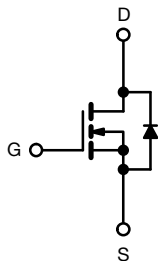
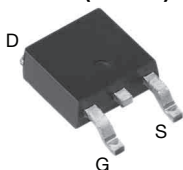


## Power MOSFET

**DPAK (TO-252)**


N-Channel MOSFET

### FEATURES

- Low drive current
- Surface-mount
- Fast switching
- Ease of paralleling
- Excellent temperature stability
- Material categorization: for definitions of compliance please see [www.vishay.com/doc?99912](http://www.vishay.com/doc?99912)


**RoHS**  
COMPLIANT

### DESCRIPTION

The power MOSFET technology is the key to Vishay's advanced line of power MOSFET transistors. The efficient geometry and unique processing of this latest "State of the Art" design achieves: very low on-state resistance combined with high transconductance; superior reverse energy and diode recovery dV/dt capability.

The power MOSFET transistors also feature all of the well established advantages of MOSFET'S such as voltage control, very fast switching, ease of paralleling and temperature stability of the electrical parameters.

Surface mount packages enhance circuit performance by reducing stray inductances and capacitance. The DPAK (TO-252) surface-mount package brings the advantages of power MOSFET's to high volume applications where PC Board surface mounting is desirable. The surface mount option IRFR9012, SiHFR9012 is provided on 16 mm tape. The straight lead option IRFU9012, SiHFU9012 of the device is called the IPAK (TO-251).

They are well suited for applications where limited heat dissipation is required such as, computers and peripherals, telecommunication equipment, dc-to-dc converters, and a wide range of consumer products.

### PRODUCT SUMMARY

|                            |                        |      |
|----------------------------|------------------------|------|
| V <sub>DS</sub> (V)        | 50                     |      |
| R <sub>DS(on)</sub> (Ω)    | V <sub>GS</sub> = 10 V | 0.20 |
| Q <sub>g</sub> (Max.) (nC) | 10                     |      |
| Q <sub>gs</sub> (nC)       | 2.6                    |      |
| Q <sub>gd</sub> (nC)       | 4.8                    |      |
| Configuration              | Single                 |      |

### ORDERING INFORMATION

| Package                         | DPAK (TO-252) | DPAK (TO-252)  | DPAK (TO-252)   | DPAK (TO-252)  |
|---------------------------------|---------------|----------------|-----------------|----------------|
| Lead (Pb)-free and halogen-free | SiHFR010-GE3  | SiHFR010TR-GE3 | SiHFR010TRL-GE3 | IRFR010PbF-BE3 |
| Lead (Pb)-free                  | IRFR010PbF    | IRFR010TRPbF   | IRFR010TRLPbF   | IRFR010TRRPbF  |

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

| PARAMETER                                                 | SYMBOL                            | LIMIT                   | UNIT |
|-----------------------------------------------------------|-----------------------------------|-------------------------|------|
| Drain-source voltage                                      | V <sub>DS</sub>                   | 50                      | V    |
| Gate-source voltage                                       | V <sub>GS</sub>                   | ± 20                    |      |
| 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>                   | 33                      |      |
| Avalanche current <sup>b</sup>                            | I <sub>AS</sub>                   | 1.5                     |      |
| Linear derating factor                                    |                                   | 0.20                    | W/°C |
| Maximum power dissipation                                 | P <sub>D</sub>                    | 25                      | W    |
| Peak diode recovery dV/dt <sup>c</sup>                    | dV/dt                             | 2.0                     | 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                          | 300                     |      |

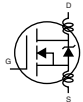
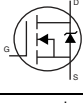
#### Notes

- Repetitive rating; pulse width limited by maximum junction temperature (see fig. 11)
- V<sub>DD</sub> = 25 V, starting T<sub>J</sub> = 25 °C, L = 100 μH, R<sub>g</sub> = 25 Ω
- I<sub>SD</sub> ≤ 8.2 A, dI/dt ≤ 130 A/μs, V<sub>DD</sub> ≤ 40 V, 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     | MIN. | TYP. | MAX. | UNIT |
|----------------------------------|------------|------|------|------|------|
| Maximum junction-to-ambient      | $R_{thJA}$ | -    | -    | 110  | °C/W |
| Case-to-sink                     | $R_{thCS}$ | -    | 1.7  | -    |      |
| Maximum junction-to-case (drain) | $R_{thJC}$ | -    | -    | 5.0  |      |

