## Cool MOS™ Power Transistor

### Feature

- New revolutionary high voltage technology
- Worldwide best $R_{DS(on)}$ in TO 247
- Ultra low gate charge
- Periodic avalanche rated
- Extreme d$v$/d$t$ rated
- Ultra low effective capacitances

| | | |
|---|---|---|
| $V_{DS}$ @ $T_{jmax}$ | 650 | V |
| $R_{DS(on)}$ | 0.07 | Ω |
| $I_D$ | 47 | A |
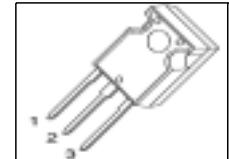
P-TO247

| Type | Package | Ordering Code | Marking |
|---|---|---|---|
| SPW47N60C3 | P-TO247 | Q67040-S4491 | 47N60C3 |

Drain
pin 2

Gate
pin 1

Source
pin 3
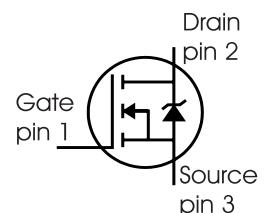
### Maximum Ratings

| Parameter | Symbol | Value | Unit |
|---|---|---|---|
| Continuous drain current | $I_D$ | | A |
| $T_C$ = 25 °C | | 47 | |
| $T_C$ = 100 °C | | 30 | |
| Pulsed drain current, $t_p$ limited by $T_{jmax}$ | $I_{D\,puls}$ | 141 | |
| Avalanche energy, single pulse | $E_{AS}$ | 1800 | mJ |
| $I_D$ = 10 A, $V_{DD}$ = 50 V | | | |
| Avalanche energy, repetitive $t_{AR}$ limited by $T_{jmax}$[1] | $E_{AR}$ | 1 | |
| $I_D$ = 20 A, $V_{DD}$ = 50 V | | | |
| Avalanche current, repetitive $t_{AR}$ limited by $T_{jmax}$ | $I_{AR}$ | 20 | A |
| Reverse diode d$v$/d$t$ | d$v$/d$t$ | 6 | V/ns |
| $I_S$=47A, $V_{DS}$=480V, $T_j$=125°C | | | |
| Gate source voltage static | $V_{GS}$ | ±20 | V |
| Gate source voltage AC (f >1Hz) | $V_{GS}$ | ±30 | |
| Power dissipation, $T_C$ = 25°C | $P_{tot}$ | 415 | W |
| Operating and storage temperature | $T_j$, $T_{stg}$ | -55... +150 | °C |

## Maximum Ratings

| Parameter | Symbol | Value | Unit |
|---|---|---|---|
| Drain Source voltage slope<br>$V_{DS}$ = 480 V, $I_D$ = 47 A, $T_j$ = 125 °C | d$v$/d$t$ | 50 | V/ns |

## Thermal Characteristics

| Parameter | Symbol | Values | | | Unit |
|---|---|---|---|---|---|
| | | min. | typ. | max. | |
| Thermal resistance, junction - case | $R_{thJC}$ | - | - | 0.3 | K/W |
| Thermal resistance, junction - ambient, leaded | $R_{thJA}$ | - | - | 62 | |
| Soldering temperature,<br>1.6 mm (0.063 in.) from case for 10s | $T_{sold}$ | - | - | 260 | °C |

## Electrical Characteristics, at $T_j$=25°C unless otherwise specified

| Parameter | Symbol | Conditions | Values | | | Unit |
|---|---|---|---|---|---|---|
| | | | min. | typ. | max. | |
| Drain-source breakdown voltage | $V_{(BR)DSS}$ | $V_{GS}$=0V, $I_D$=0.25mA | 600 | - | - | V |
| Drain-Source avalanche breakdown voltage | $V_{(BR)DS}$ | $V_{GS}$=0V, $I_D$=20A | - | 700 | - | |
| Gate threshold voltage | $V_{GS(th)}$ | $I_D$=2700µA, $V_{GS}$=$V_{DS}$ | 2.1 | 3 | 3.9 | |
| Zero gate voltage drain current | $I_{DSS}$ | $V_{DS}$=600V, $V_{GS}$=0V,<br>$T_j$=25°C,<br>$T_j$=150°C | -<br>- | 0.5<br>- | 25<br>250 | µA |
| Gate-source leakage current | $I_{GSS}$ | $V_{GS}$=30V, $V_{DS}$=0V | - | - | 100 | nA |
| Drain-source on-state resistance | $R_{DS(on)}$ | $V_{GS}$=10V, $I_D$=30A,<br>$T_j$=25°C<br>$T_j$=150°C | -<br>- | 0.06<br>0.16 | 0.07<br>- | Ω |
| Gate input resistance | $R_G$ | $f$=1MHz, open Drain | - | 0.62 | - | |

**Electrical Characteristics** , at $T_j$ = 25 °C, unless otherwise specified

| Parameter | Symbol | Conditions | Values | | | Unit |
|---|---|---|---|---|---|---|
| | | | min. | typ. | max. | |
| Transconductance | $g_{fs}$ | $V_{DS} \geq 2*I_D*R_{DS(on)max}$, $I_D$=30A | - | 40 | - | S |
| Input capacitance | $C_{iss}$ | $V_{GS}$=0V, $V_{DS}$=25V, $f$=1MHz | - | 6800 | - | pF |
| Output capacitance | $C_{oss}$ | | - | 2200 | - | |
| Reverse transfer capacitance | $C_{rss}$ | | - | 145 | - | |
| Effective output capacitance,[2] energy related | $C_{o(er)}$ | $V_{GS}$=0V, $V_{DS}$=0V to 480V | - | 193 | - | pF |
| Effective output capacitance,[3] time related | $C_{o(tr)}$ | | - | 412 | - | |
| Turn-on delay time | $t_{d(on)}$ | $V_{DD}$=380V, $V_{GS}$=0/13V, $I_D$=47A, $R_G$=1.8Ω, $T_j$=125 | - | 18 | - | ns |
| Rise time | $t_r$ | | - | 27 | - | |
| Turn-off delay time | $t_{d(off)}$ | | - | 111 | 165 | |
| Fall time | $t_f$ | | - | 8 | 12 | |

