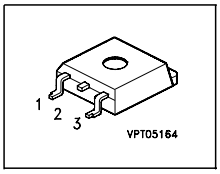
## Cool MOS™ Power Transistor

| | | |
|---|---|---|
| $V_{DS}$ @ $T_{jmax}$ | 650 | V |
| $R_{DS(on)}$ | 0.19 | Ω |
| $I_D$ | 20.7 | A |

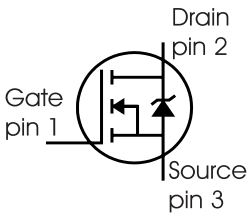
### Feature

- New revolutionary high voltage technology
- Ultra low gate charge
- Periodic avalanche rated
- Extreme d*v*/d*t* rated
- High peak current capability
- Improved transconductance
- Qualified according to JEDEC[0)] for target applications

PG-TO263




| Type | Package | Ordering Code | Marking |
|---|---|---|---|
| SPB20N60C3 | PG-TO263 | Q67040-S4397 | 20N60C3 |




### Maximum Ratings

| Parameter | Symbol | Value | | Unit |
|---|---|---|---|---|
| | | SPB | | |
| Continuous drain current<br>$T_C$ = 25 °C<br>$T_C$ = 100 °C | $I_D$ | <br>20.7<br>13.1 | | A |
| Pulsed drain current, $t_p$ limited by $T_{jmax}$ | $I_{D\ puls}$ | 62.1 | | A |
| Avalanche energy, single pulse<br>$I_D$=10A, $V_{DD}$=50V | $E_{AS}$ | 690 | | mJ |
| Avalanche energy, repetitive $t_{AR}$ limited by $T_{jmax}$[2)]<br>$I_D$=20A, $V_{DD}$=50V | $E_{AR}$ | 1 | | |
| Avalanche current, repetitive $t_{AR}$ limited by $T_{jmax}$ | $I_{AR}$ | 20 | | A |
| Gate source voltage static | $V_{GS}$ | ±20 | | V |
| Gate source voltage AC (f >1Hz) | $V_{GS}$ | ±30 | | |
| Power dissipation, $T_C$ = 25°C | $P_{tot}$ | 208 | | W |
| Operating and storage temperature | $T_j$ , $T_{stg}$ | -55...+150 | | °C |
| Reverse diode dv/dt [7)] | dv/dt | 15 | | V/ns |

## Maximum Ratings

| Parameter | Symbol | Value | Unit |
|---|---|---|---|
| Drain Source voltage slope<br>$V_{DS}$ = 480 V, $I_D$ = 20.7 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 | $R_{thJC}$ | - | - | 0.6 | K/W |
| | | - | - | | |
| Thermal resistance, junction - ambient, leaded | $R_{thJA}$ | - | - | 62 | |
| | | - | - | | |
| SMD version, device on PCB:<br>@ min. footprint<br>@ 6 cm$^2$ cooling area [3)] | $R_{thJA}$ | <br>-<br>- | <br>-<br>35 | <br>62<br>- | |
| Soldering temperature, reflow soldering, MSL1 | $T_{sold}$ | - | - | 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 | $V_{GS(th)}$ | $I_D$=1000µA, $V_{GS}$=$V_{DS}$ | 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>-<br>- | <br>0.1<br>- | <br>1<br>100 | 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, $I_D$=13.1A<br>$T_j$=25°C<br>$T_j$=150°C | <br>-<br>- | <br>0.16<br>0.43 | <br>0.19<br>- | Ω |
| Gate input resistance | $R_G$ | *f*=1MHz, open drain | - | 0.54 | - | |

## Electrical Characteristics

| Parameter | Symbol | Conditions | Values | | | Unit |
|---|---|---|---|---|---|---|
| | | | min. | typ. | max. | |
| Transconductance | $g_{fs}$ | $V_{DS}\geq 2*I_D*R_{DS(on)max}$, $I_D$=13.1A | - | 17.5 | - | S |
| Input capacitance | $C_{iss}$ | $V_{GS}$=0V, $V_{DS}$=25V, $f$=1MHz | - | 2400 | - | pF |
| Output capacitance | $C_{oss}$ | | - | 780 | - | |
| Reverse transfer capacitance | $C_{rss}$ | | - | 50 | - | |
| Effective output capacitance,[5] energy related | $C_{o(er)}$ | $V_{GS}$=0V, $V_{DS}$=0V to 480V | - | 83 | - | |
| Effective output capacitance,[6] time related | $C_{o(tr)}$ | | - | 160 | - | |
| Turn-on delay time | $t_{d(on)}$ | $V_{DD}$=380V, $V_{GS}$=0/13V, $I_D$=20.7A, $R_G$=3.6Ω, $T_j$=125 | - | 10 | - | ns |
| Rise time | $t_r$ | $V_{DD}$=380V, $V_{GS}$=0/13V, $I_D$=20.7A, $R_G$=3.6Ω | - | 5 | - | |
| Turn-off delay time | $t_{d(off)}$ | | - | 67 | 100 | |
| Fall time | $t_f$ | | - | 4.5 | 12 | |

## Gate Charge Characteristics

| | | | | | | |
|---|---|---|---|---|---|---|
| Gate to source charge | $Q_{gs}$ | $V_{DD}$=480V, $I_D$=20.7A | - | 11 | - | nC |
| Gate to drain charge | $Q_{gd}$ | | - | 33 | - | |
| Gate charge total | $Q_g$ | $V_{DD}$=480V, $I_D$=20.7A, $V_{GS}$=0 to 10V | - | 87 | 114 | |
| Gate plateau voltage | $V_{(plateau)}$ | $V_{DD}$=480V, $I_D$=20.7A | - | 5.5 | - | V |

[0] J-STD20 and JESD22

[1] Limited only by maximum temperature

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

[3] Device on 40mm*40mm*1.5mm epoxy PCB FR4 with 6cm² (one layer, 70 µm thick) copper area for drain connection. PCB is vertical without blown air.