**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 <sub>DS</sub>     | V <sub>GS</sub> = 0 V, I <sub>D</sub> = 250 μA                                                                                                                                |                                                                                   | 50   | -    | -     | V    |
| 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                                                                                                                                                      |                                                                                   | -    | -    | ± 500 | nA   |
| Zero gate voltage drain current           | I <sub>DSS</sub>    | V <sub>DS</sub> = 50 V, V <sub>GS</sub> = 0 V                                                                                                                                 |                                                                                   | -    | -    | 250   | μA   |
|                                           |                     | V <sub>DS</sub> = 40 V, V <sub>GS</sub> = 0 V, T <sub>J</sub> = 125 °C                                                                                                        |                                                                                   | -    | -    | 1000  |      |
| Drain-source on-state resistance          | R <sub>DS(on)</sub> | V <sub>GS</sub> = 10 V                                                                                                                                                        | I <sub>D</sub> = 4.6 A <sup>b</sup>                                               | -    | 0.16 | 0.20  | Ω    |
| Forward transconductance                  | g <sub>fs</sub>     | V <sub>DS</sub> ≥ 50 V, I <sub>D</sub> = 3.6 A                                                                                                                                |                                                                                   | 2.1  | 3.1  | -     | 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. 10                                                                                                 |                                                                                   | -    | 250  | -     | pF   |
| Output capacitance                        | C <sub>oss</sub>    |                                                                                                                                                                               |                                                                                   | -    | 150  | -     |      |
| Reverse transfer capacitance              | C <sub>rss</sub>    |                                                                                                                                                                               |                                                                                   | -    | 29   | -     |      |
| Total gate charge                         | Q <sub>g</sub>      | V <sub>GS</sub> = 10 V                                                                                                                                                        | I <sub>D</sub> = 7.3 A, V <sub>DS</sub> = 40 V,<br>see fig. 6 and 13 <sup>b</sup> | -    | 6.7  | 10    | nC   |
| Gate-source charge                        | Q <sub>gs</sub>     |                                                                                                                                                                               |                                                                                   | -    | 1.8  | 2.6   |      |
| Gate-drain charge                         | Q <sub>gd</sub>     |                                                                                                                                                                               |                                                                                   | -    | 3.2  | 4.8   |      |
| Turn-on delay time                        | t <sub>d(on)</sub>  | V <sub>DD</sub> = 25 V, I <sub>D</sub> = 7.3 A,<br>R <sub>g</sub> = 24 Ω, R <sub>D</sub> = 3.3 Ω, see fig. 10 <sup>b</sup>                                                    |                                                                                   | -    | 11   | 17    | ns   |
| Rise time                                 | t <sub>r</sub>      |                                                                                                                                                                               |                                                                                   | -    | 33   | 50    |      |
| Turn-off delay time                       | t <sub>d(off)</sub> |                                                                                                                                                                               |                                                                                   | -    | 12   | 18    |      |
| Fall time                                 | t <sub>f</sub>      |                                                                                                                                                                               |                                                                                   | -    | 23   | 35    |      |
| Internal drain inductance                 | L <sub>D</sub>      | Between lead,<br>6 mm (0.25") from<br>package and center of<br>die contact <sup>c</sup>  |                                                                                   | -    | 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                 |                                                                                   | -    | -    | 8.2   | A    |
| Pulsed diode forward current <sup>a</sup> | I <sub>SM</sub>     |                                                                                                                                                                               |                                                                                   | -    | -    | 33    |      |
| Body diode voltage                        | V <sub>SD</sub>     | T <sub>J</sub> = 25 °C, I <sub>S</sub> = 8.2 A, V <sub>GS</sub> = 0 V <sup>b</sup>                                                                                            |                                                                                   | -    | -    | 1.6   | V    |
| Body diode reverse recovery time          | t <sub>rr</sub>     | T <sub>J</sub> = 25 °C, I <sub>F</sub> = 7.3 A, dI/dt = 100 A/μs <sup>b</sup>                                                                                                 |                                                                                   | 41   | 86   | 190   | ns   |
| Body diode reverse recovery charge        | Q <sub>rr</sub>     |                                                                                                                                                                               |                                                                                   | 0.15 | 0.33 | 0.78  | 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)