**Gate Charge Characteristics**

| Gate to source charge | $Q_{gs}$ | $V_{DD}$=350V, $I_D$=47A | - | 24 | - | nC |
|---|---|---|---|---|---|---|
| Gate to drain charge | $Q_{gd}$ | | - | 121 | - | |
| Gate charge total | $Q_g$ | $V_{DD}$=350V, $I_D$=47A, $V_{GS}$=0 to 10V | - | 252 | 320 | |
| Gate plateau voltage | $V_{(plateau)}$ | $V_{DD}$=350V, $I_D$=47A | - | 5.5 | - | V |

[1]Repetitve avalanche causes additional power losses that can be calculated as $P_{AV}=E_{AR}*f$.

[2]$C_{o(er)}$ is a fixed capacitance that gives the same stored energy as $C_{oss}$ while $V_{DS}$ is rising from 0 to 80% $V_{DSS}$.

[3]$C_{o(tr)}$ is a fixed capacitance that gives the same charging time as $C_{oss}$ while $V_{DS}$ is rising from 0 to 80% $V_{DSS}$.

**Electrical Characteristics**, at $T_j$ = 25 °C, unless otherwise specified

| Parameter | Symbol | Conditions | Values | | | Unit |
|---|---|---|---|---|---|---|
| | | | min. | typ. | max. | |
| Inverse diode continuous forward current | $I_S$ | $T_C$=25°C | - | - | 47 | A |
| Inverse diode direct current, pulsed | $I_{SM}$ | | - | - | 141 | |
| Inverse diode forward voltage | $V_{SD}$ | $V_{GS}$=0V, $I_F$=$I_S$ | - | 1 | 1.2 | V |
| Reverse recovery time | $t_{rr}$ | $V_R$=350V, $I_F$=$I_S$ , | - | 580 | - | ns |
| Reverse recovery charge | $Q_{rr}$ | $di_F/dt$=100A/µs | - | 23 | - | µC |
| Peak reverse recovery current | $I_{rrm}$ | | - | 73 | - | A |
| Peak rate of fall of reverse recovery current | $di_{rr}/dt$ | | - | 900 | - | A/µs |

**Typical Transient Thermal Characteristics**

| Symbol | Value | Unit | Symbol | Value | Unit |
|---|---|---|---|---|---|
| | typ. | | | typ. | |
| Thermal resistance | | | Thermal capacitance | | |
| $R_{th1}$ | 0.002689 | K/W | $C_{th1}$ | 0.001081 | Ws/K |
| $R_{th2}$ | 0.005407 | | $C_{th2}$ | 0.004021 | |
| $R_{th3}$ | 0.011 | | $C_{th3}$ | 0.005415 | |
| $R_{th4}$ | 0.054 | | $C_{th4}$ | 0.014 | |
| $R_{th5}$ | 0.071 | | $C_{th5}$ | 0.025 | |
| $R_{th6}$ | 0.036 | | $C_{th6}$ | 0.158 | |



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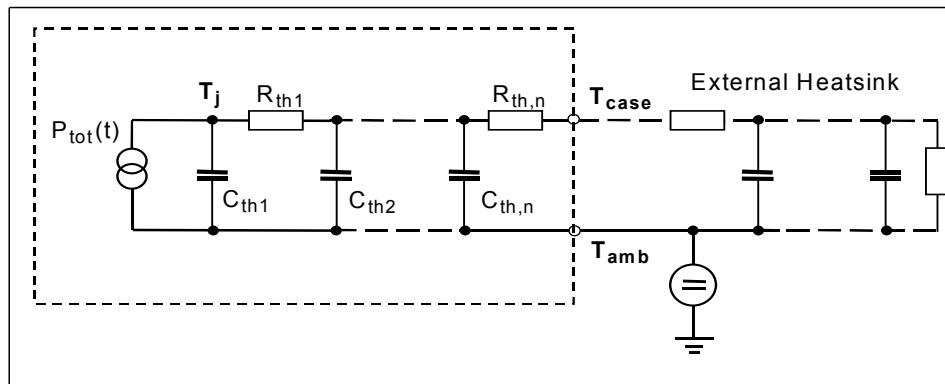
## 1 Power dissipation