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

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

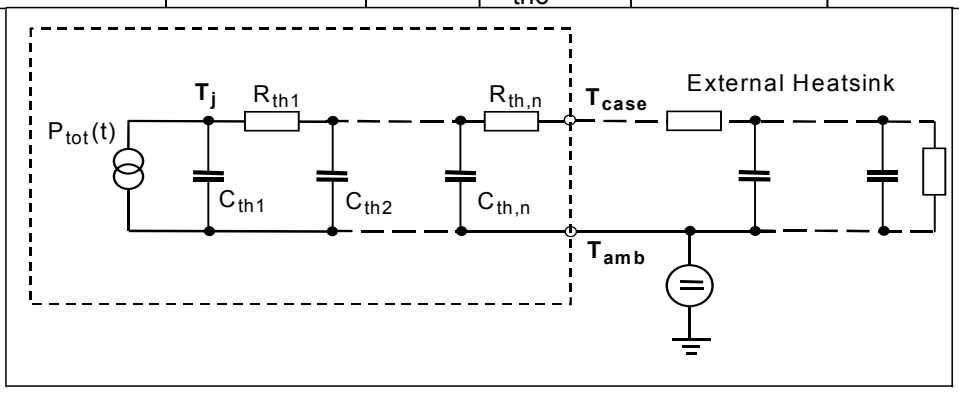
[7] $I_{SD}$<=$I_D$, di/dt<=400A/us, $V_{DClink}$=400V, $V_{peak}$<$V_{BR, DSS}$, $T_j$<$T_{j,max}$.
Identical low-side and high-side switch.

## Electrical Characteristics

| Parameter | Symbol | Conditions | Values | | | Unit |
|---|---|---|---|---|---|---|
| | | | min. | typ. | max. | |
| Inverse diode continuous forward current | $I_S$ | $T_C$=25°C | - | - | 20.7 | A |
| Inverse diode direct current, pulsed | $I_{SM}$ | | - | - | 62.1 | |
| Inverse diode forward voltage | $V_{SD}$ | $V_{GS}$=0V, $I_F$=$I_S$ | - | 1 | 1.2 | V |
| Reverse recovery time | $t_{rr}$ | $V_R$=480V, $I_F$=$I_S$ , | - | 500 | 800 | ns |
| Reverse recovery charge | $Q_{rr}$ | d$i_F$/d$t$=100A/µs | - | 11 | - | µC |
| Peak reverse recovery current | $I_{rrm}$ | | - | 70 | - | A |
| Peak rate of fall of reverse recovery current | $di_{rr}/dt$ | $T_j$=25°C | - | 1400 | - | A/µs |

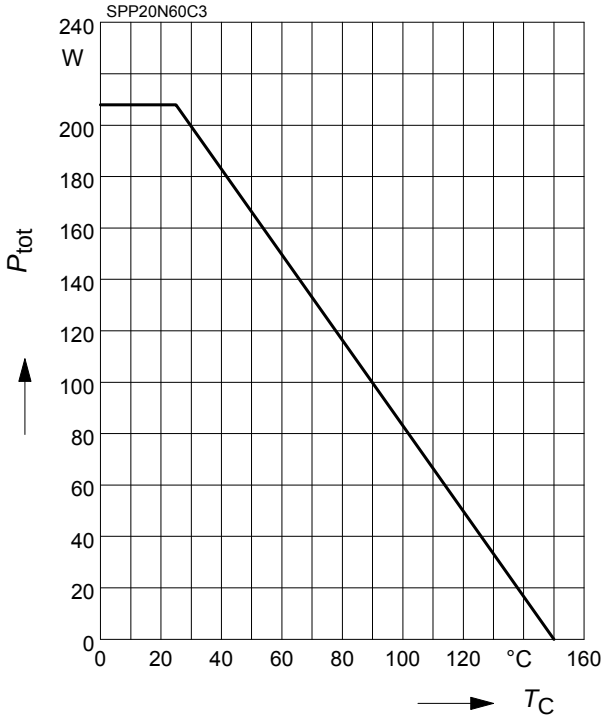
## Typical Transient Thermal Characteristics

| Symbol | Value | | Unit | Symbol | Value | | Unit |
|---|---|---|---|---|---|---|---|
| | SPB | | | | SPB | | |
| $R_{th1}$ | 0.00769 | | K/W | $C_{th1}$ | 0.0003763 | | Ws/K |
| $R_{th2}$ | 0.015 | | | $C_{th2}$ | 0.001411 | | |
| $R_{th3}$ | 0.029 | | | $C_{th3}$ | 0.001931 | | |
| $R_{th4}$ | 0.114 | | | $C_{th4}$ | 0.005297 | | |
| $R_{th5}$ | 0.136 | | | $C_{th5}$ | 0.012 | | |
| $R_{th6}$ | 0.059 | | | $C_{th6}$ | 0.091 | | |



