# CoolMOS™ Power Transistor

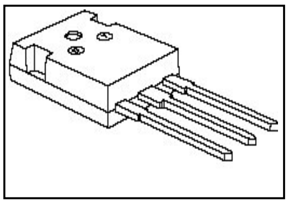
**Features**

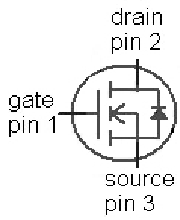
- New revolutionary high voltage technology
- Ultra low gate charge
- Periodic avalanche rated
- Extreme d$v$/d$t$ rated
- Ultra low effective capacitances
- Improved transconductance

**Product Summary**

| | | |
|---|---|---|
| $V_{DS}$ @ $T_{j,max}$ | 650 | V |
| $R_{DS(on),max}$ | 0.1 | Ω |
| $I_D$ | 34.6 | A |

P-TO247






| Type | Package | Ordering Code | Marking |
|---|---|---|---|
| SPW35N60C3 | P-TO247 | Q67040-S4673 | 35N60C3 |

**Maximum ratings,** at $T_j$=25 °C, unless otherwise specified

| Parameter | Symbol | Conditions | Value | Unit |
|---|---|---|---|---|
| Continuous drain current | $I_D$ | $T_C$=25 °C | 34.6 | A |
| | | $T_C$=100 °C | 21.9 | |
| Pulsed drain current[1)] | $I_{D,pulse}$ | $T_C$=25 °C | 103.8 | |
| Avalanche energy, single pulse | $E_{AS}$ | $I_D$=17.3 A, $V_{DD}$=50 V | 1500 | mJ |
| Avalanche energy, repetitive $t_{AR}$[1),2)] | $E_{AR}$ | $I_D$=34.6 A, $V_{DD}$=50 V | 1.5 | |
| Avalanche current, repetitive $t_{AR}$[1)] | $I_{AR}$ | | 34.6 | A |
| Drain source voltage slope | d$v$/d$t$ | $I_D$=34.6 A, $V_{DS}$=480 V, $T_j$=125 °C | 50 | V/ns |
| Gate source voltage | $V_{GS}$ | static | ±20 | V |
| | $V_{GS}$ | AC ($f$>1 Hz) | ±30 | |
| Power dissipation | $P_{tot}$ | $T_C$=25 °C | 313 | W |
| Operating and storage temperature | $T_j$, $T_{stg}$ | | -55 ... 150 | °C |

| Parameter | Symbol | Conditions | Values | | | Unit |
|---|---|---|---|---|---|---|
| | | | min. | typ. | max. | |
| **Thermal characteristics** | | | | | | |
| Thermal resistance, junction - case | $R_{thJC}$ | | - | - | 0.4 | K/W |
| Thermal resistance, junction - ambient | $R_{thJA}$ | leaded | - | - | 62 | |
| Soldering temperature | $T_{sold}$ | 1.6 mm (0.063 in.) from case for 10 s | - | - | 260 | °C |

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

| Parameter | Symbol | Conditions | min. | typ. | max. | Unit |
|---|---|---|---|---|---|---|
| **Static characteristics** | | | | | | |
| Drain-source breakdown voltage | $V_{(BR)DSS}$ | $V_{GS}$=0 V, $I_D$=250 µA | 600 | - | - | V |
| Avalanche breakdown voltage | $V_{(BR)DS}$ | $V_{GS}$=0 V, $I_D$=34.6 A | - | 700 | - | |
| Gate threshold voltage | $V_{GS(th)}$ | $V_{DS}$=$V_{GS}$, $I_D$=1.9 mA | 2.1 | 3 | 3.9 | |
| Zero gate voltage drain current | $I_{DSS}$ | $V_{DS}$=600 V, $V_{GS}$=0 V, $T_j$=25 °C | - | 0.1 | 1 | µA |
| | | $V_{DS}$=600 V, $V_{GS}$=0 V, $T_j$=150 °C | - | - | 100 | |
| Gate-source leakage current | $I_{GSS}$ | $V_{GS}$=20 V, $V_{DS}$=0 V | - | - | 100 | nA |
| Drain-source on-state resistance | $R_{DS(on)}$ | $V_{GS}$=10 V, $I_D$=21.9 A, $T_j$=25 °C | - | 0.081 | 0.1 | Ω |
| | | $V_{GS}$=10 V, $I_D$=21.9 A, $T_j$=150 °C | - | 0.2 | - | |
| Gate resistance | $R_G$ | $f$=1 MHz, open drain | - | 0.6 | - | |
| Transconductance | $g_{fs}$ | $\|V_{DS}\|$>2$\|I_D\|R_{DS(on)max}$, $I_D$=21.9 A | - | 36 | - | S |

