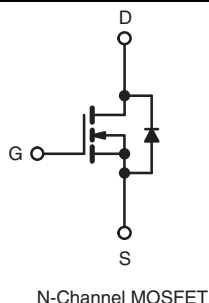
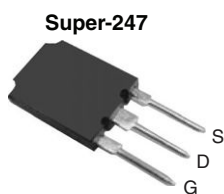


## Power MOSFET

### PRODUCT SUMMARY

|                           |                        |       |
|---------------------------|------------------------|-------|
| $V_{DS}$ (V)              | 600                    |       |
| $R_{DS(on)}$ ( $\Omega$ ) | $V_{GS} = 10\text{ V}$ | 0.110 |
| $Q_g$ (Max.) (nC)         | 330                    |       |
| $Q_{gs}$ (nC)             | 84                     |       |
| $Q_{gd}$ (nC)             | 150                    |       |
| Configuration             | Single                 |       |



### FEATURES

- Low Gate Charge  $Q_g$  Results in Simple Drive Requirement
- Improved Gate, Avalanche and Dynamic  $dV/dt$  Ruggedness
- Fully Characterized Capacitance and Avalanche Voltage and Current
- Enhanced Body Diode  $dV/dt$  Capability
- Compliant to RoHS Directive 2002/95/EC



**RoHS\***  
COMPLIANT

### APPLICATIONS

- Hard Switching Primary or PFC Switch
- Switch Mode Power Supply (SMPS)
- Uninterruptible Power Supply
- High Speed Power Switching
- Motor Drive

### ORDERING INFORMATION

|                |                 |
|----------------|-----------------|
| Package        | Super-247       |
| Lead (Pb)-free | IRFPS40N60KPbF  |
|                | SiHFPS40N60K-E3 |
| SnPb           | IRFPS40N60K     |
|                | SiHFPS40N60K    |

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

| PARAMETER                                        | SYMBOL         | LIMIT                             | UNIT                |
|--------------------------------------------------|----------------|-----------------------------------|---------------------|
| Drain-Source Voltage                             | $V_{DS}$       | 600                               | V                   |
| Gate-Source Voltage                              | $V_{GS}$       | $\pm 30$                          |                     |
| Continuous Drain Current                         | $I_D$          | $T_C = 25\text{ }^\circ\text{C}$  | A                   |
|                                                  |                | $T_C = 100\text{ }^\circ\text{C}$ |                     |
| Pulsed Drain Current <sup>a</sup>                | $I_{DM}$       | 160                               |                     |
| Linear Derating Factor                           |                | 4.5                               | W/ $^\circ\text{C}$ |
| Single Pulse Avalanche Energy <sup>b</sup>       | $E_{AS}$       | 600                               | mJ                  |
| Repetitive Avalanche Current <sup>a</sup>        | $I_{AR}$       | 40                                | A                   |
| Repetitive Avalanche Energy <sup>a</sup>         | $E_{AR}$       | 57                                | mJ                  |
| Maximum Power Dissipation                        | $P_D$          | 570                               | W                   |
| Peak Diode Recovery $dV/dt^c$                    | $dV/dt$        | 7.5                               | V/ns                |
| Operating Junction and Storage Temperature Range | $T_J, T_{stg}$ | - 55 to + 150                     | $^\circ\text{C}$    |
| Soldering Recommendations (Peak Temperature)     | for 10 s       | 300 <sup>d</sup>                  |                     |

#### Notes

- Repetitive rating; pulse width limited by maximum junction temperature (see fig. 11).
- Starting  $T_J = 25\text{ }^\circ\text{C}$ ,  $L = 0.84\text{ mH}$ ,  $R_g = 25\text{ }\Omega$ ,  $I_{AS} = 38\text{ A}$ ,  $dV/dt = 5.5\text{ V/ns}$  (see fig. 12a).
- $I_{SD} \leq 38\text{ A}$ ,  $dI/dt \leq 150\text{ A}/\mu\text{s}$ ,  $V_{DD} \leq V_{DS}$ ,  $T_J \leq 150\text{ }^\circ\text{C}$ .
- 1.6 mm from case.