## 1 Power dissipation

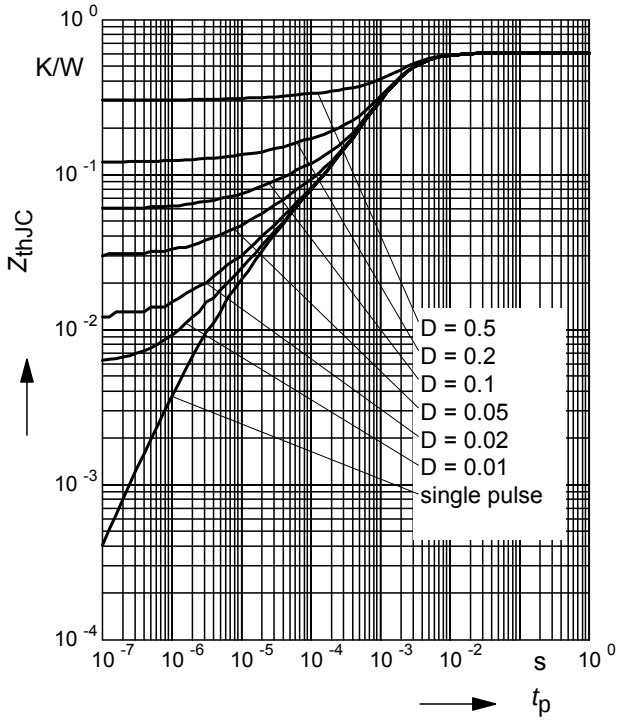
$P_{tot} = f(T_C)$




## 2 Transient thermal impedance

$Z_{thJC} = f(t_p)$

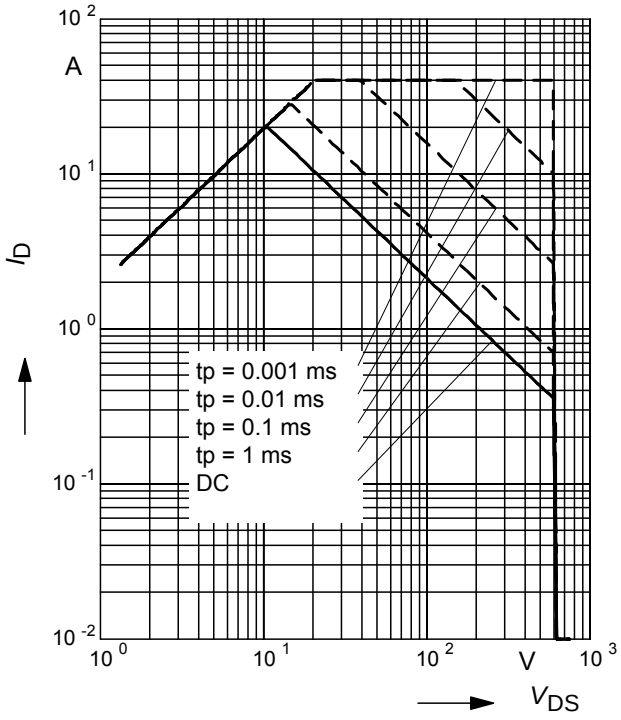
parameter: $D = t_p/T$




## 3 Safe operating area

$I_D = f(V_{DS})$

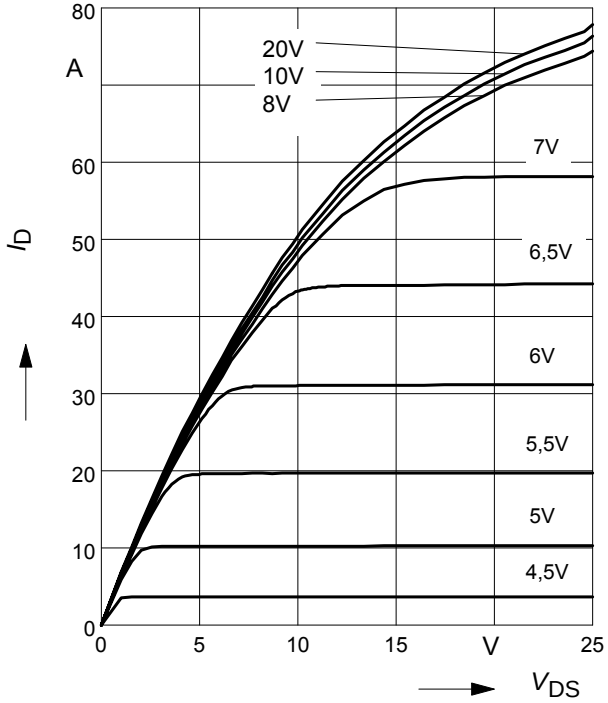
parameter : $D = 0$ , $T_C$=25°C




## 4 Typ. output characteristic

$I_D = f(V_{DS})$; $T_j$=25°C

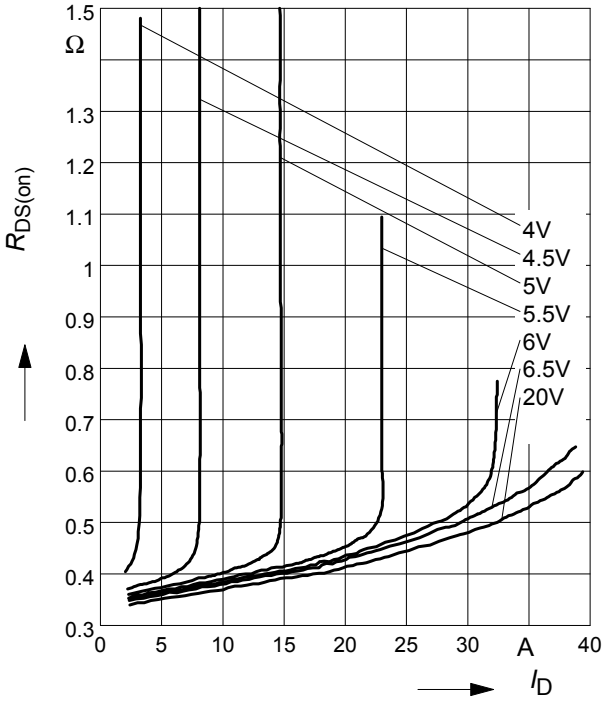
parameter: $t_p$ = 10 µs, $V_{GS}$