| Parameter | Symbol | Conditions | Values | | | Unit |
|---|---|---|---|---|---|---|
| | | | min. | typ. | max. | |
| **Dynamic characteristics** | | | | | | |
| Input capacitance | $C_{iss}$ | $V_{GS}$=0 V, $V_{DS}$=25 V, $f$=1 MHz | - | 4500 | - | pF |
| Output capacitance | $C_{oss}$ | | - | 1500 | - | |
| Reverse transfer capacitance | $C_{rss}$ | | - | 100 | - | |
| Effective output capacitance, energy related[3)] | $C_{o(er)}$ | $V_{GS}$=0 V, $V_{DS}$=0 V to 480 V | - | 180 | - | |
| Effective output capacitance, time related[4)] | $C_{o(tr)}$ | | - | 324 | - | |
| Turn-on delay time | $t_{d(on)}$ | $V_{DD}$=480 V, $V_{GS}$=10 V, $I_D$=34.6 A, $R_G$=3.3 Ω | - | 10 | - | ns |
| Rise time | $t_r$ | | - | 5 | - | |
| Turn-off delay time | $t_{d(off)}$ | | - | 70 | - | |
| Fall time | $t_f$ | | - | 10 | - | |
| Gate Charge Characteristics | | | | | | |
| Gate to source charge | $Q_{gs}$ | $V_{DD}$=480 V, $I_D$=34.6 A, $V_{GS}$=0 to 10 V | - | 18 | - | nC |
| Gate to drain charge | $Q_{gd}$ | | - | 70 | - | |
| Gate charge total | $Q_g$ | | - | 150 | 200 | |
| Gate plateau voltage | $V_{plateau}$ | | - | 5.3 | - | V |

[1)] Pulse width limited by maximum temperature $T_{j,max}$ only

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

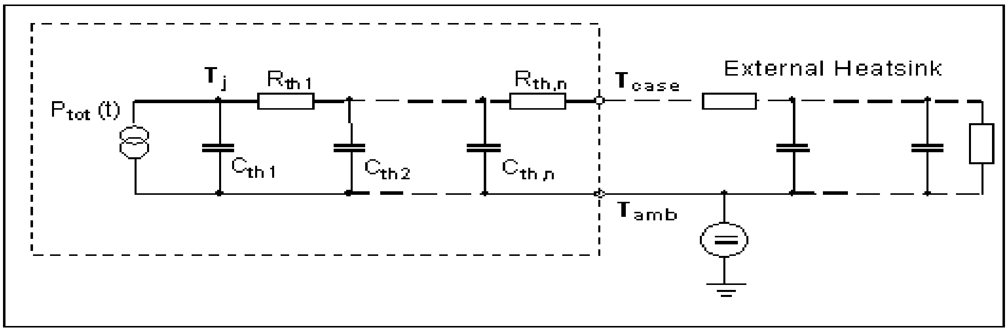
[3)] $C_{o(er)}$ is a fixed capacitance that gives the same stored energy as $C_{oss}$ while $V_{DS}$ is rising from 0 to 80% $V_{DSS}$.

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

| Parameter | Symbol | Conditions | Values | | | Unit |
|---|---|---|---|---|---|---|
| | | | min. | typ. | max. | |
| **Reverse Diode** | | | | | | |
| Diode continuous forward current | $I_S$ | $T_C$=25 °C | - | - | 34.6 | A |
| Diode pulse current | $I_{S,pulse}$ | | - | - | 103.8 | |
| Diode forward voltage | $V_{SD}$ | $V_{GS}$=0 V, $I_F$=34.6 A, $T_j$=25 °C | - | 0.95 | 1.2 | V |
| Reverse recovery time | $t_{rr}$ | $V_R$=480 V, $I_F$=$I_S$, d$i_F$/d$t$=100 A/µs | - | 600 | - | ns |
| Reverse recovery charge | $Q_{rr}$ | | - | 21 | - | µC |
| Peak reverse recovery current | $I_{rrm}$ | | - | 90 | - | A |

