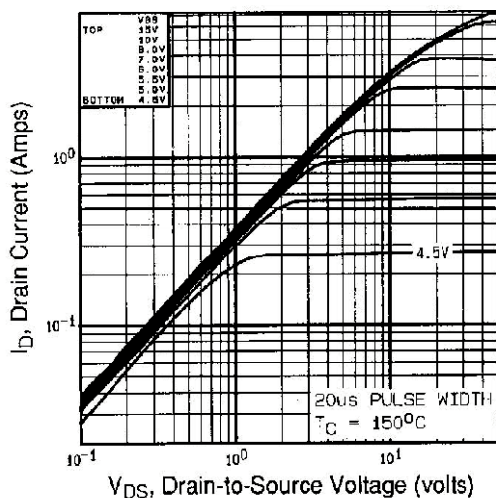


Fig. 2 - Typical Output Characteristics,  $T_C = 150^\circ C$

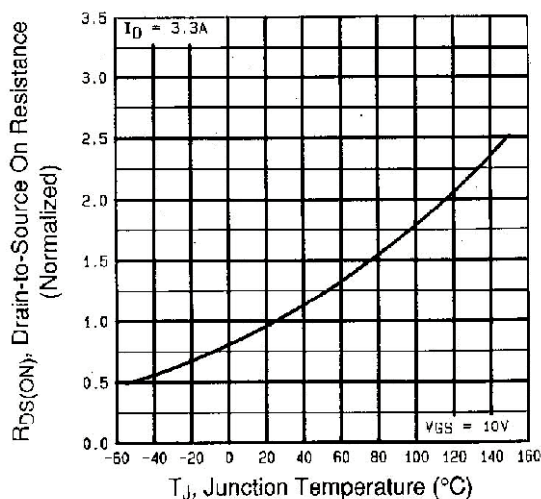
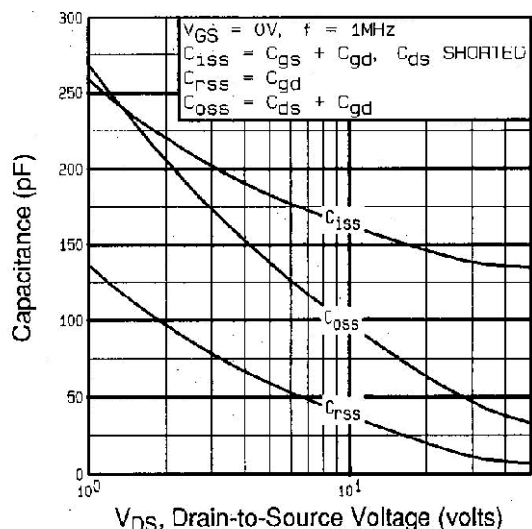
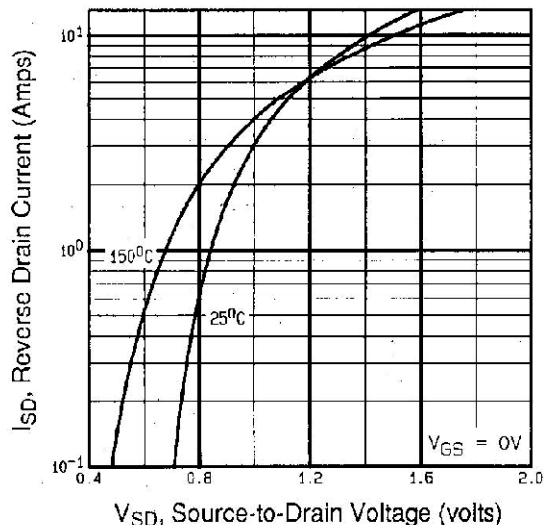
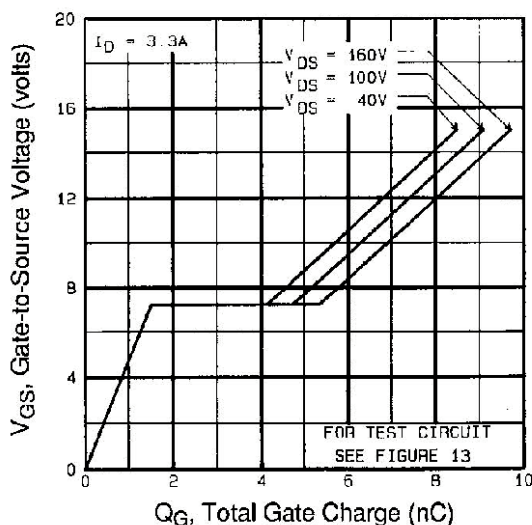
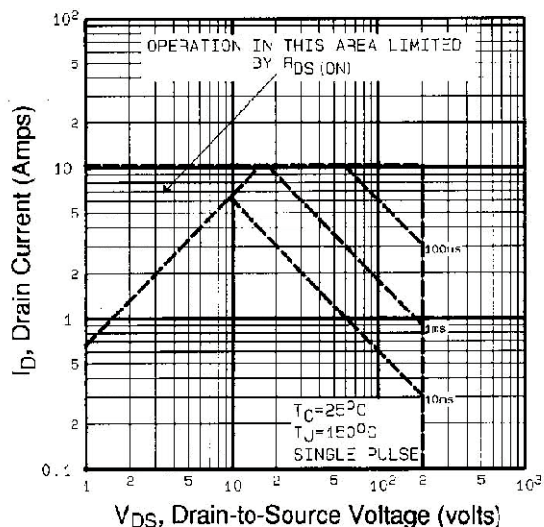