$P_{tot} = f(T_C)$
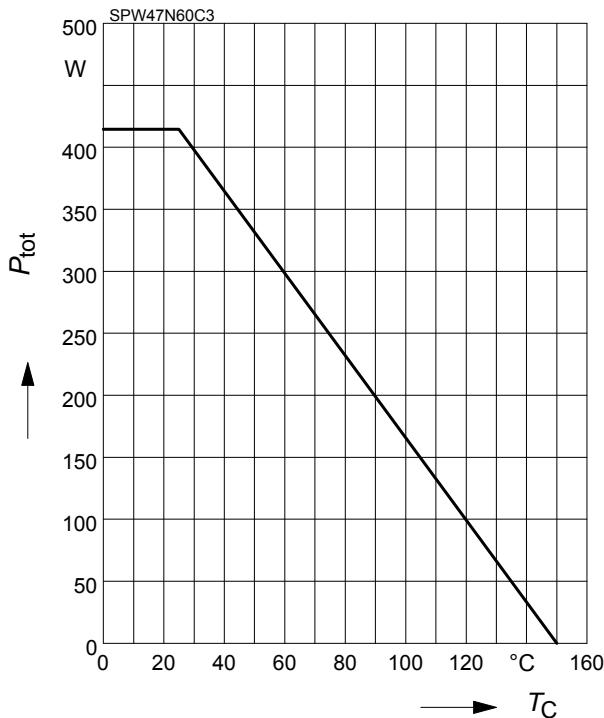


## 2 Safe operating area

$I_D = f(V_{DS})$

parameter : $D = 0$ , $T_C$=25°C



tp = 0.001 ms
tp = 0.01 ms
tp = 0.1 ms
tp = 1 ms
DC
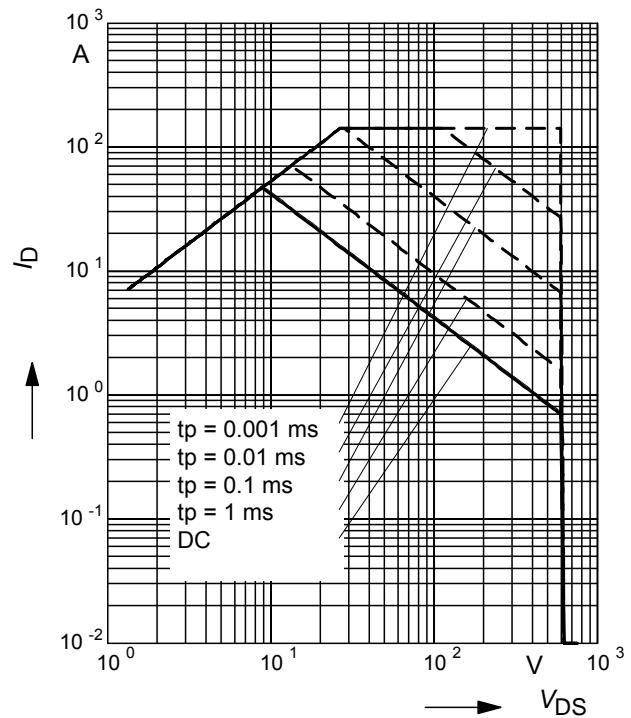
## 3 Transient thermal impedance

$Z_{thJC} = f(t_p)$

parameter: $D = t_p/T$



D = 0.5
D = 0.2
D = 0.1
D = 0.05
D = 0.02
D = 0.01
single pulse
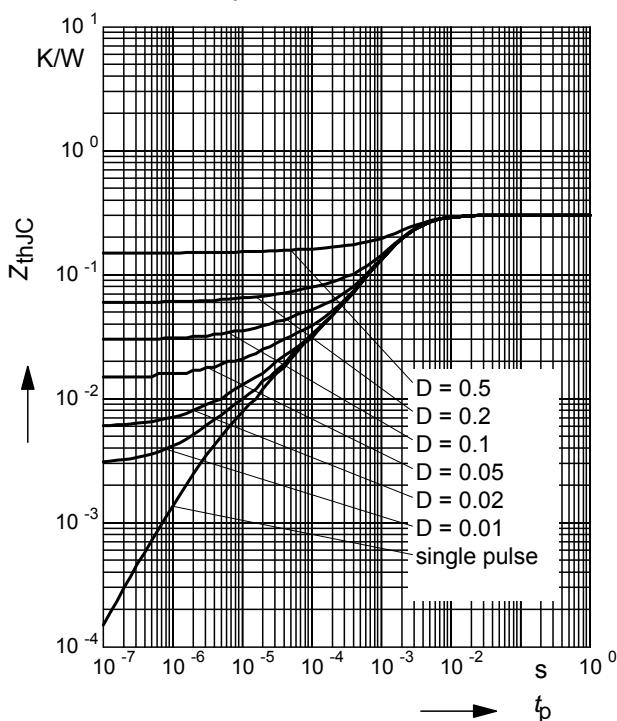
## 4 Typ. output characteristic

$I_D = f(V_{DS})$;  $T_j$=25°C

parameter: $t_p$ = 10 µs, $V_{GS}$



20V
7.5V
7V
6.5V
6V
5.5V
5V
4.5V
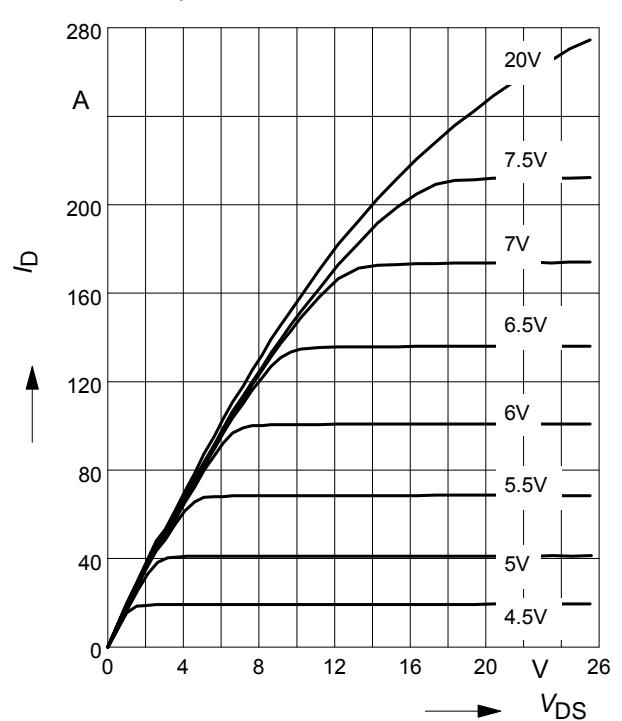
## 5 Typ. output characteristic