**Typical Transient Thermal Characteristics**

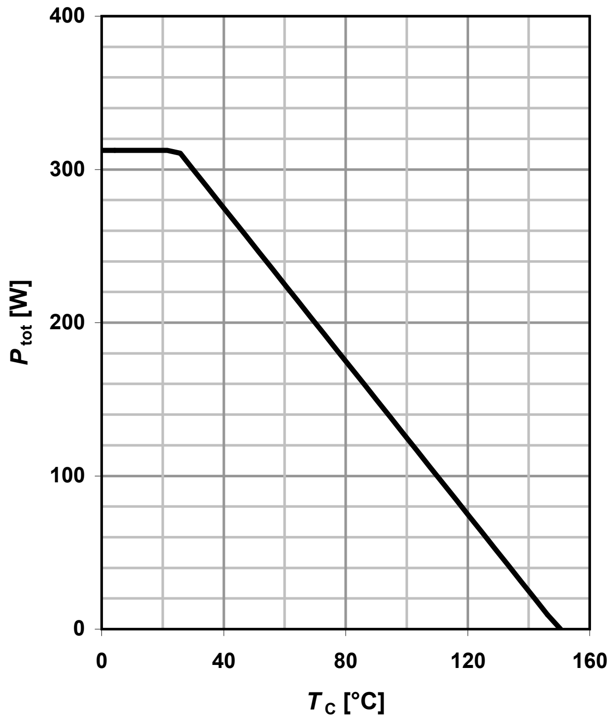
| Symbol | Value | Unit | Symbol | Value | Unit |
|---|---|---|---|---|---|
| | typ. | | | typ. | |
| $R_{th1}$ | 0.00441 | K/W | $C_{th1}$ | 0.00037 | Ws/K |
| $R_{th2}$ | 0.00608 | | $C_{th2}$ | 0.00223 | |
| $R_{th3}$ | 0.0341 | | $C_{th3}$ | 0.00315 | |
| $R_{th4}$ | 0.0602 | | $C_{th4}$ | 0.0179 | |
| $R_{th5}$ | 0.0884 | | $C_{th5}$ | 0.098 | |
| | | | $C_{th6}$ | 4.4[5)] | |




[5)] $C_{th6}$ models the additional heat capacitance of the package in case of non-ideal cooling. It is not needed if $R_{thCA}$=0 K/W.