## 5 Typ. drain-source on resistance

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

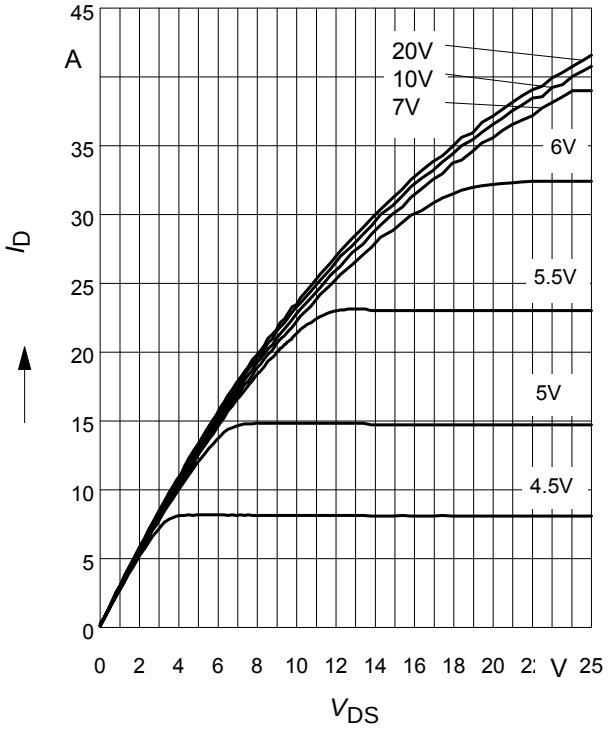
parameter: $T_j$= 150°C, $V_{GS}$




## 6 Typ. output characteristic

$I_D = f(V_{DS})$; $T_j$=150°C

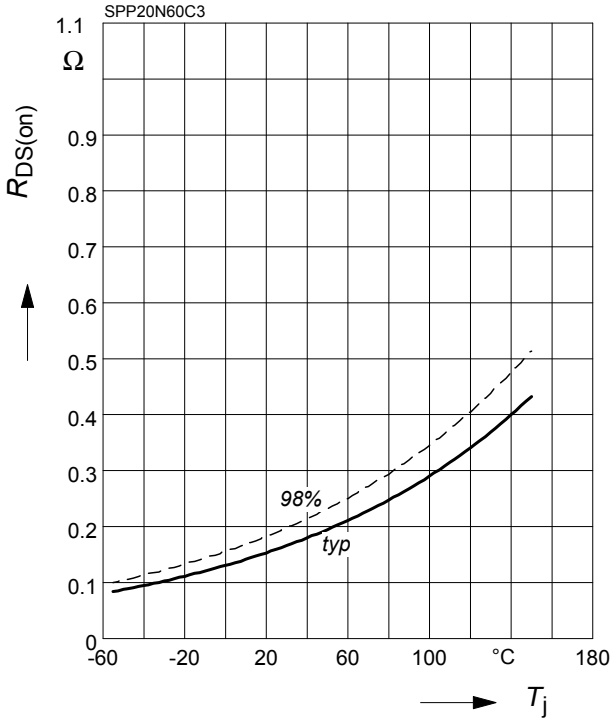
parameter: $t_p$ = 10 µs, $V_{GS}$




## 7 Drain-source on-state resistance

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

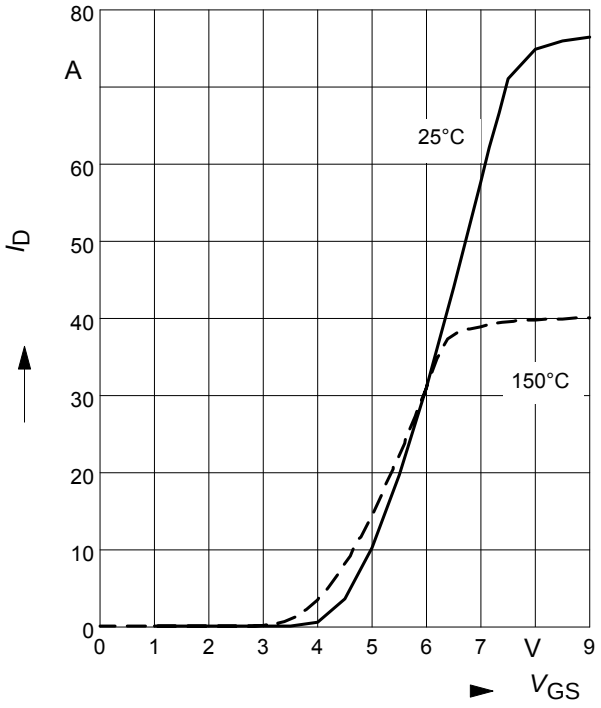
parameter : $I_D$ = 13.1 A, $V_{GS}$ = 10 V