$I_D = f(V_{DS})$;  $T_j$=150°C

parameter: $t_p$ = 10 µs, $V_{GS}$
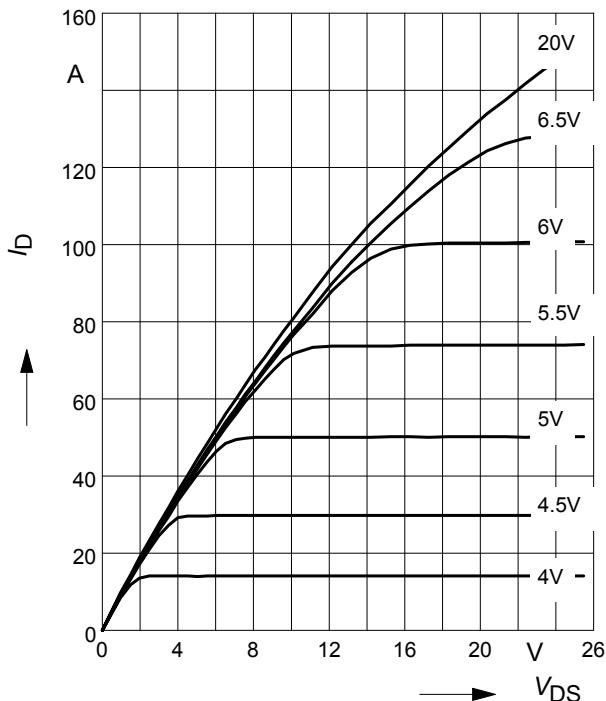


## 6 Typ. drain-source on resistance

$R_{DS(on)} = f(I_D)$

parameter: $T_j$=150°C, $V_{GS}$
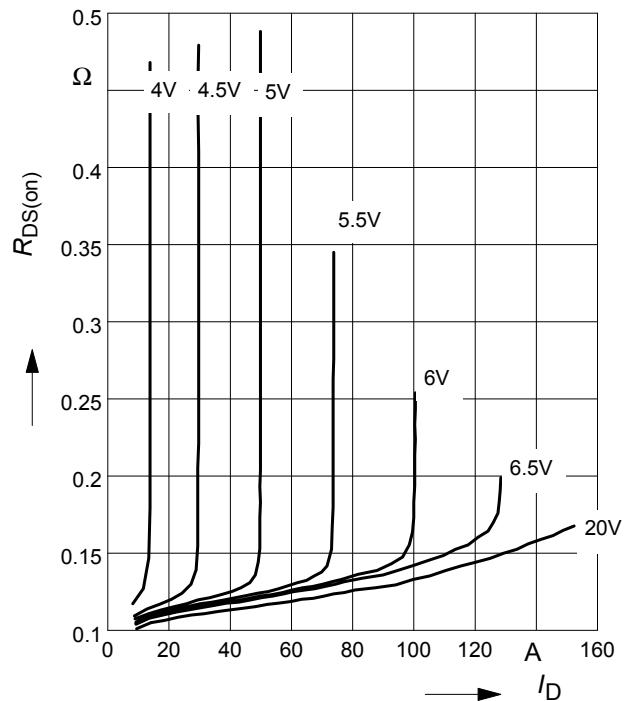


## 7 Drain-source on-state resistance

$R_{DS(on)} = f(T_j)$

parameter : $I_D$ = 47 A, $V_{GS}$ = 10 V
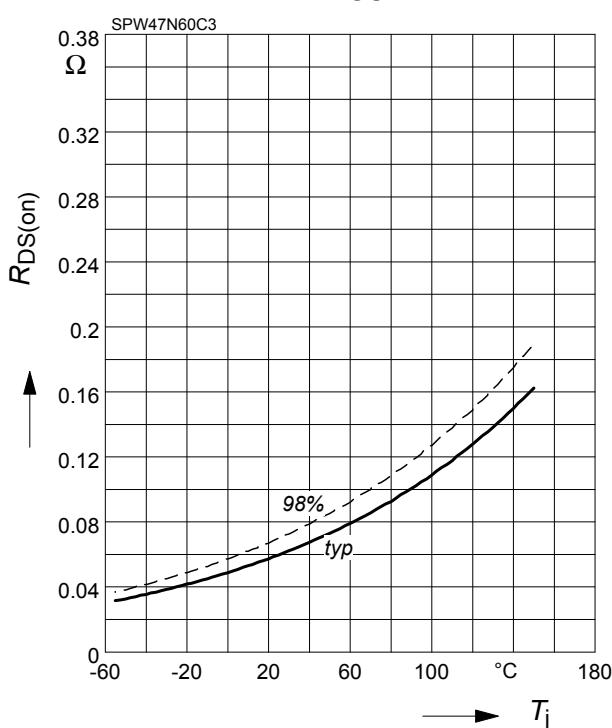