**1 Power dissipation**

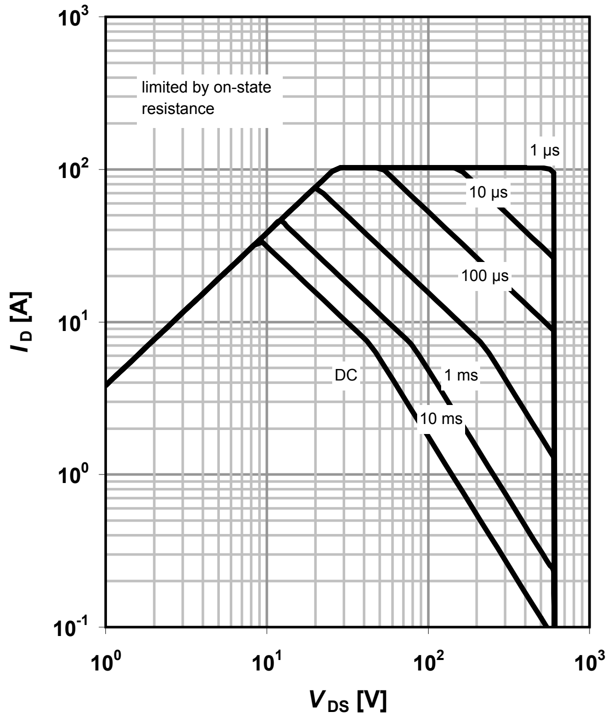
$P_{tot}=f(T_C)$




**2 Safe operating area**

$I_D=f(V_{DS})$; $T_C=25$ °C; $D=0$

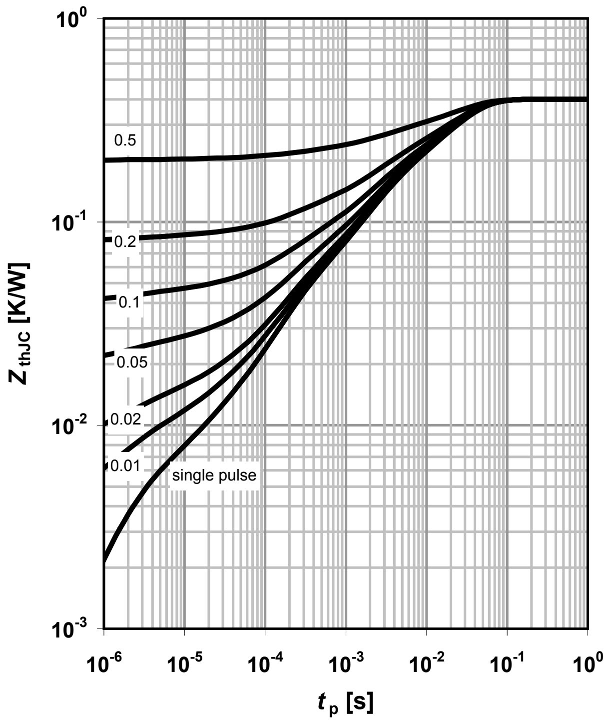
parameter: $t_p$




**3 Max. transient thermal impedance**

$I_D=f(V_{DS})$; $T_j=25$ °C

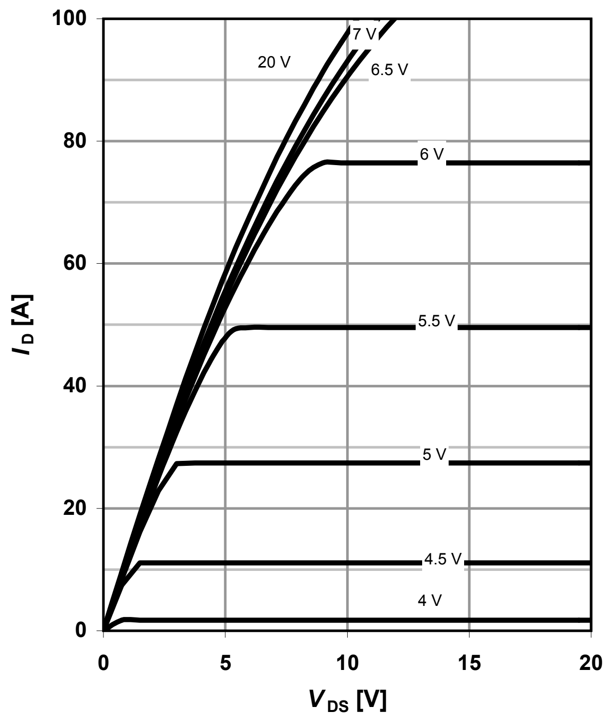
parameter: $D=t_p/T$




**4 Typ. output characteristics**

$I_D=f(V_{DS})$; $T_j=25$ °C

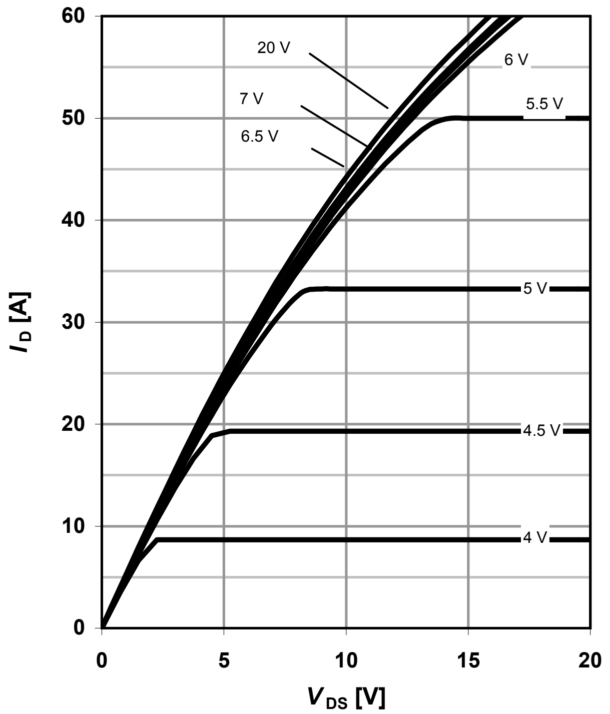