## 8 Typ. transfer characteristics

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

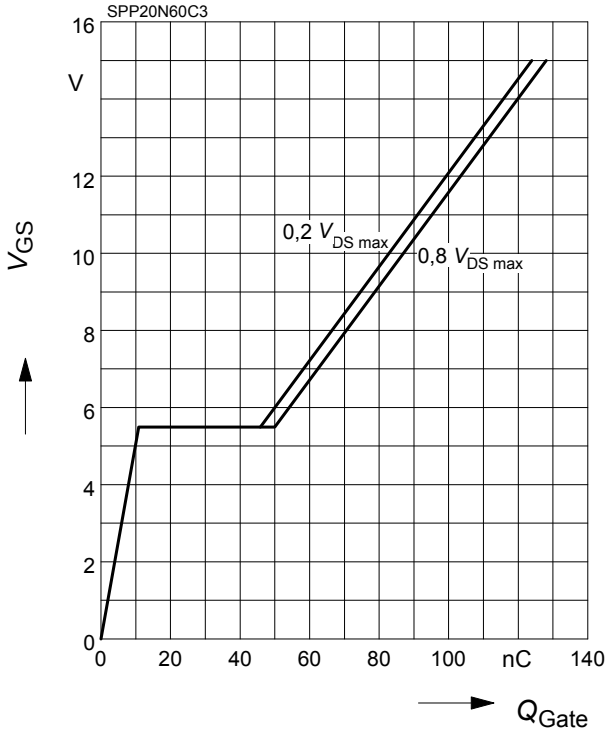
parameter: $t_p$ = 10 µs



## 9 Typ. gate charge

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

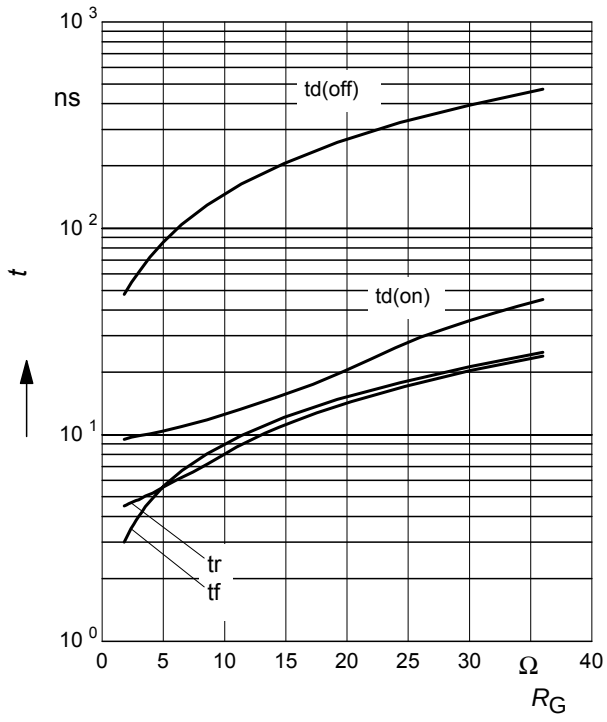
parameter: $I_D$ = 20.7 A pulsed




## 10 Typ. switching time

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

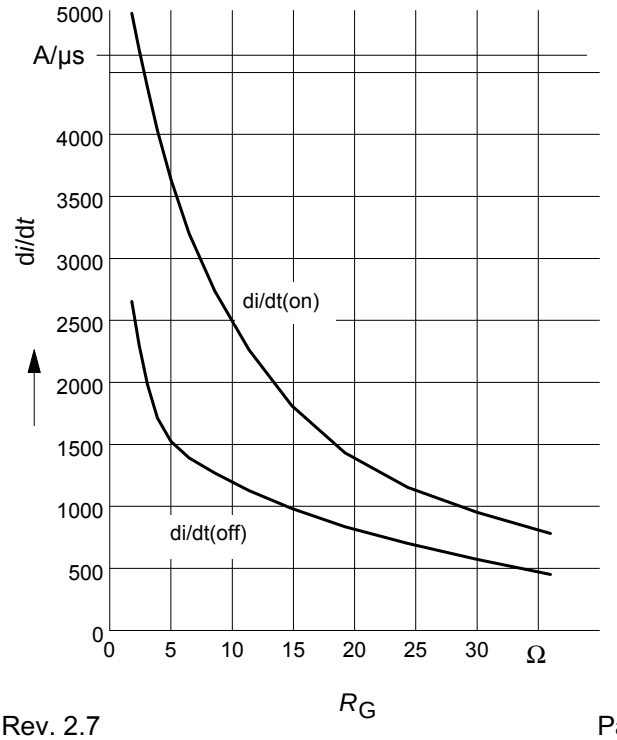
par.: $V_{DS}$=380V, $V_{GS}$=0/+13V, $I_D$=20.7 A




## 11 Typ. drain current slope

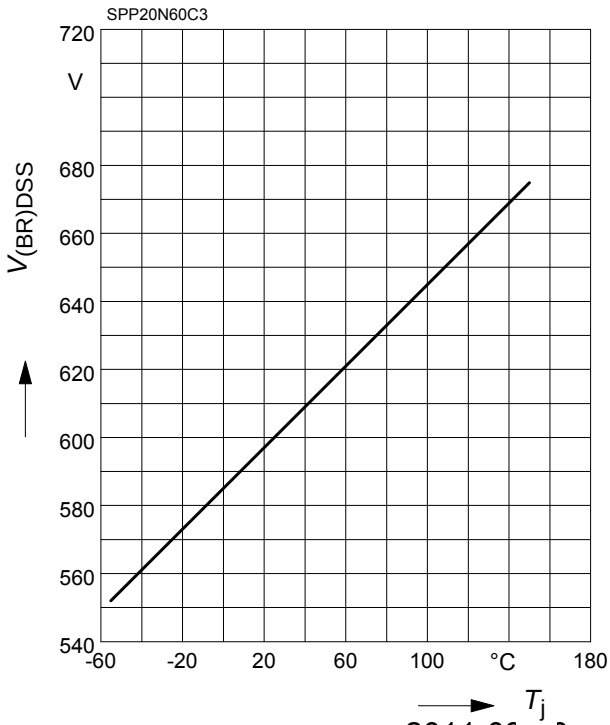
d$i$/d$t$ = f($R_G$), inductive load, $T_j$ = 125°C