## 8 Typ. transfer characteristics

$I_D = f(V_{GS})$; $V_{DS} \geq$ 2 x $I_D$ x $R_{DS(on)max}$
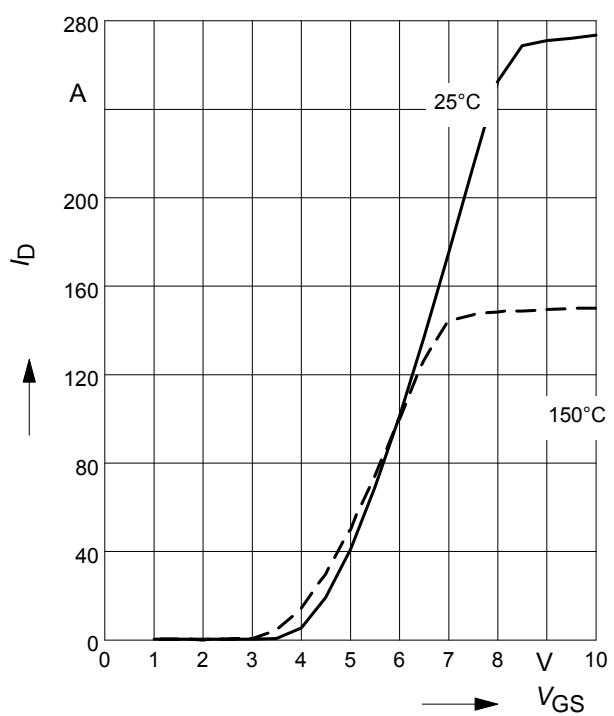
parameter: $t_p$ = 10 µs

## 9 Typ. gate charge

$V_{GS} = f\ (Q_{Gate})$

parameter: $I_D = 47$ A pulsed



## 10 Forward characteristics of body diode

$I_F = f\ (V_{SD})$

parameter: $T_j$ , $t_p = 10$ µs



## 11 Typ. drain current slope

$di/dt = f(R_G)$, inductive load, $T_j = 125°C$

par.: $V_{DS}=380V$, $V_{GS}=0/+13V$, $I_D=47A$
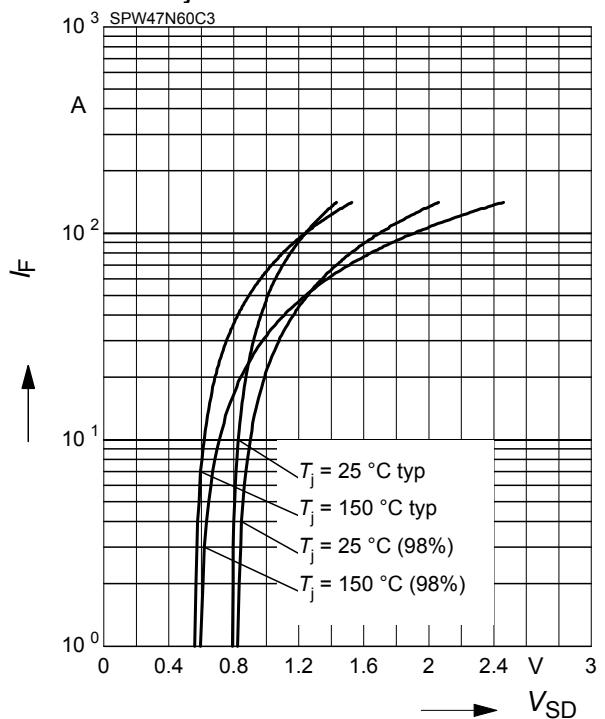


## 12 Typ. switching time

$t = f\ (R_G)$, inductive load, $T_j=125°C$

par.: $V_{DS}=380V$, $V_{GS}=0/+13V$, $I_D=47$ A



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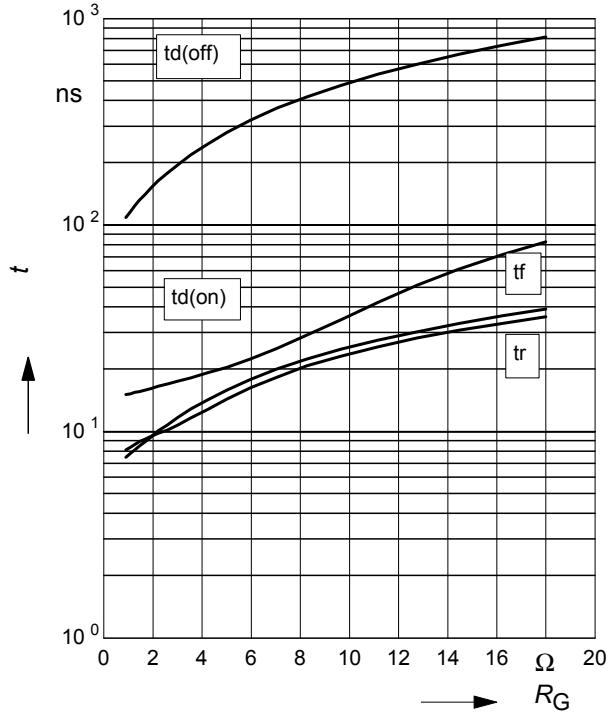
## 13 Typ. switching time

$t = f(I_D)$, inductive load, $T_j=125°C$

par.: $V_{DS}=380V$, $V_{GS}=0/+13V$, $R_G=1.8\Omega$
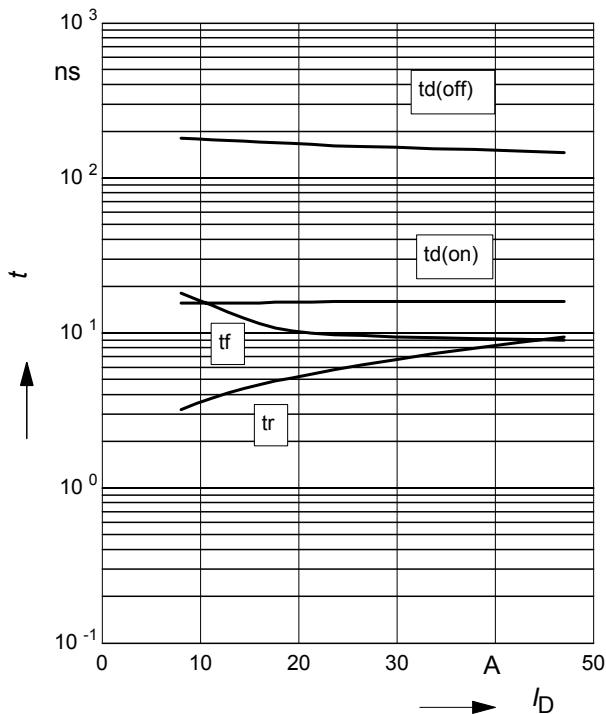