parameter: $V_{GS}$



**5 Typ. output characteristics**

$I_D$=f($V_{DS}$); $T_j$=150 °C

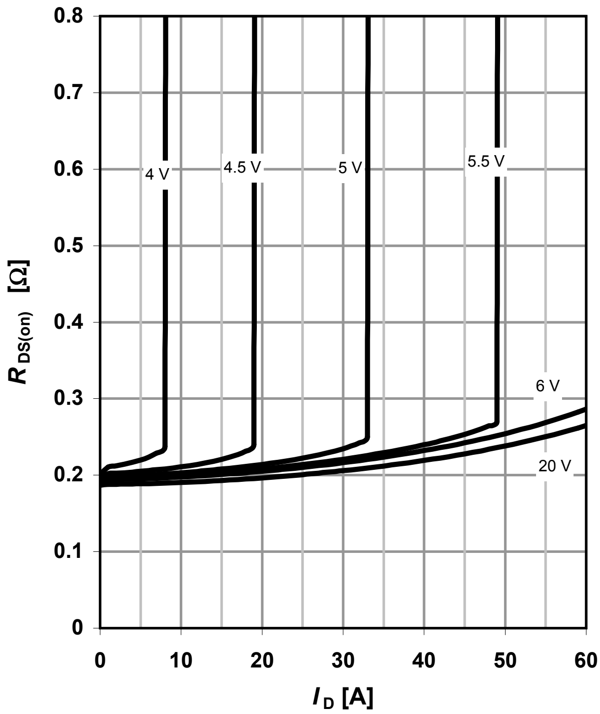
parameter: $V_{GS}$




**6 Typ. drain-source on-state resistance**

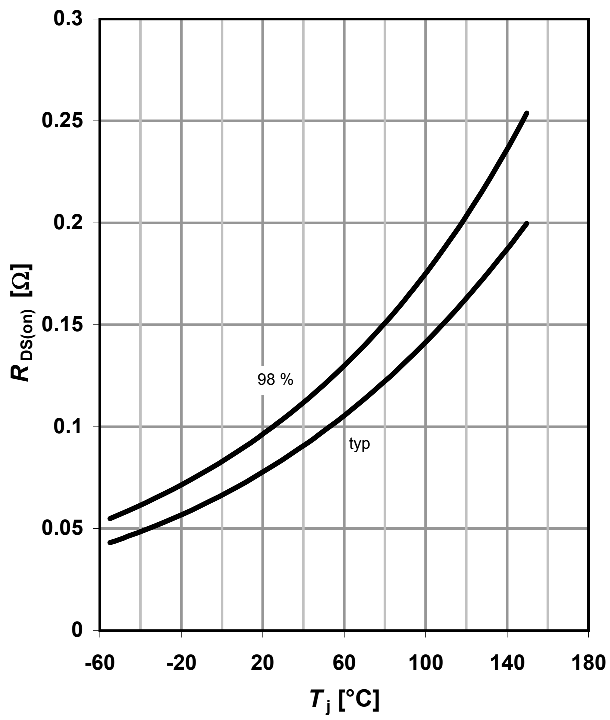
$R_{DS(on)}$=f($I_D$); $T_j$=150 °C

parameter: $V_{GS}$




**7 Drain-source on-state resistance**

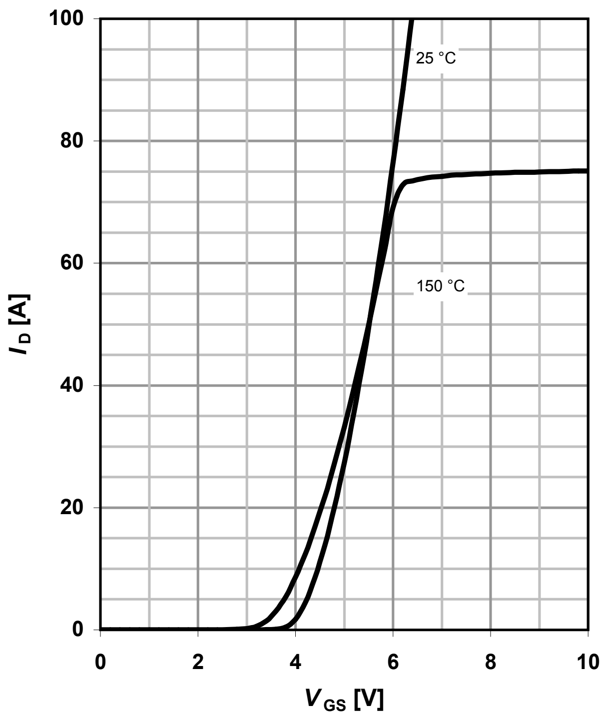
$R_{DS(on)}$=f($T_j$); $I_D$=21.9 A; $V_{GS}$=10 V