par.: $V_{DS}$=380V, $V_{GS}$=0/+13V, $I_D$=20.7A




## 12 Drain-source breakdown voltage

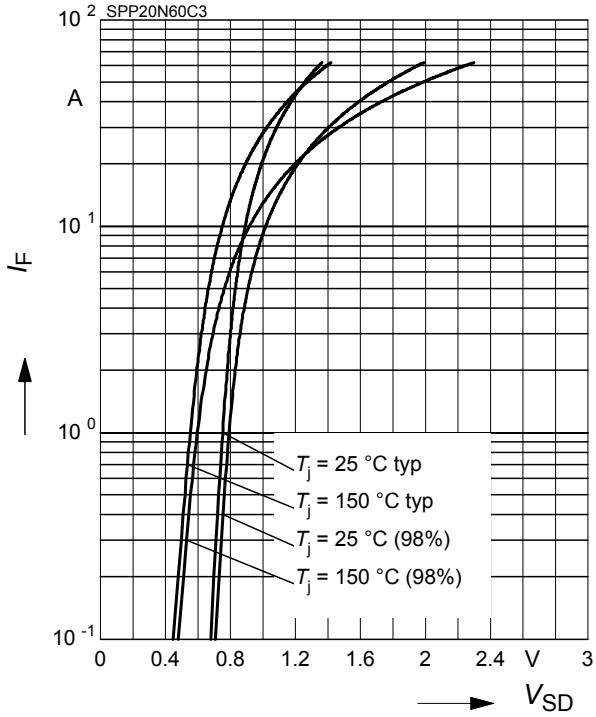
$V_{(BR)DSS} = f\ (T_j)$



## 13 Forward characteristics of body diode

$I_F = f(V_{SD})$

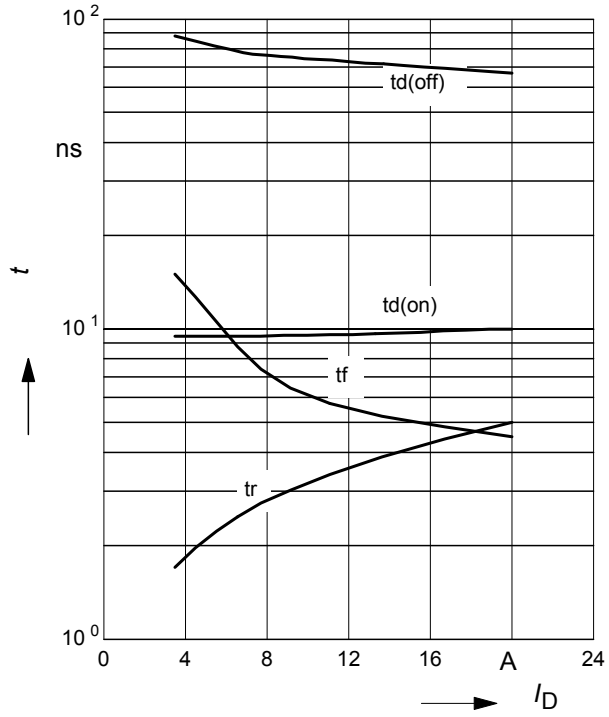
parameter: $T_j$, tp = 10 µs




## 14 Typ. switching time

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

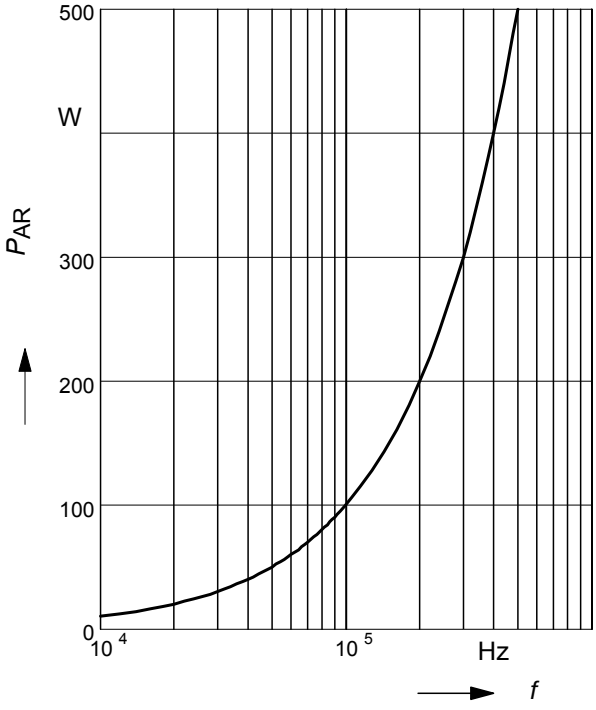
par.: $V_{DS}$=380V, $V_{GS}$=0/+13V, $R_G$=3.6Ω




## 15 Avalanche power losses

$P_{AR} = f(f)$

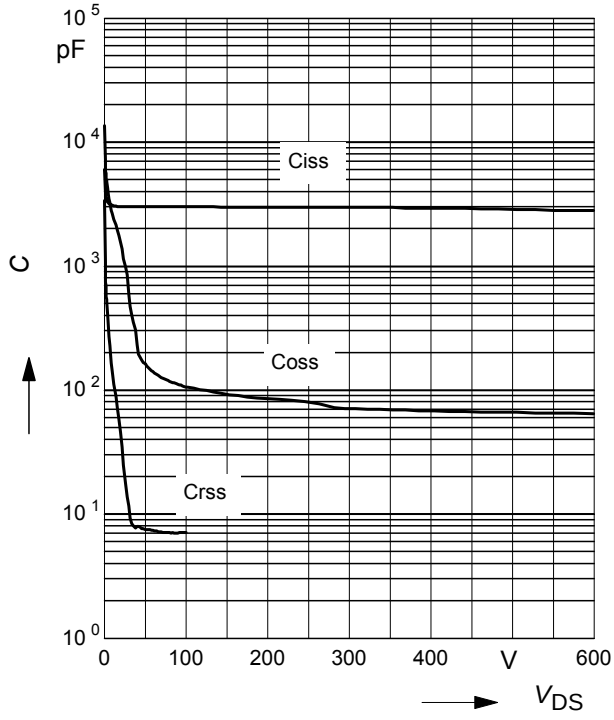
parameter: $E_{AR}$=1mJ




## 16 Typ. capacitances

$C = f(V_{DS})$

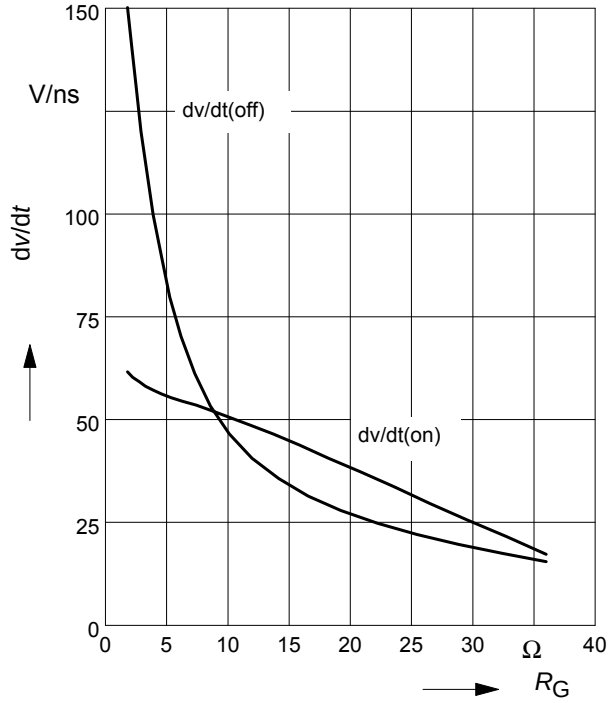
parameter: $V_{GS}$=0V, $f$=1 MHz



## 17 Typ. drain source voltage slope

d*v*/d*t* = f($R_G$), inductive load, $T_j$ = 125°C

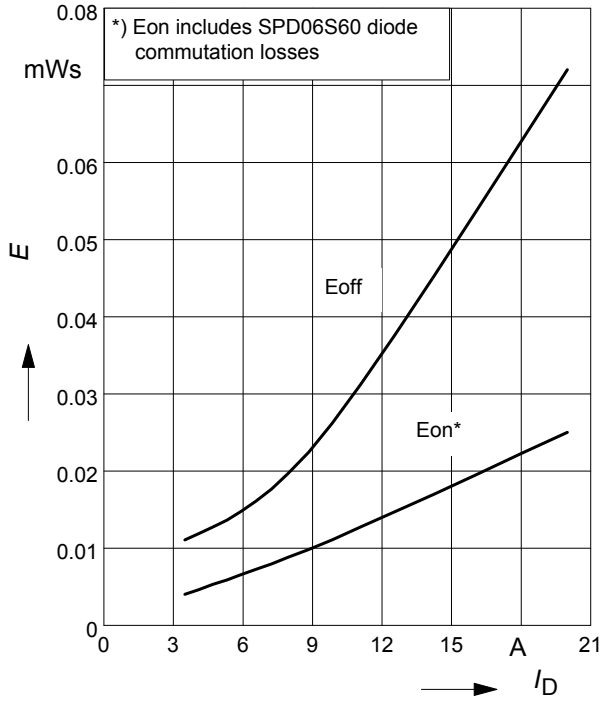
par.: $V_{DS}$=380V, $V_{GS}$=0/+13V, $I_D$=20.7A