## 14 Typ. drain source voltage slope

$dv/dt = f(R_G)$, inductive load, $T_j = 125°C$

par.: $V_{DS}=380V$, $V_{GS}=0/+13V$, $I_D=47A$
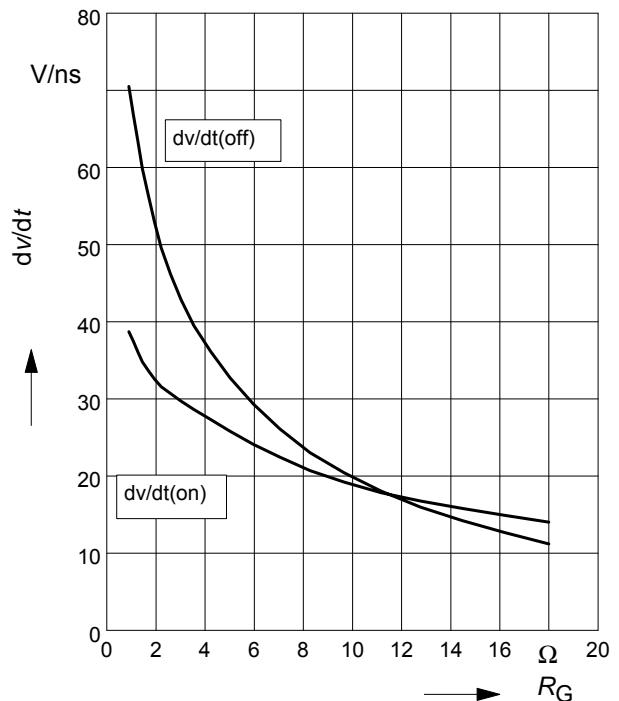


## 15 Typ. switching losses

$E = f(I_D)$, inductive load, $T_j=125°C$

par.: $V_{DS}=380V$, $V_{GS}=0/+13V$, $R_G=1.8\Omega$



*) Eon includes SDP06S60 diode commutation losses.
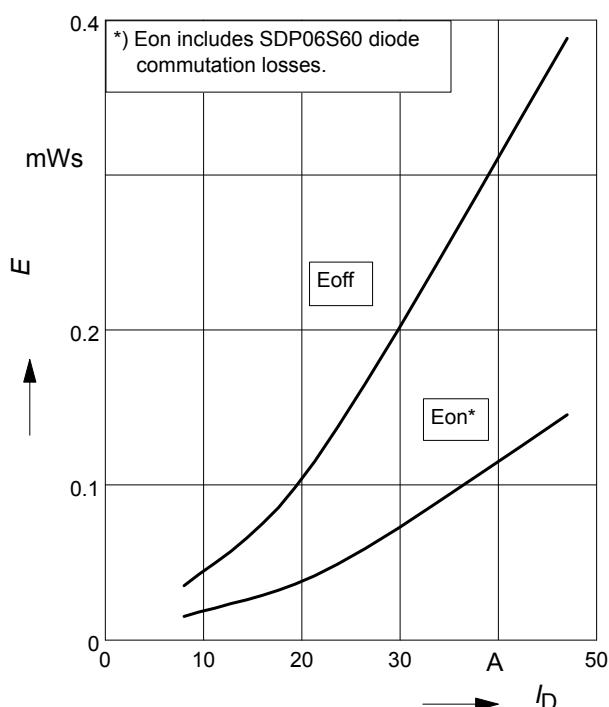
## 16 Typ. switching losses

$E = f(R_G)$, inductive load, $T_j=125°C$

par.: $V_{DS}=380V$, $V_{GS}=0/+13V$, $I_D=47A$



*) Eon includes SDP06S60 diode commutation losses.

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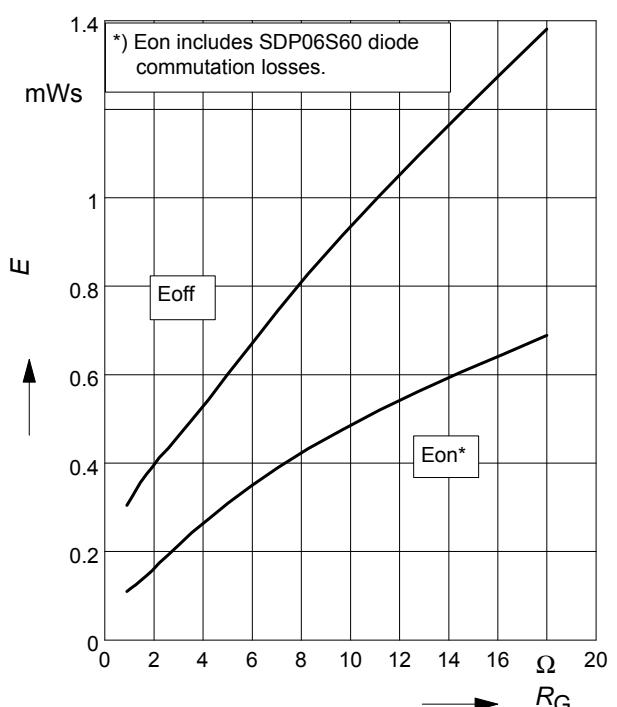
## 17 Avalanche SOA

