# Cool MOS™ Power Transistor

COOLMOS Power Semiconductors

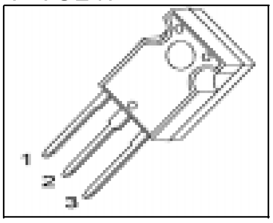
## Feature

- 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
- Improved noise immunity

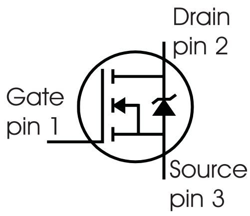
**Product Summary**

| | | |
|---|---|---|
| $V_{DS}$ | 600 | V |
| $R_{DS(on)}$ | 0.07 | Ω |
| $I_D$ | 47 | A |

P-TO247




| Type | Package | Ordering Code | Marking |
|---|---|---|---|
| SPW47N60C2 | P-TO247 | Q67040-S4323 | 47N60C2 |




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

| 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 $T_{jmax}$ | $I_{D\ puls}$ | 94 | |
| Avalanche energy, single pulse<br>$I_D$=10A, $V_{DD}$=50V | $E_{AS}$ | 1800 | mJ |
| Avalanche energy, repetitive $t_{AR}$ limited by $T_{jmax}$[1)]<br>$I_D$=20A, $V_{DD}$=50V | $E_{AR}$ | 1 | |
| Avalanche current, repetitive $t_{AR}$ limited by $T_{jmax}$ | $I_{AR}$ | 20 | A |
| Reverse diode d$v$/d$t$<br>$I_S$=47A, $V_{DS}$ < $V_{DD}$, d$i$/d$t$=100A/µs, $T_{jmax}$=150°C | d$v$/d$t$ | 6 | V/ns |
| Gate source voltage | $V_{GS}$ | ±20 | V |
| Power dissipation<br>$T_C$ = 25 °C | $P_{tot}$ | 415 | W |
| Operating and storage temperature | $T_j$ , $T_{stg}$ | -55... +150 | °C |

## Thermal Characteristics

| Parameter | Symbol | Values | | | Unit |
|---|---|---|---|---|---|
| | | min. | typ. | max. | |
| **Characteristics** | | | | | |
| Thermal resistance, junction - case | $R_{thJC}$ | - | - | 0.3 | K/W |
| Thermal resistance, junction - ambient, leaded | $R_{thJA}$ | - | - | 62 | |
| Linear derating factor | | - | - | 3.33 | W/K |
| Soldering temperature, 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 | min. | typ. | max. | Unit |
|---|---|---|---|---|---|
| **Static Characteristics** | | | | | |
| Drain-source breakdown voltage $V_{GS}$=0V, $I_D$=0.25mA | $V_{(BR)DSS}$ | 600 | - | - | V |
| Drain-source avalanche breakdown voltage $V_{GS}$=0V, $I_D$=20A | $V_{(BR)DS}$ | - | 700 | - | |
| Gate threshold voltage, $V_{GS} = V_{DS}$ $I_D$=2.7mA | $V_{GS(th)}$ | 3.5 | 4.5 | 5.5 | |
| Zero gate voltage drain current | $I_{DSS}$ | | | | µA |
| $V_{DS}$ = 600 V, $V_{GS}$ = 0 V, $T_j$ = 25 °C | | - | 0.5 | 25 | |
| $V_{DS}$ = 600 V, $V_{GS}$ = 0 V, $T_j$ = 150 °C | | - | - | 250 | |
| Gate-source leakage current $V_{GS}$=20V, $V_{DS}$=0V | $I_{GSS}$ | - | - | 100 | nA |
| Drain-source on-state resistance | $R_{DS(on)}$ | | | | Ω |
| $V_{GS}$=10V, $I_D$=30A, $T_j$=25°C | | - | 0.06 | 0.07 | |
| $V_{GS}$=10V, $I_D$=47A, $T_j$=150°C | | - | 0.17 | 0.2 | |
| Gate input resistance $f$ = 1 MHz, open drain | $R_G$ | - | 0.62 | - | |