\* Pb containing terminations are not RoHS compliant, exemptions may apply

**THERMAL RESISTANCE RATINGS**

| PARAMETER                           | SYMBOL     | TYP. | MAX. | UNIT |
|-------------------------------------|------------|------|------|------|
| Maximum Junction-to-Ambient         | $R_{thJA}$ | -    | 40   | °C/W |
| Case-to-Sink, Flat, Greased Surface | $R_{thCS}$ | 0.24 | -    |      |
| Maximum Junction-to-Case (Drain)    | $R_{thJC}$ | -    | 0.22 |      |

**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                                                                                                          |                                                                                   | 600                                                                                                 | -     | -     | 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                                                                                                               |                                                                                   | -                                                                                                   | 0.63  | -     | 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                                                                                             |                                                                                   | 3.0                                                                                                 | -     | 5.0   | V    |
| Gate-Source Leakage                       | I <sub>GSS</sub>                 | V <sub>GS</sub> = ± 30 V                                                                                                                                |                                                                                   | -                                                                                                   | -     | ± 100 | nA   |
| Zero Gate Voltage Drain Current           | I <sub>DSS</sub>                 | V <sub>DS</sub> = 600 V, V <sub>GS</sub> = 0 V                                                                                                          |                                                                                   | -                                                                                                   | -     | 50    | μA   |
|                                           |                                  | V <sub>DS</sub> = 480 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> = 24 A <sup>b</sup>                                                | -                                                                                                   | 0.110 | 0.130 | Ω    |
| Forward Transconductance                  | g <sub>fs</sub>                  | V <sub>DS</sub> = 50 V, I <sub>D</sub> = 24 A <sup>b</sup>                                                                                              |                                                                                   | 21                                                                                                  | -     | -     | 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                                                                            |                                                                                   | -                                                                                                   | 7970  | -     | pF   |
| Output Capacitance                        | C <sub>oss</sub>                 |                                                                                                                                                         |                                                                                   | -                                                                                                   | 750   | -     |      |
| Reverse Transfer Capacitance              | C <sub>rss</sub>                 |                                                                                                                                                         |                                                                                   | -                                                                                                   | 75    | -     |      |
| Output Capacitance                        | C <sub>oss</sub>                 | V <sub>GS</sub> = 0 V                                                                                                                                   | V <sub>DS</sub> = 1.0 V , f = 1.0 MHz                                             | -                                                                                                   | 9440  | -     | pF   |
|                                           |                                  |                                                                                                                                                         | V <sub>DS</sub> = 480 V , f = 1.0 MHz                                             | -                                                                                                   | 200   | -     |      |
| Effective Output Capacitance              | C <sub>oss eff.</sub>            |                                                                                                                                                         | V <sub>DS</sub> = 0 V to 480 V <sup>c</sup>                                       | -                                                                                                   | 260   | -     |      |
| Total Gate Charge                         | Q <sub>g</sub>                   | V <sub>GS</sub> = 10 V                                                                                                                                  | I <sub>D</sub> = 38 A, V <sub>DS</sub> = 480 V,<br>see fig. 6 and 13 <sup>b</sup> | -                                                                                                   | -     | 330   | nC   |
| Gate-Source Charge                        | Q <sub>gs</sub>                  |                                                                                                                                                         |                                                                                   | -                                                                                                   | -     | 84    |      |
| Gate-Drain Charge                         | Q <sub>gd</sub>                  |                                                                                                                                                         |                                                                                   | -                                                                                                   | -     | 150   |      |
| Turn-On Delay Time                        | t <sub>d(on)</sub>               |                                                                                                                                                         | V <sub>GS</sub> = 10 V                                                            | V <sub>DD</sub> = 300 V, I <sub>D</sub> = 38 A,<br>R <sub>G</sub> = 4.3 Ω, see fig. 10 <sup>b</sup> | -     | 47    | -    |
| Rise Time                                 | t <sub>r</sub>                   | -                                                                                                                                                       |                                                                                   |                                                                                                     | 110   | -     |      |
| Turn-Off Delay Time                       | t <sub>d(off)</sub>              | -                                                                                                                                                       |                                                                                   |                                                                                                     | 97    | -     |      |
| Fall Time                                 | t <sub>f</sub>                   | -                                                                                                                                                       |                                                                                   |                                                                                                     | 60    | -     |      |
| 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> |                                                                                   | -                                                                                                   | -     | 40    | A    |
| Pulsed Diode Forward Current <sup>a</sup> | I <sub>SM</sub>                  |                                                                                                                                                         |                                                                                   | -                                                                                                   | -     | 160   |      |
| Body Diode Voltage                        | V <sub>SD</sub>                  | T <sub>J</sub> = 25 °C, I <sub>S</sub> = 38 A, V <sub>GS</sub> = 0 V <sup>b</sup>                                                                       |                                                                                   | -                                                                                                   | -     | 1.5   | V    |
| Body Diode Reverse Recovery Time          | t <sub>rr</sub>                  | T <sub>J</sub> = 25 °C                                                                                                                                  | I <sub>F</sub> = 38 A, dI/dt = 100 A/μs                                           | -                                                                                                   | 630   | 950   | ns   |
|                                           |                                  | T <sub>J</sub> = 125 °C                                                                                                                                 |                                                                                   | -                                                                                                   | 730   | 1090  |      |
| Body Diode Reverse Recovery Charge        | Q <sub>rr</sub>                  | T <sub>J</sub> = 25 °C                                                                                                                                  |                                                                                   | -                                                                                                   | 14    | 20    | μC   |
|                                           |                                  | T <sub>J</sub> = 125 °C                                                                                                                                 |                                                                                   | -                                                                                                   | 17    | 25    |      |
| Body Diode Recovery Current               | I <sub>RRM</sub>                 | T <sub>J</sub> = 25 °C                                                                                                                                  |                                                                                   | -                                                                                                   | 39    | 58    | A    |
| 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  $\leq 2\%$ .  
c.  $C_{oss\text{ eff.}}$  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)