## 18 Typ. switching losses

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

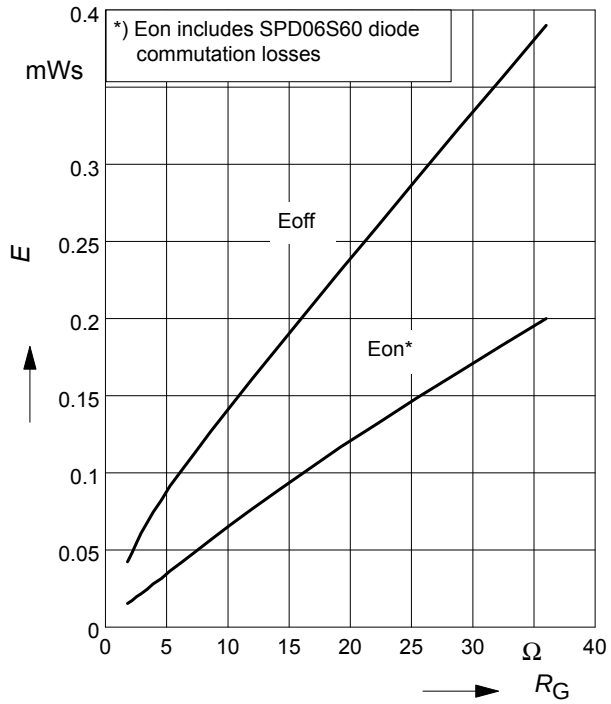
par.: $V_{DS}$=380V, $V_{GS}$=0/+13V, $R_G$=3.6Ω




## 19 Typ. switching losses

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

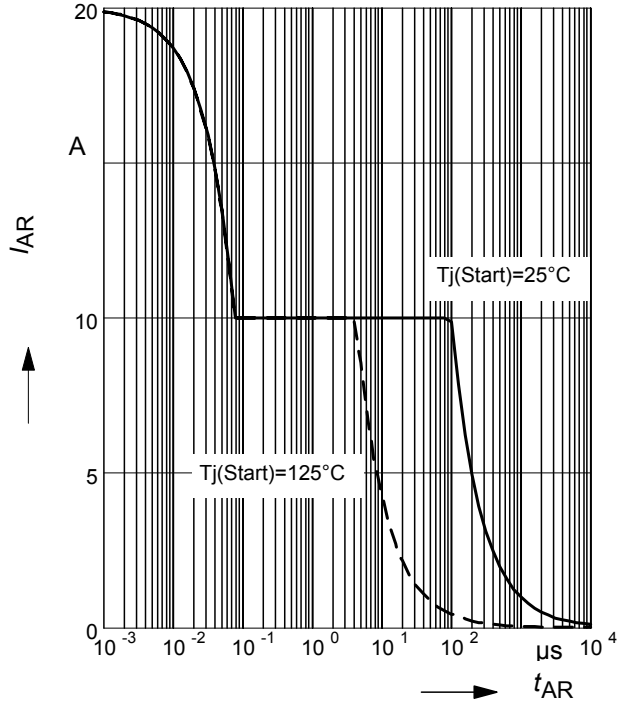
par.: $V_{DS}$=380V, $V_{GS}$=0/+13V, $I_D$=20.7A