$I_{AR} = f(t_{AR})$

par.: $T_j \leq 150\ °C$
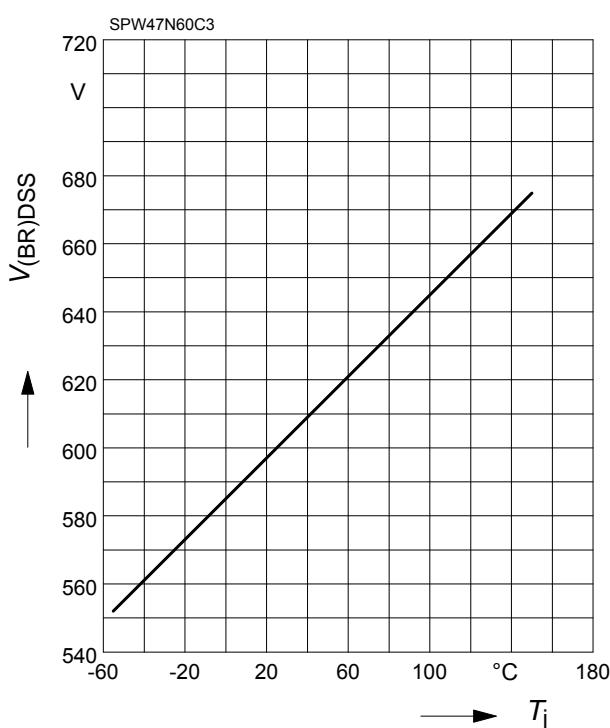


## 18 Avalanche energy

$E_{AS} = f(T_j)$

par.: $I_D = 10\ A,\ V_{DD} = 50\ V$



## 19 Drain-source breakdown voltage

$V_{(BR)DSS} = f(T_j)$



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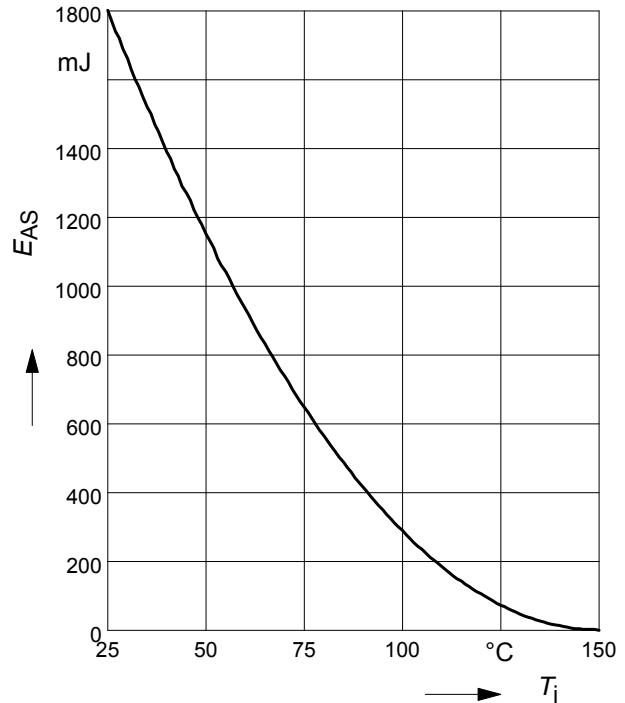
## 20 Avalanche power losses

$P_{AR} = f(f)$

parameter: $E_{AR} = 1mJ$



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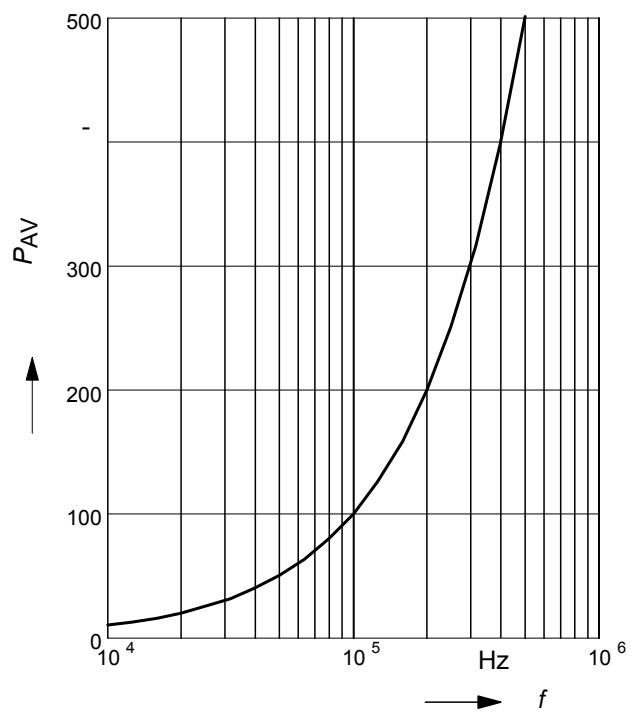
## 21 Typ. capacitances