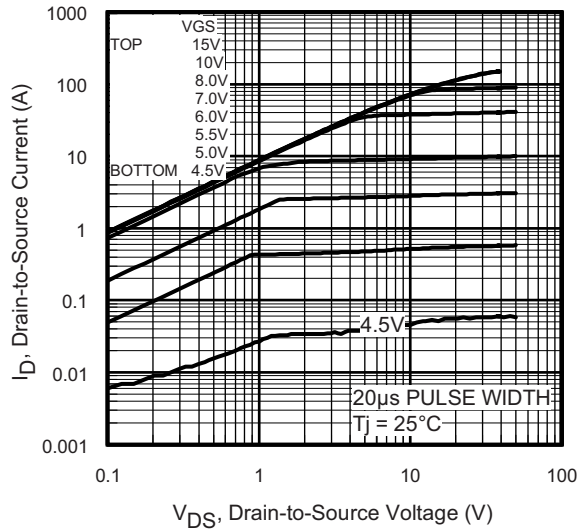


Fig. 1 - Typical Output Characteristics

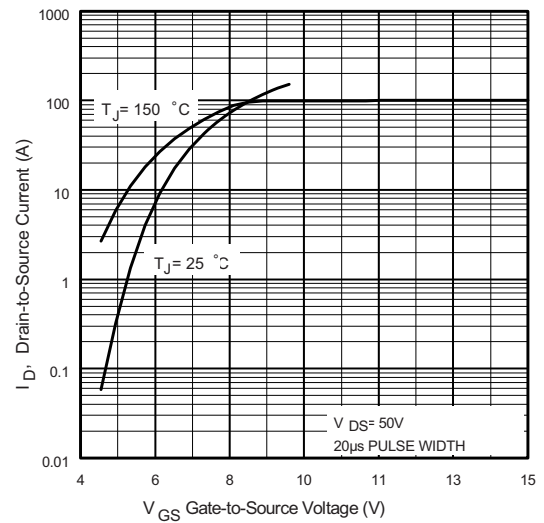


Fig. 3 - Typical Transfer Characteristics

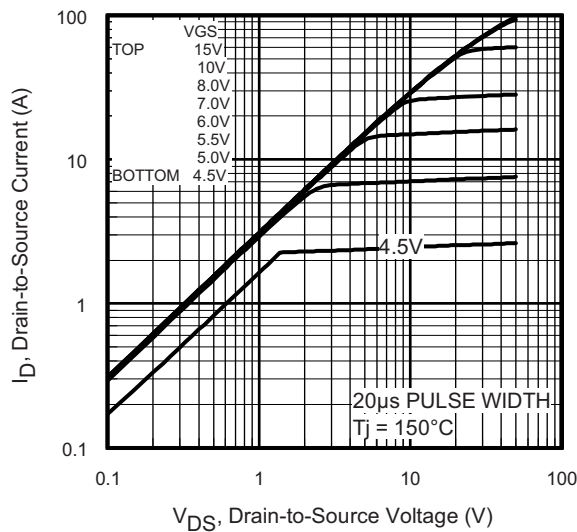


Fig. 2 - Typical Output Characteristics

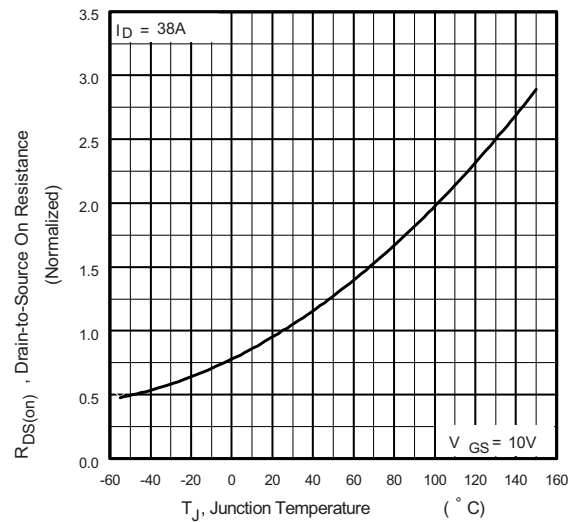