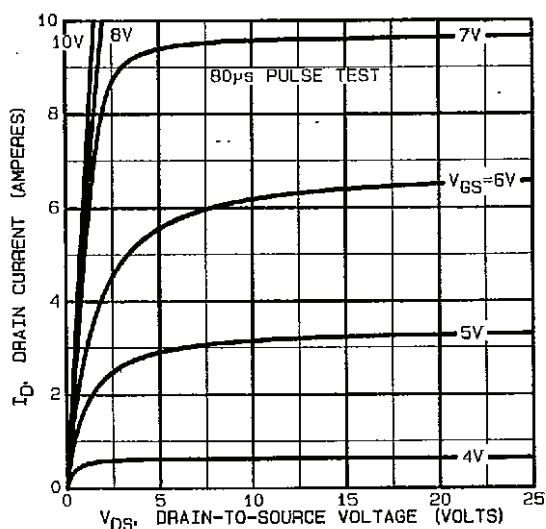


Fig. 1 - Typical Output Characteristics

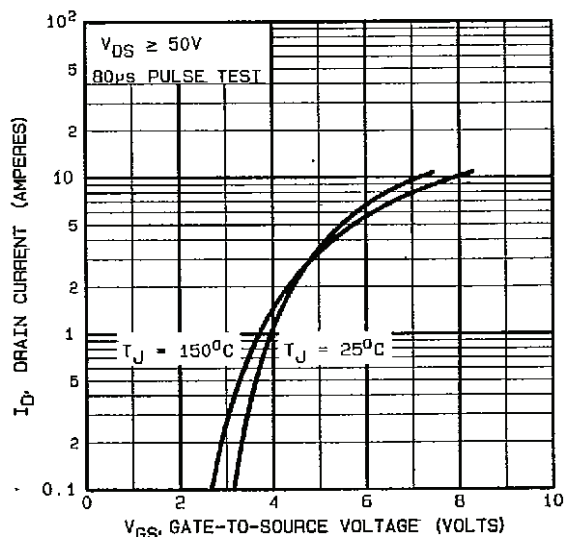


Fig. 2 - Typical Transfer Characteristics

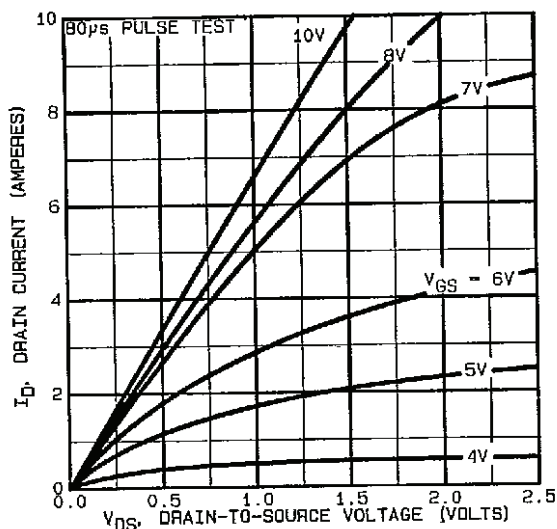


Fig. 1 - Typical Output Characteristics