**8 Typ. transfer characteristics**

$I_D$=f($V_{GS}$); $|V_{DS}|>2|I_D|R_{DS(on)max}$

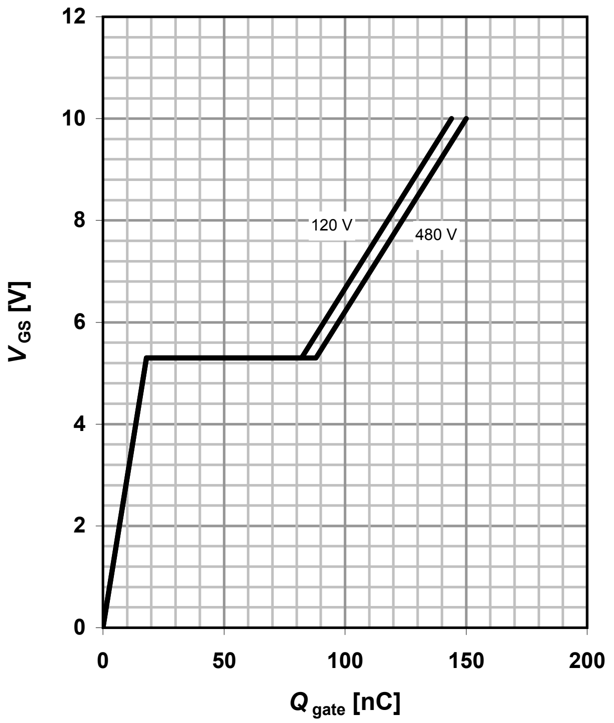
parameter: $T_j$



**9 Typ. gate charge**

$V_{GS}$=f($Q_{gate}$); $I_D$=34.6 A pulsed

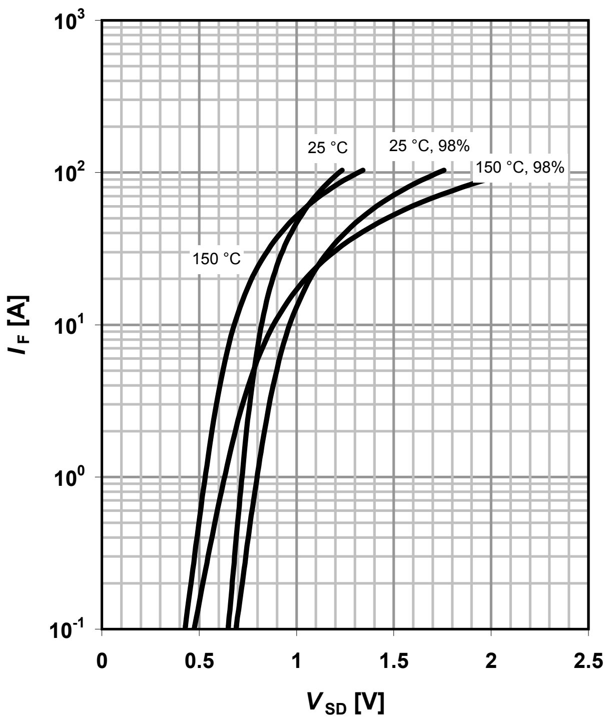
parameter: $V_{DD}$




**10 Forward characteristics of reverse diode**

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

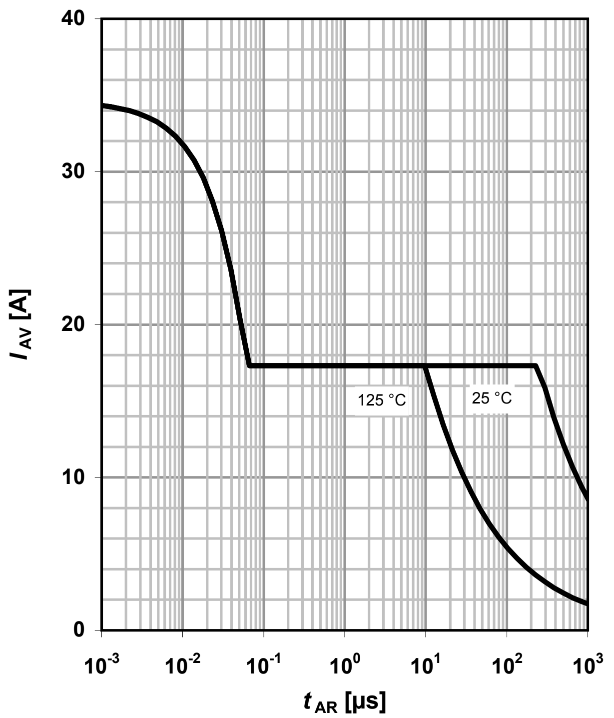
parameter: $T_j$




**11 Avalanche SOA**

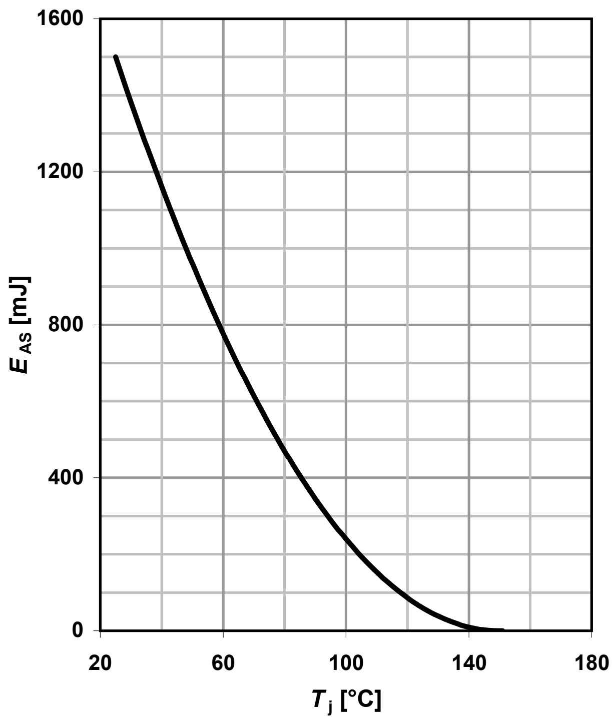
$I_{AR}$=f($t_{AR}$)