Fig. 4 - Normalized On-Resistance vs. Temperature

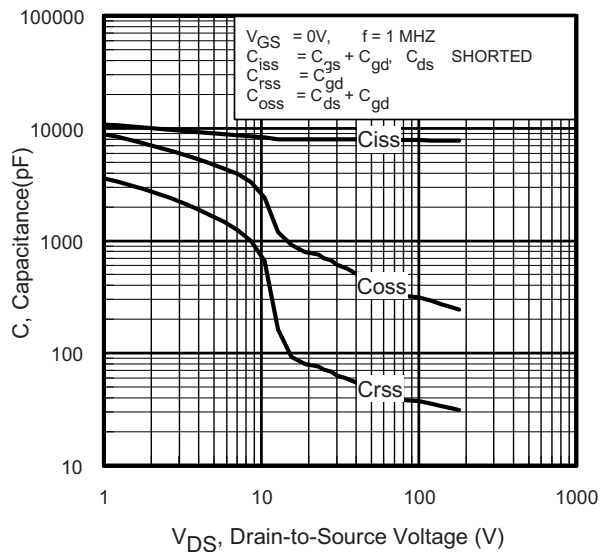


Fig. 5 - Typical Capacitance vs. Drain-to-Source Voltage

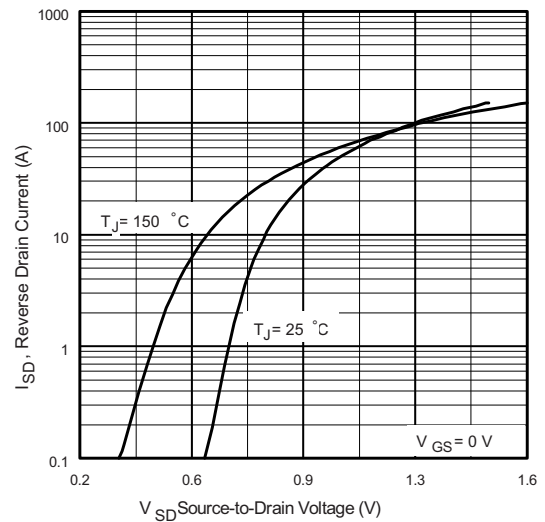


Fig. 7 - Typical Source-Drain Diode Forward Voltage

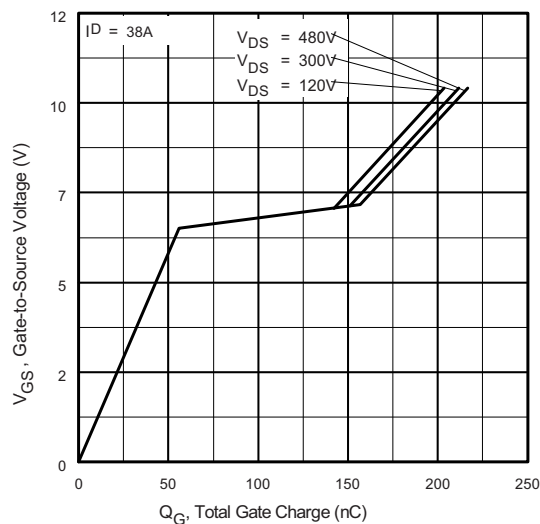


Fig. 6 - Typical Gate Charge vs. Gate-to-Source Voltage