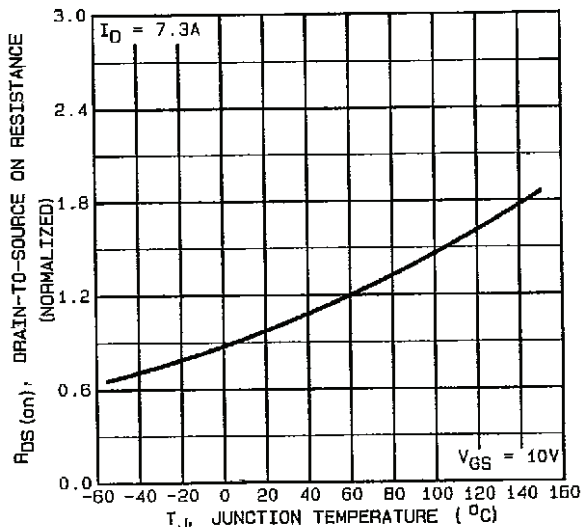
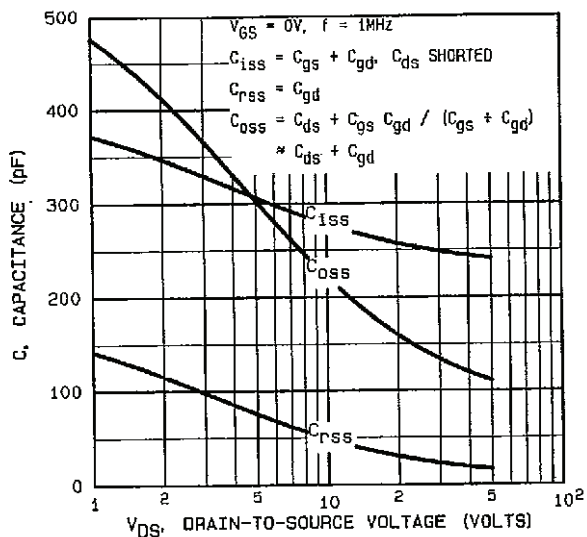
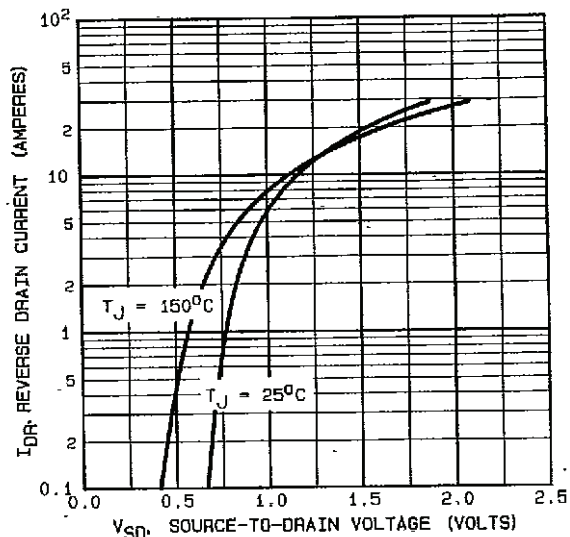


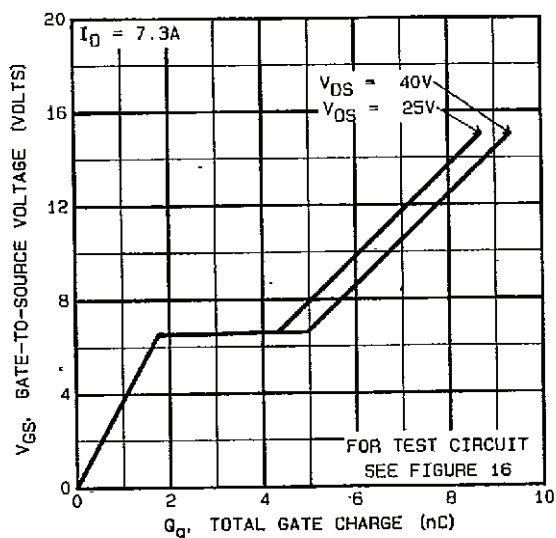
Fig. 3 - Normalized On-Resistance vs. Temperature