parameter: $T_{j(start)}$



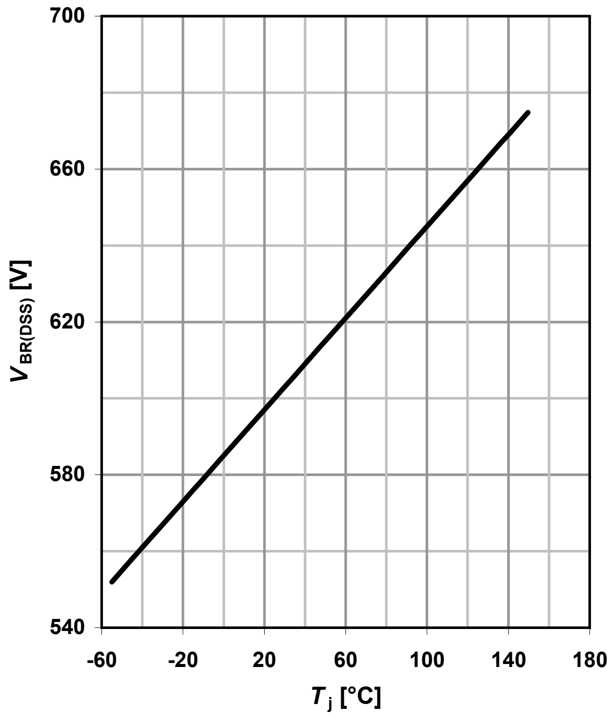

**12 Avalanche energy**

$E_{AS}$=f($T_j$); $I_D$=17.3 A; $V_{DD}$=50 V



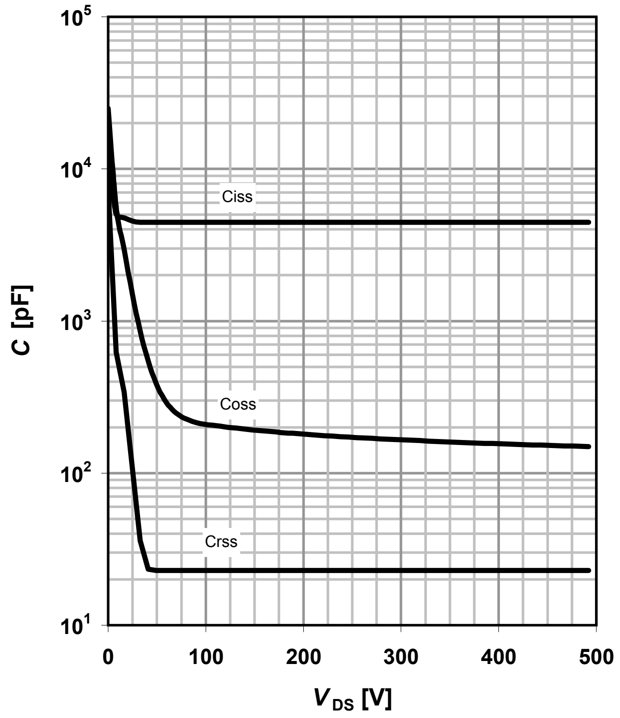
**13 Drain-source breakdown voltage**

$V_{BR(DSS)}$=f($T_j$); $I_D$=0.25 mA



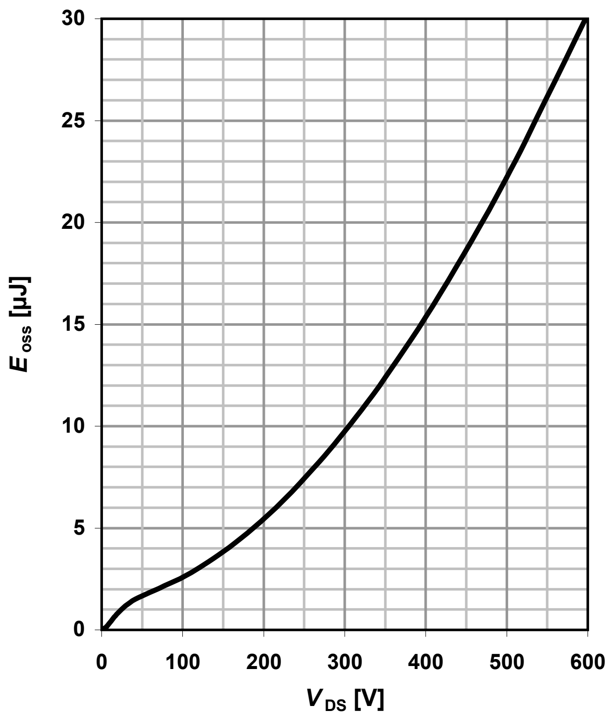

**14 Typ. capacitances**

$C$=f($V_{DS}$); $V_{GS}$=0 V; $f$=1 MHz