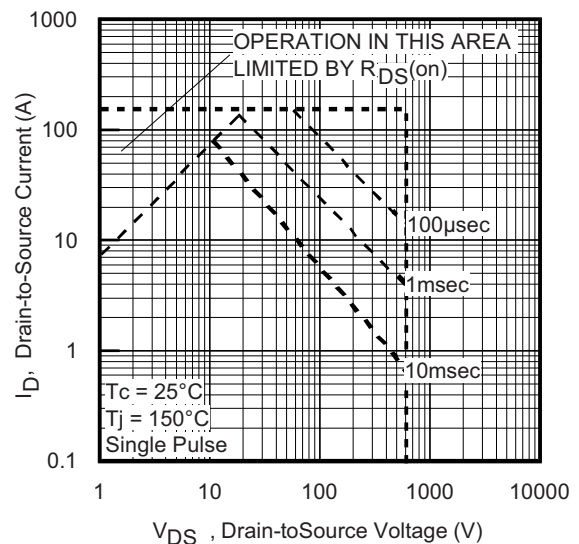
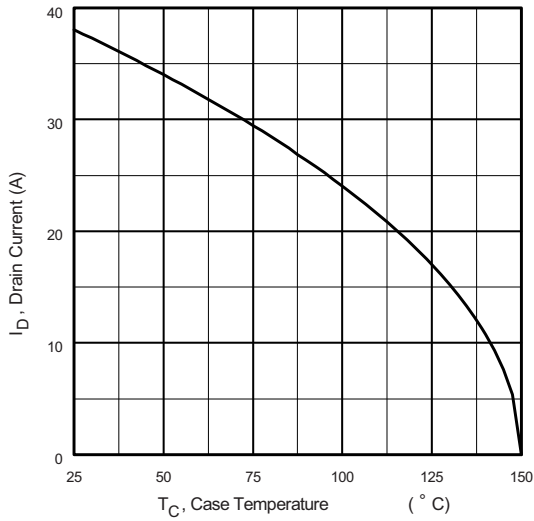
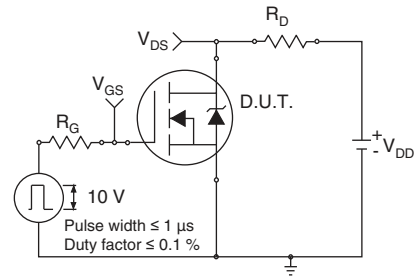


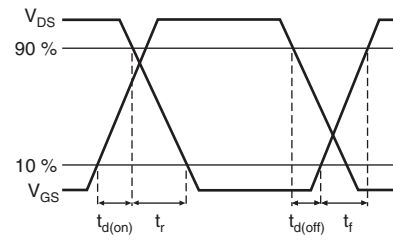
Fig. 8 - Maximum Safe Operating Area



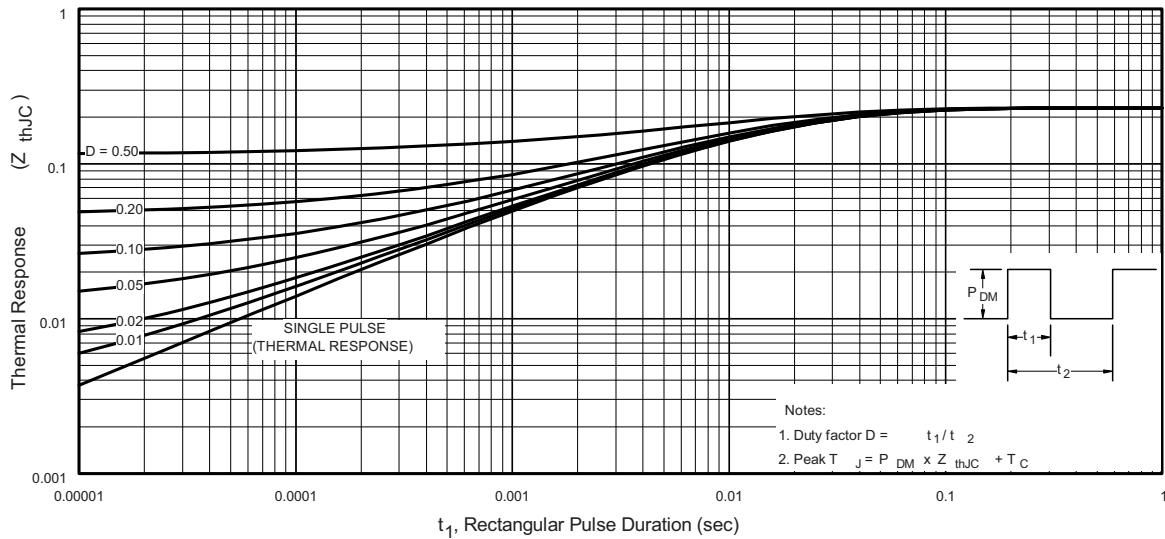
**Fig. 9 - Maximum Drain Current vs. Case Temperature**