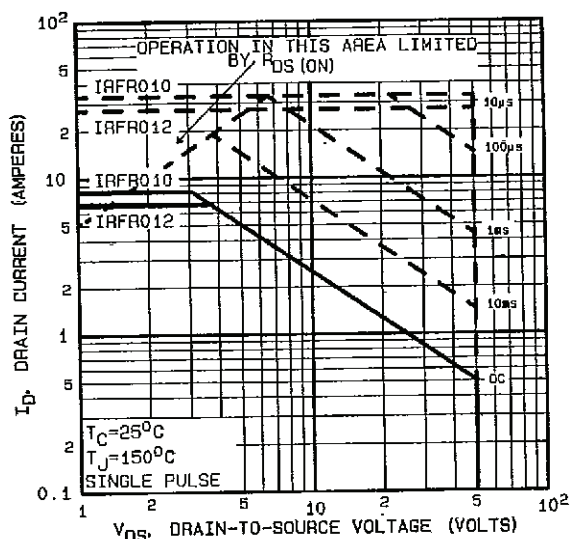
**Fig. 4 - Typical Capacitance vs. Drain-to-Source Voltage**



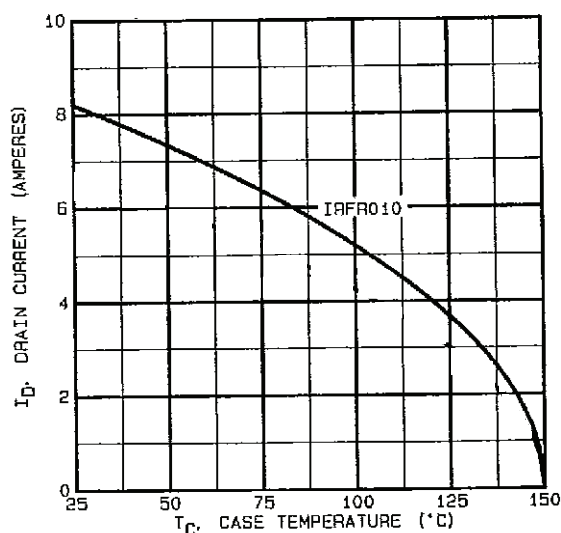
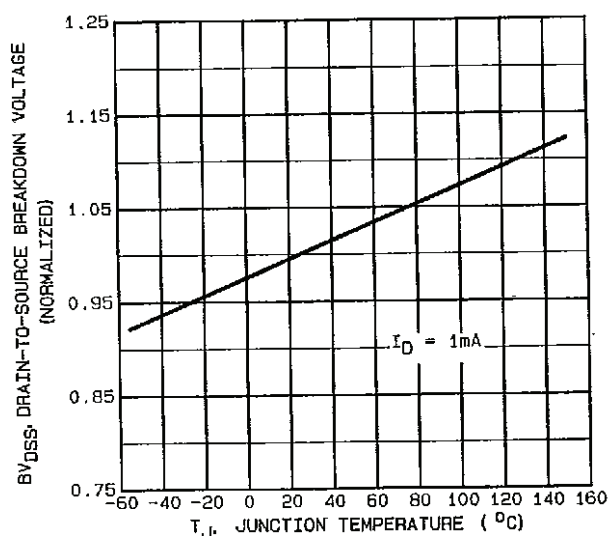
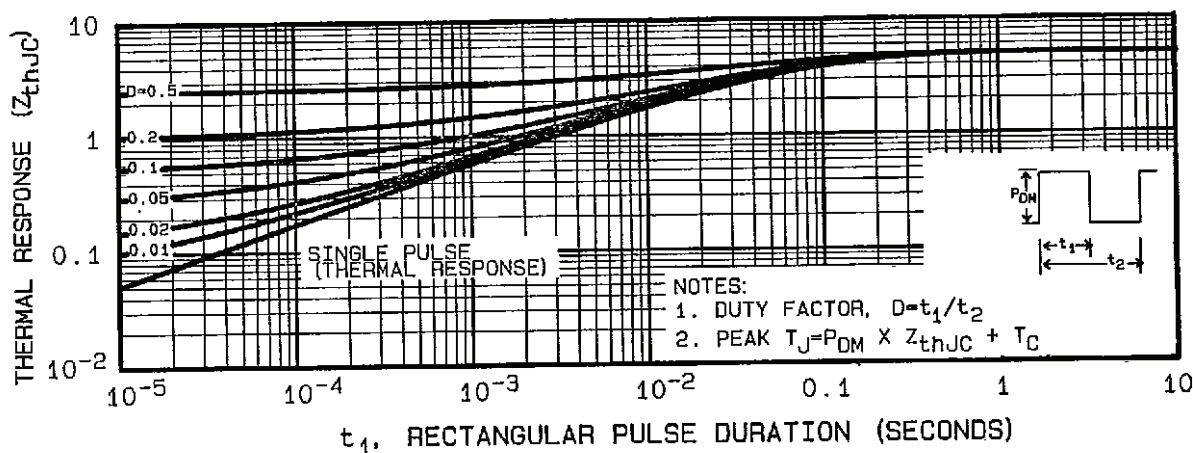
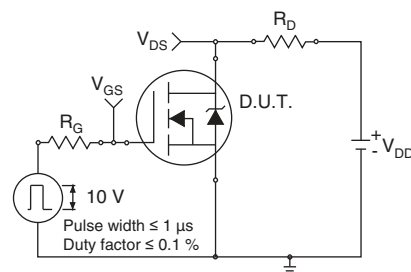
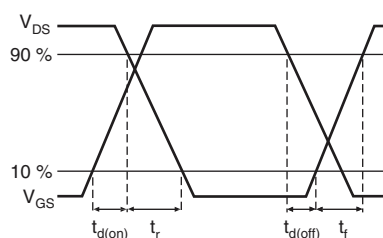
**Fig. 6 - Typical Source-Drain Diode Forward Voltage**