## 20 Avalanche SOA

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

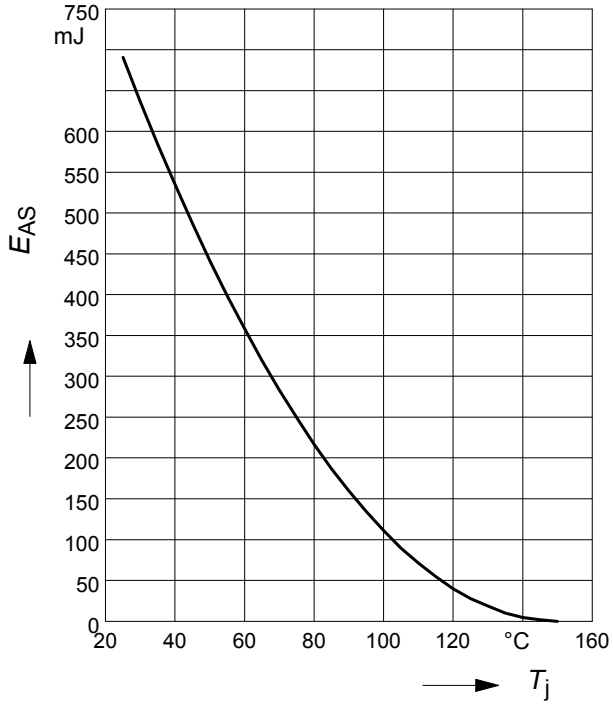
par.: $T_j \leq 150$ °C



## 21 Avalanche energy

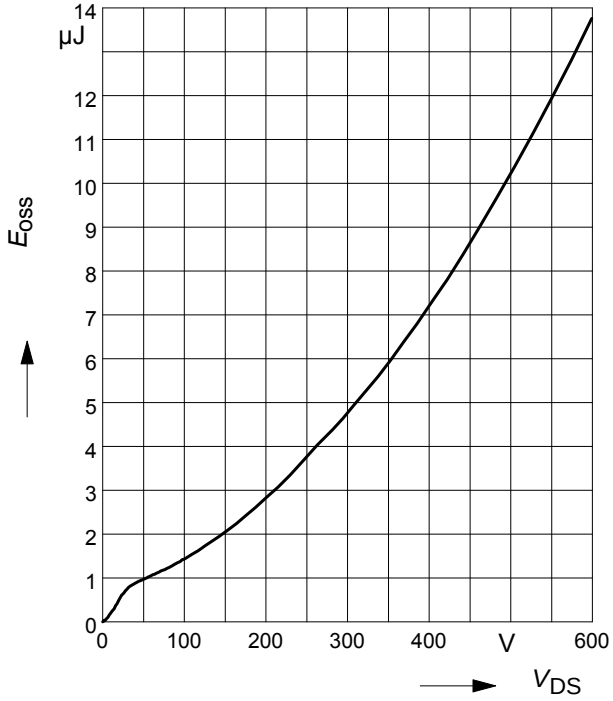
$E_{AS} = f(T_j)$

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

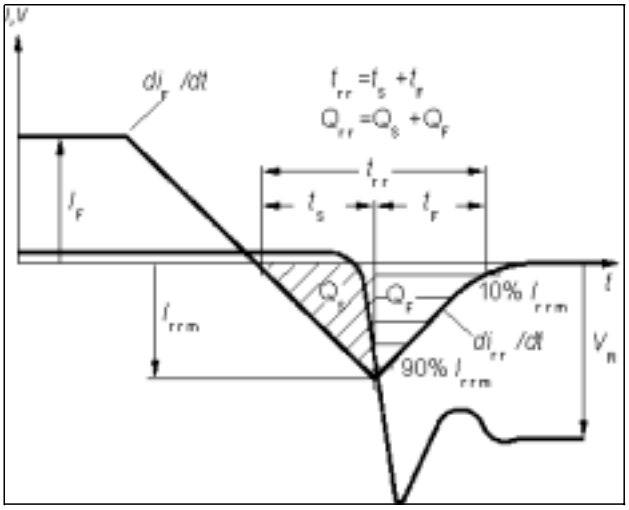



## 22 Typ. $C_{oss}$ stored energy

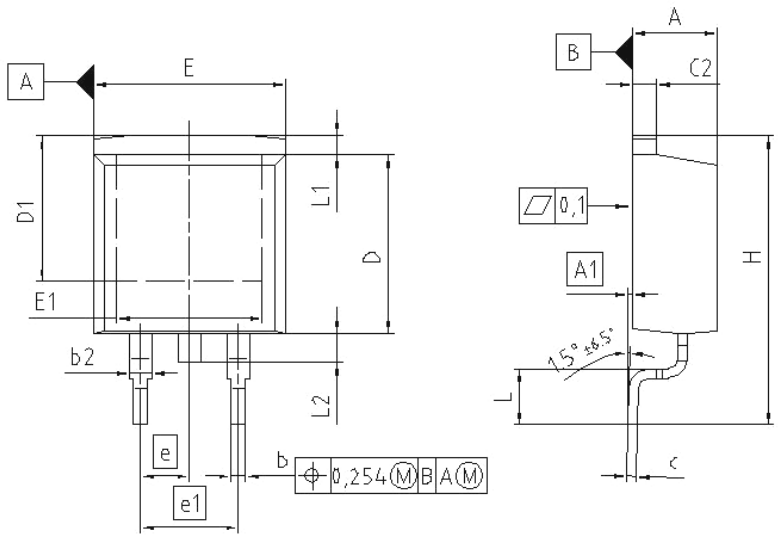
$E_{oss}=f(V_{DS})$



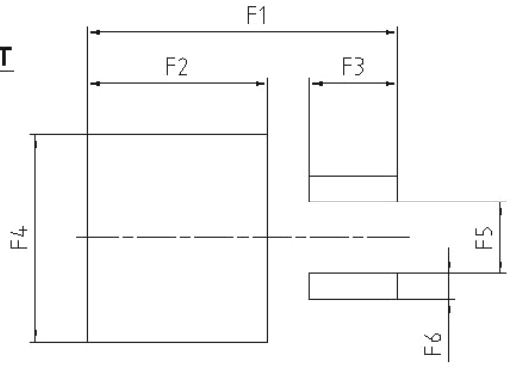

Definition of diodes switching characteristics



PG-TO263-3-2/ PG-TO263-3-5/ PG-TO263-3-22




**FOOTPRINT**




| DIM | MILLIMETERS | | INCHES | |
|---|---|---|---|---|
| | MIN | MAX | MIN | MAX |
| A | 4.300 | 4.572 | 0.169 | 0.180 |
| A1 | 0.000 | 0.254 | 0.000 | 0.010 |
| b | 0.650 | 0.850 | 0.026 | 0.033 |
| b2 | 0.950 | 1.321 | 0.037 | 0.052 |
| c | 0.330 | 0.650 | 0.013 | 0.026 |
| c2 | 0.170 | 1.400 | 0.046 | 0.055 |
| D | 8.509 | 9.450 | 0.335 | 0.372 |
| D1 | 7.100 | - | 0.280 | - |
| E | 9.800 | 10.312 | 0.386 | 0.406 |
| E1 | 6.500 | | 0.256 | |
| e | 2.540 | | 0.100 | |
| e1 | 5.080 | | 0.200 | |
| N | 2 | | 2 | |
| H | 14.605 | 15.875 | 0.575 | 0.625 |
| L | 2.200 | 3.000 | 0.087 | 0.118 |
| L1 | - | 1.600 | - | 0.063 |
| L2 | 1.000 | 1.778 | 0.039 | 0.070 |
| F1 | 16.050 | 16.250 | 0.632 | 0.640 |
| F2 | 9.300 | 9.500 | 0.366 | 0.374 |
| F3 | 4.500 | 4.700 | 0.177 | 0.185 |
| F4 | 10.700 | 10.900 | 0.421 | 0.429 |
| F5 | 3.630 | 3.830 | 0.143 | 0.151 |
| F6 | 1.100 | 1.300 | 0.043 | 0.051 |

| |
|---|
| REFERENCE<br>JEDEC TO263 |
| SCALE<br>0 5 5<br>7.5mm |
| EUROPEAN PROJECTION |
| ISSUE DATE<br>12-02-2006 |
| FILE<br>TO263_2 |

**Published by**
**Infineon Technologies AG**
**81726 Munich, Germany**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