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



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



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

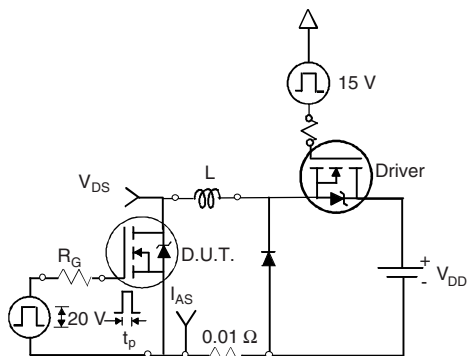


Fig. 12a - Unclamped Inductive Test Circuit

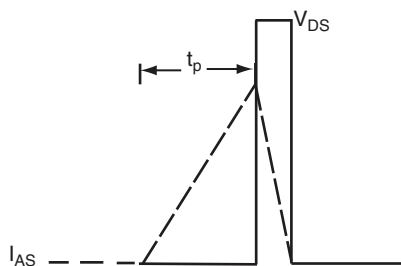


Fig. 12b - Unclamped Inductive Waveforms

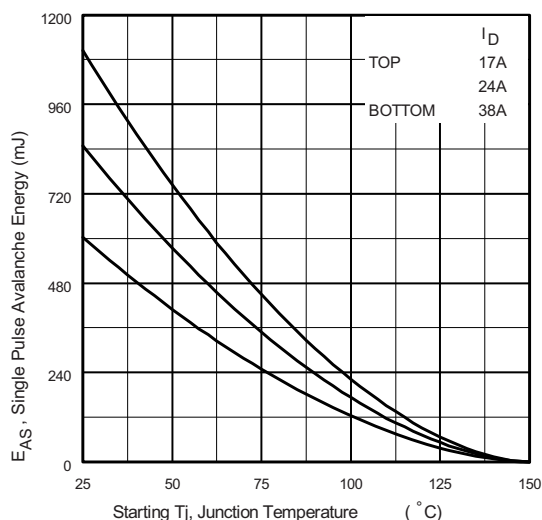


Fig. 12c - Maximum Avalanche Energy vs. Drain Current

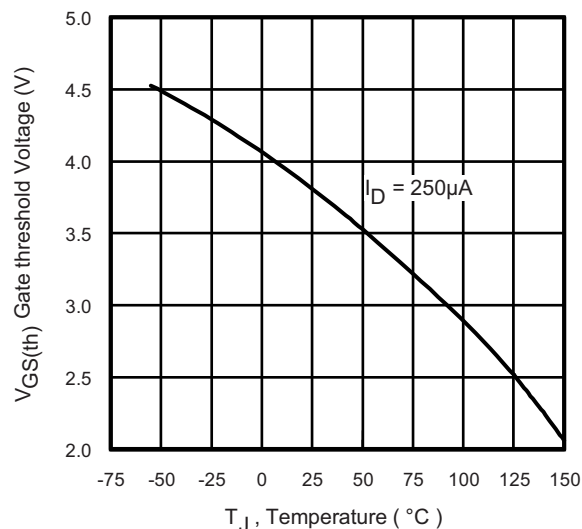


Fig. 12d - Threshold Voltage vs. Temperature

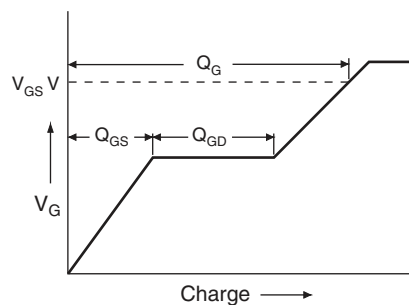


Fig. 13a - Basic Gate Charge Waveform

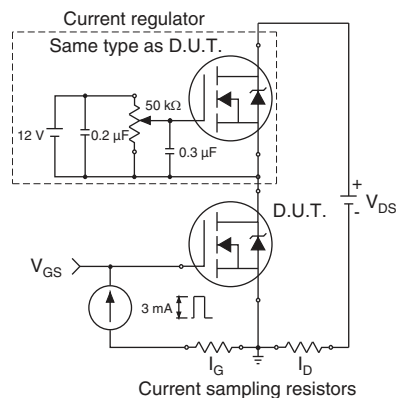


Fig. 13b - Gate Charge Test Circuit



**Note**

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

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

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