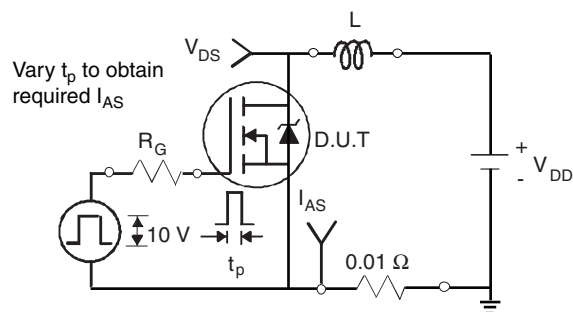


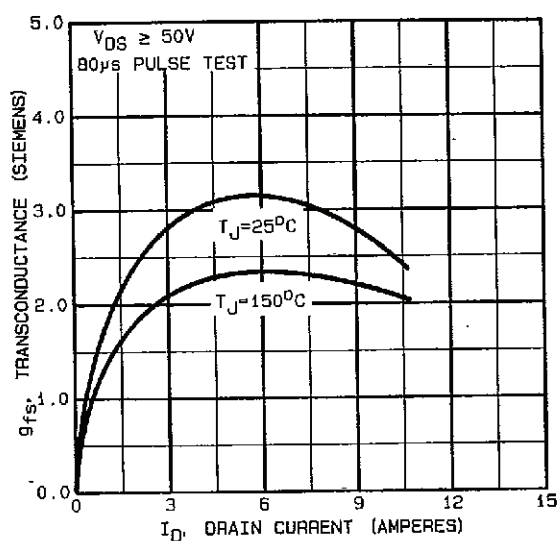
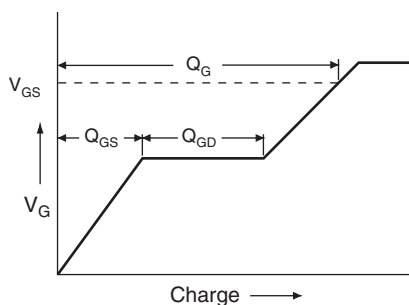
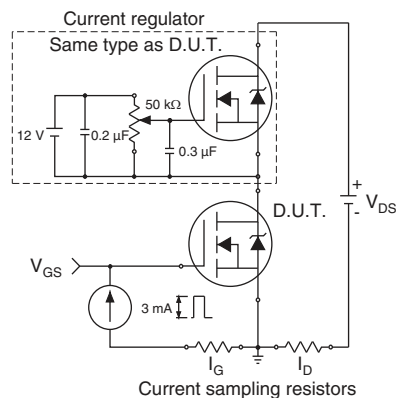
**Fig. 5 - Typical Gate Charge vs. Gate-to-Source Voltage**