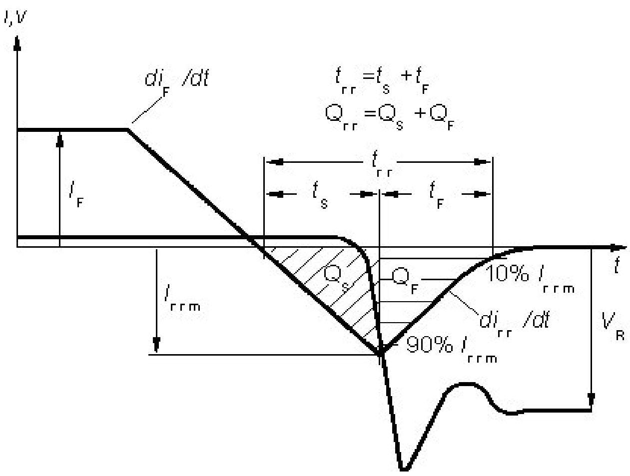



**15 Typ. $C_{oss}$ stored energy**

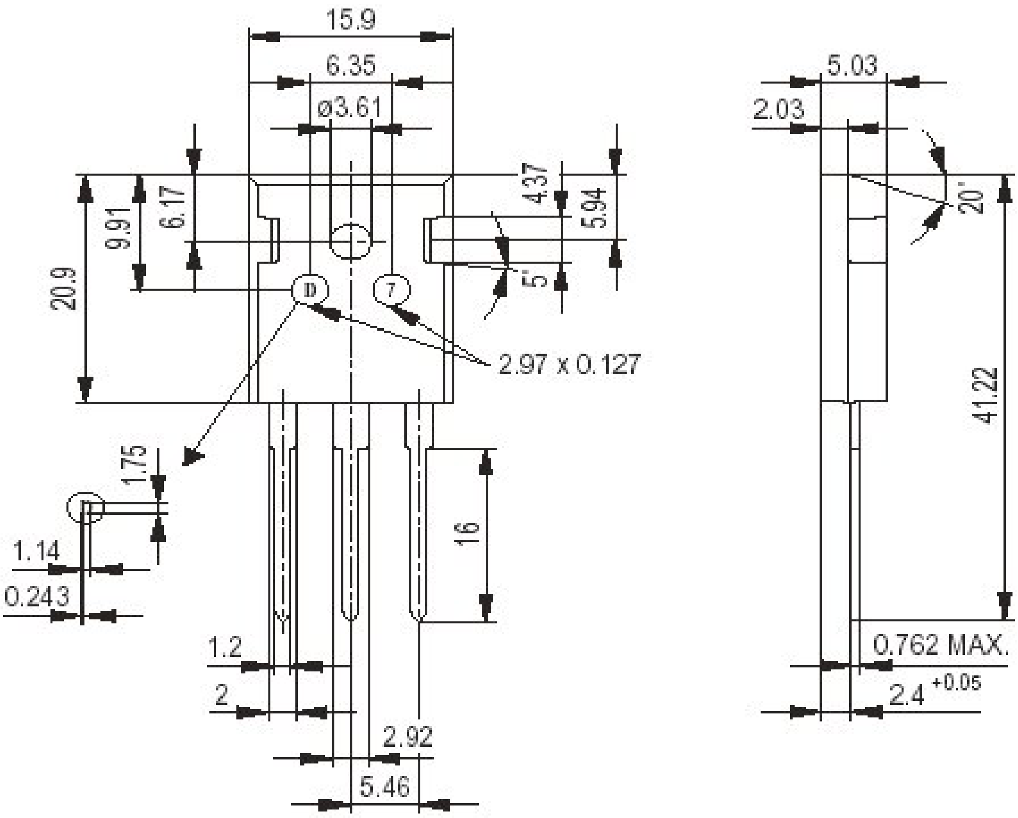
$E_{oss}$=f($V_{DS}$)



**Definition of diode switching characteristics**




**P-TO247: Outline**




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

Dimensions in mm

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