Fig. 4 - Normalized On-Resistance vs. Temperature


**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**

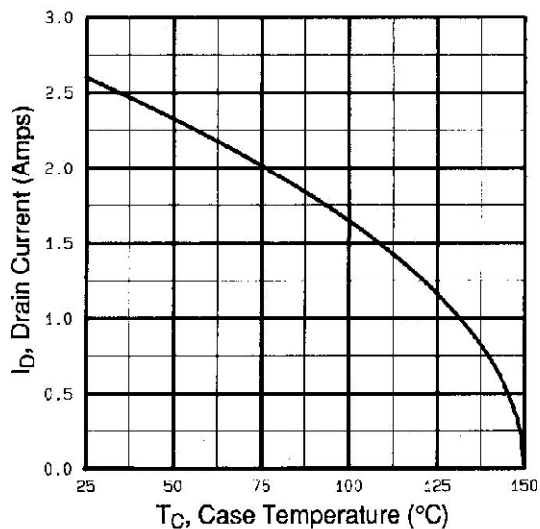


Fig. 9 - Maximum Drain Current vs. Case Temperature



Fig. 10a - Switching Time Test Circuit

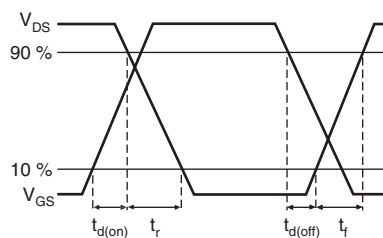


Fig. 10b - Switching Time Waveforms

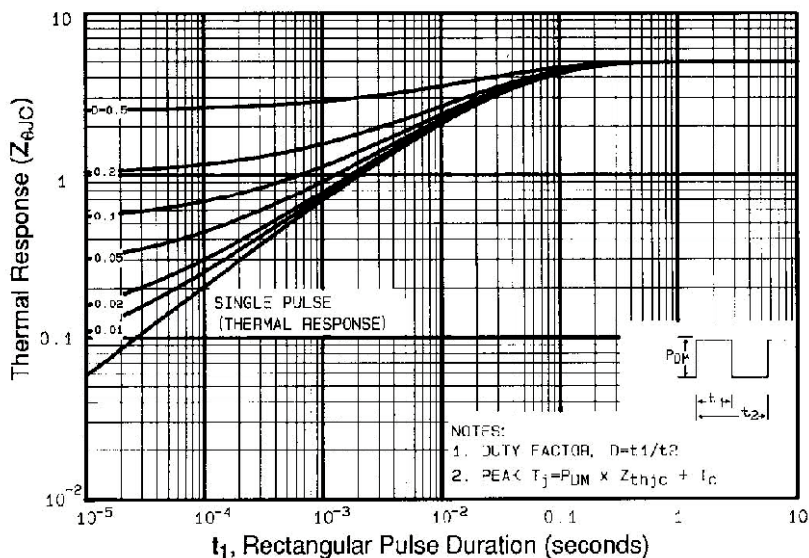


Fig. 11 - Maximum Effective Transient Thermal Impedance, Junction-to-Case

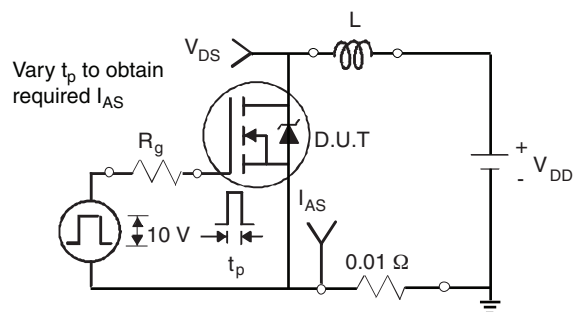


Fig. 12a - Unclamped Inductive Test Circuit



Fig. 12b - Unclamped Inductive Waveforms

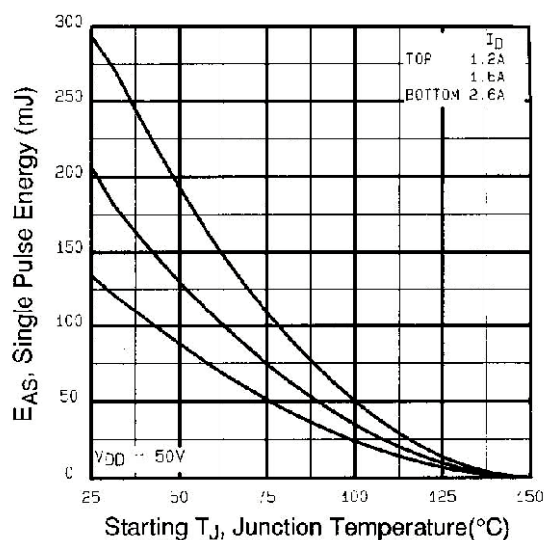


Fig. 12c - Maximum Avalanche Energy vs. Drain Current

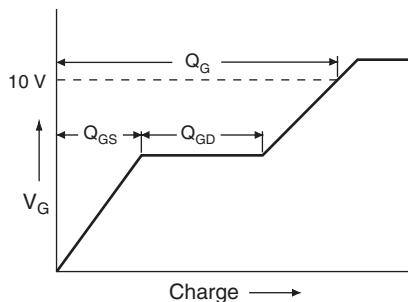


Fig. 13a - Basic Gate Charge Waveform

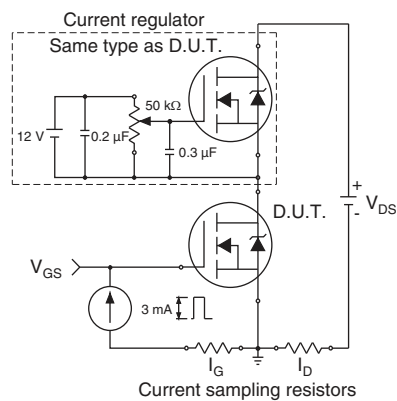
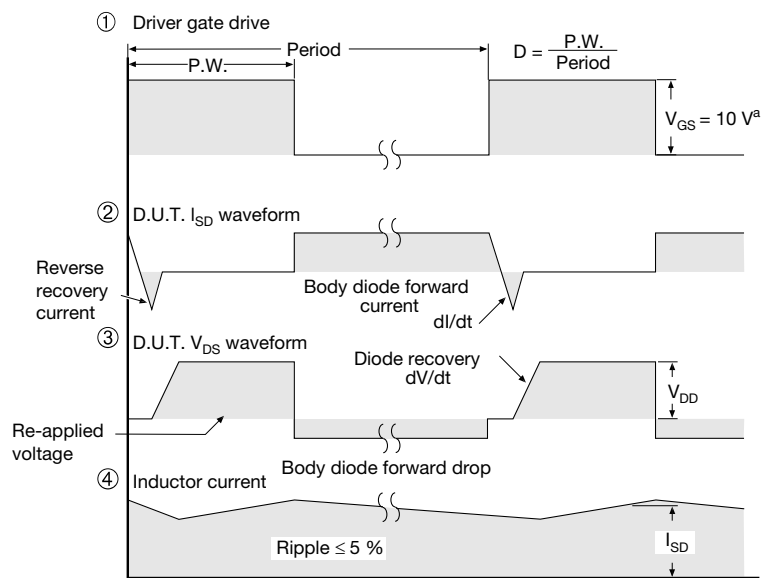
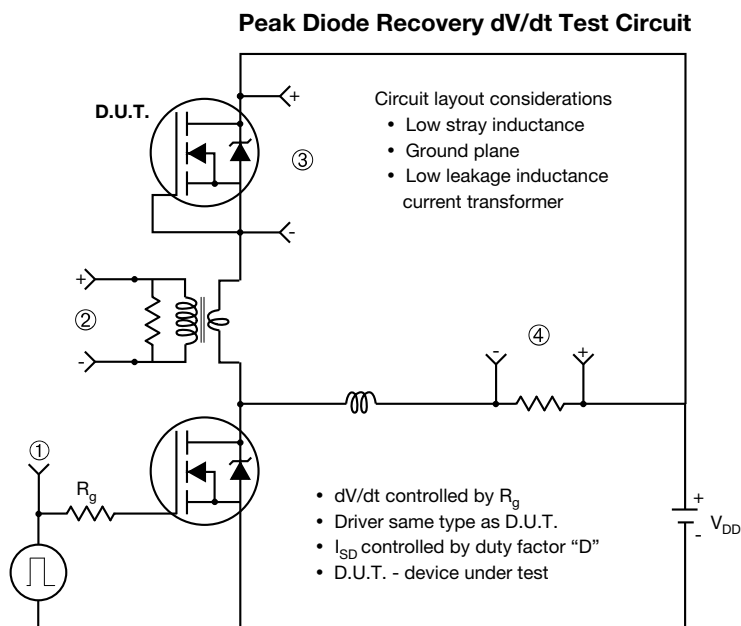


Fig. 13b - Gate Charge Test Circuit



**Note**

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

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

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## TO-252AA Case Outline