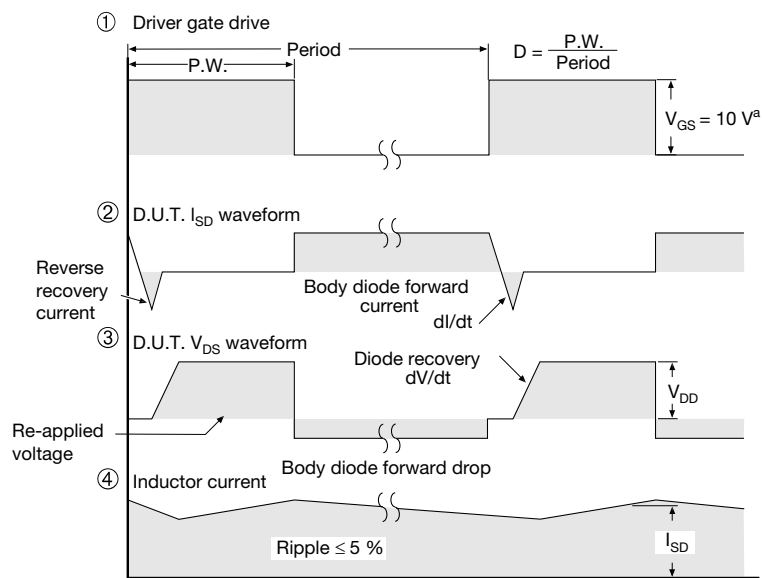
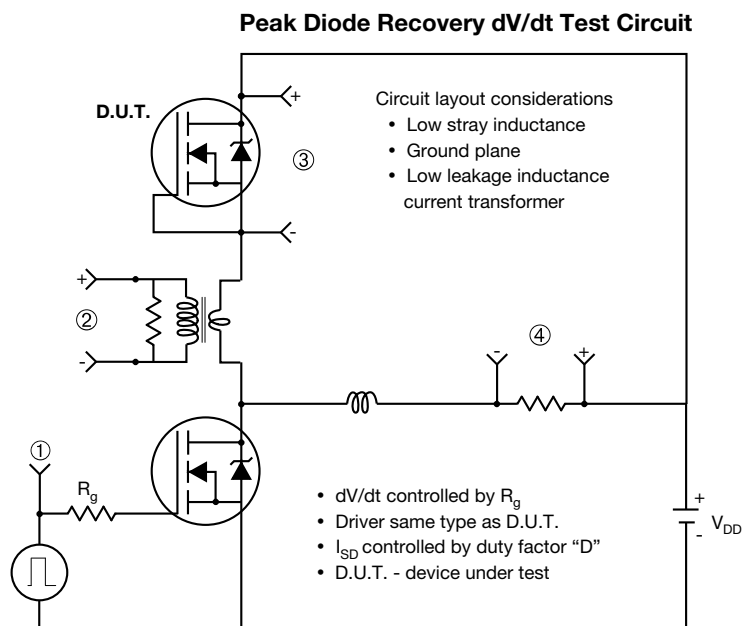


**Fig. 7 - Maximum Safe Operating Area**


**Fig. 8 - Maximum Drain Current vs. Case Temperature**

**Fig. 9 - Breakdown Voltage vs. Temperature**

**Fig. 10 - Maximum Effective Transient Thermal Impedance, Junction-to-Case**

**Fig. 10a - Switching Time Test Circuit**

**Fig. 10b - Switching Time Waveforms**


**Fig. 12a - Unclamped Inductive Test Circuit**

**Fig. 12b - Unclamped Inductive Waveforms**

**Fig. 12c - Typical Transconductance 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. 11 - 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



| DIM. | MILLIMETERS |       |
|------|-------------|-------|
|      | 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 |

| DIM.   | MILLIMETERS |      |
|--------|-------------|------|
|        | 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 |
| theta  | 0°          | 10°  |
| theta1 | 0°          | 15°  |
| theta2 | 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

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



Recommended Minimum Pads  
Dimensions in Inches/(mm)

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