$C = f(V_{DS})$

parameter: $V_{GS}=0V$, $f=1$ MHz
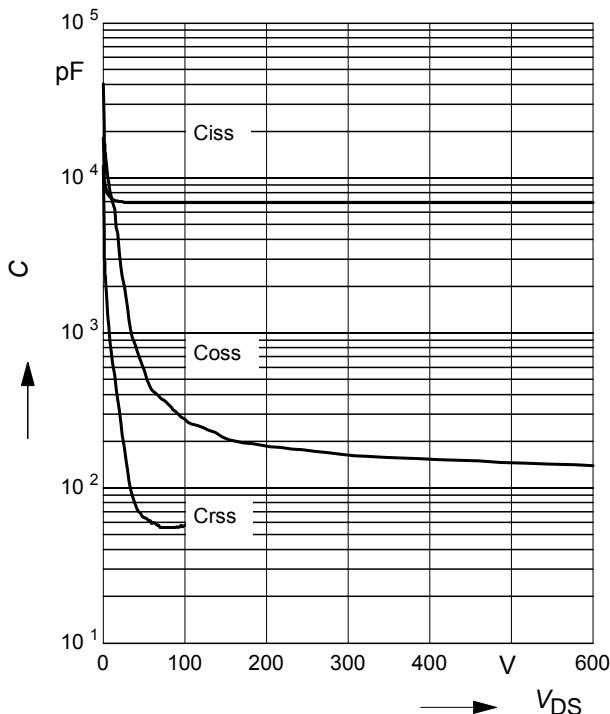


## 22 Typ. $C_{oss}$ stored energy

$E_{oss}=f(V_{DS})$
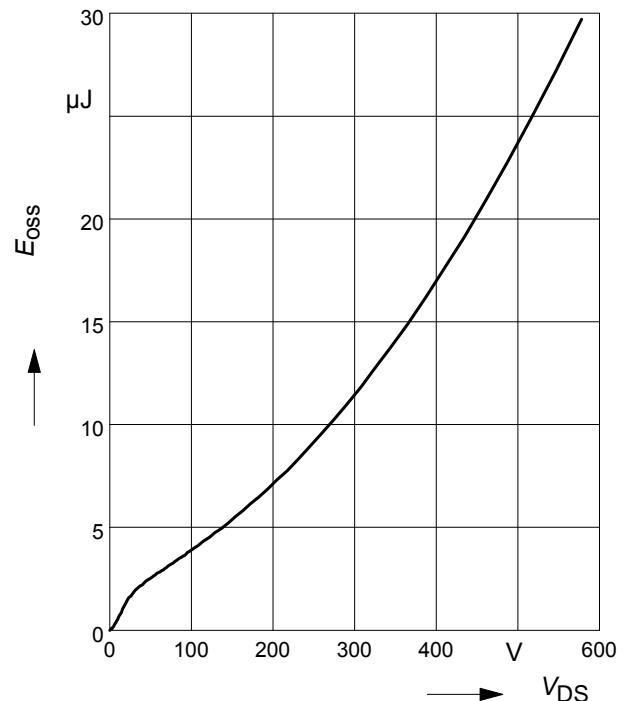


Definition of diodes switching characteristics
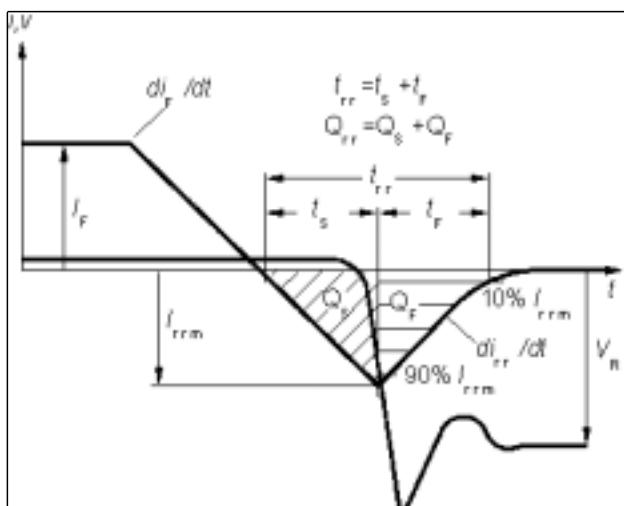
P-TO-247-3-1
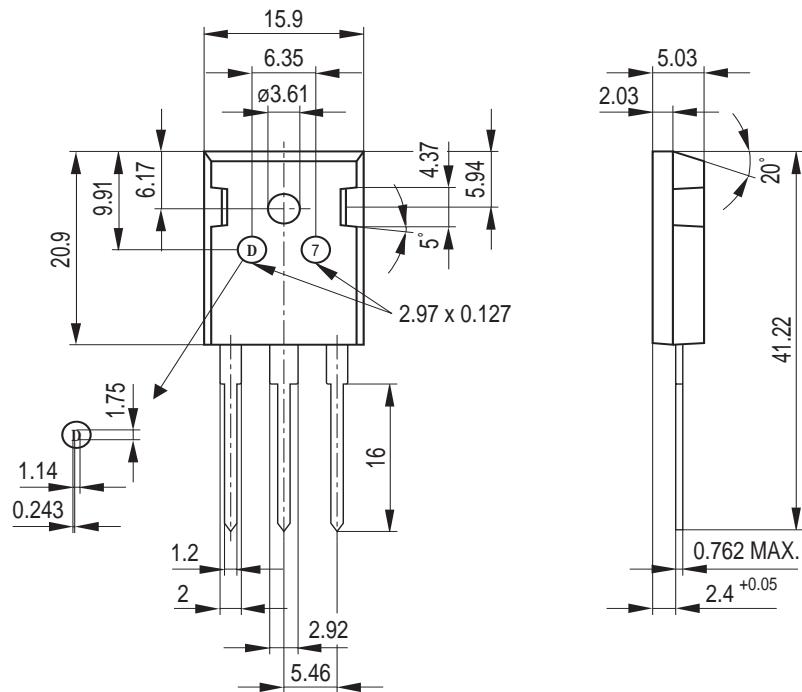


General tolerance unless otherwise specified: Leadframe parts: ±0.05
Package parts: ±0.12

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