| DIM.                                         | MILLIMETERS |       | INCHES    |       |
|----------------------------------------------|-------------|-------|-----------|-------|
|                                              | MIN.        | MAX.  | MIN.      | MAX.  |
| A                                            | 2.18        | 2.38  | 0.086     | 0.094 |
| A1                                           | -           | 0.127 | -         | 0.005 |
| b                                            | 0.64        | 0.88  | 0.025     | 0.035 |
| b2                                           | 0.76        | 1.14  | 0.030     | 0.045 |
| b3                                           | 4.95        | 5.46  | 0.195     | 0.215 |
| C                                            | 0.46        | 0.61  | 0.018     | 0.024 |
| C2                                           | 0.46        | 0.89  | 0.018     | 0.035 |
| D                                            | 5.97        | 6.22  | 0.235     | 0.245 |
| D1                                           | 4.10        | -     | 0.161     | -     |
| E                                            | 6.35        | 6.73  | 0.250     | 0.265 |
| E1                                           | 4.32        | -     | 0.170     | -     |
| H                                            | 9.40        | 10.41 | 0.370     | 0.410 |
| e                                            | 2.28 BSC    |       | 0.090 BSC |       |
| e1                                           | 4.56 BSC    |       | 0.180 BSC |       |
| L                                            | 1.40        | 1.78  | 0.055     | 0.070 |
| L3                                           | 0.89        | 1.27  | 0.035     | 0.050 |
| L4                                           | -           | 1.02  | -         | 0.040 |
| L5                                           | 1.01        | 1.52  | 0.040     | 0.060 |
| ECN: T16-0236-Rev. P, 16-May-16<br>DWG: 5347 |             |       |           |       |

### Notes

- Dimension L3 is for reference only.

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



Recommended Minimum Pads  
Dimensions in Inches/(mm)

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