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

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

| Parameter | Symbol | Conditions | Values | | | Unit |
|---|---|---|---|---|---|---|
| | | | min. | typ. | max. | |
| **Characteristics** | | | | | | |
| Transconductance | $g_{fs}$ | $V_{DS}$≥2*$I_D$*$R_{DS(on)max}$, $I_D$=30A | - | 30 | - | S |
| Input capacitance | $C_{iss}$ | $V_{GS}$=0V, $V_{DS}$=25V, $f$=1MHz | - | 8800 | - | pF |
| Output capacitance | $C_{oss}$ | | - | 3150 | - | |
| Reverse transfer capacitance | $C_{rss}$ | | - | 36 | - | |
| Effective output capacitance,[1] energy related | $C_{o(er)}$ | $V_{GS}$=0V, $V_{DS}$=0V to 480V | - | 233 | - | pF |
| Effective output capacitance,[2] time related | $C_{o(tr)}$ | | - | 470 | - | |
| Turn-on delay time | $t_{d(on)}$ | $V_{DD}$=380V, $V_{GS}$=0/13V, $I_D$=47A, $R_G$=1.8Ω, $T_j$=125°C | - | 28 | - | ns |
| Rise time | $t_r$ | | - | 95 | - | |
| Turn-off delay time | $t_{d(off)}$ | | - | 103 | 155 | |
| Fall time | $t_f$ | | - | 9.6 | 14.4 | |
| **Gate Charge Characteristics** | | | | | | |
| Gate to source charge | $Q_{gs}$ | $V_{DD}$=350V, $I_D$=47A | - | 56 | - | nC |
| Gate to drain charge | $Q_{gd}$ | | - | 123 | - | |
| Gate charge total | $Q_g$ | $V_{DD}$=350V, $I_D$=47A, $V_{GS}$=0 to 10V | - | 220 | 286 | |
| Gate plateau voltage | $V_{(plateau)}$ | $V_{DD}$=350V, $I_D$=47A | - | 8 | - | V |

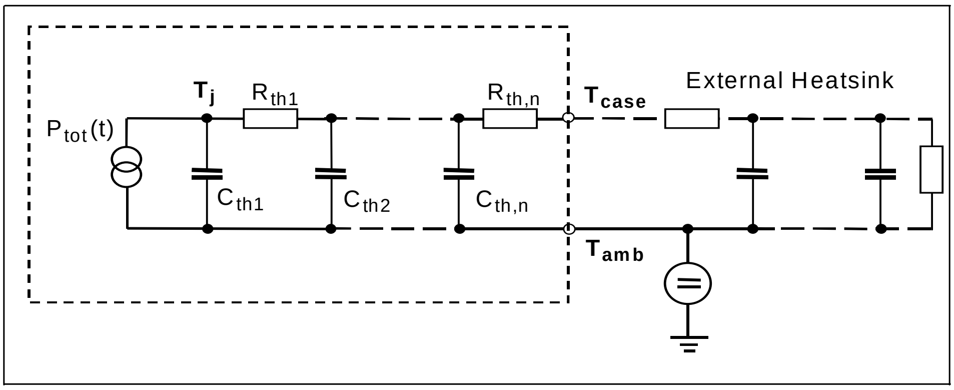
[1] $C_{o(er)}$ is a fixed capacitance that gives the same stored energy as $C_{oss}$ while $V_{DS}$ is rising from 0 to 80% $V_{DSS}$.
[2] $C_{o(tr)}$ is a fixed capacitance that gives the same charging time as $C_{oss}$ while $V_{DS}$ is rising from 0 to 80% $V_{DSS}$.

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

| Parameter | Symbol | Conditions | Values | | | Unit |
|---|---|---|---|---|---|---|
| | | | min. | typ. | max. | |
| **Reverse Diode** | | | | | | |
| Inverse diode continuous forward current | $I_S$ | $T_C$=25°C | - | - | 47 | A |
| Inverse diode direct current, pulsed | $I_{SM}$ | | - | - | 94 | |
| 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, $I_F$=$I_S$ , $di_F/dt$=100A/µs | - | 650 | 1100 | ns |
| Reverse recovery charge | $Q_{rr}$ | | - | 24 | - | µC |
| Peak reverse recovery current | $I_{rrm}$ | | - | 110 | - | A |
| Peak rate of fall of reverse recovery current | $di_{rr}/dt$ | | - | 2500 | - | A/µs |

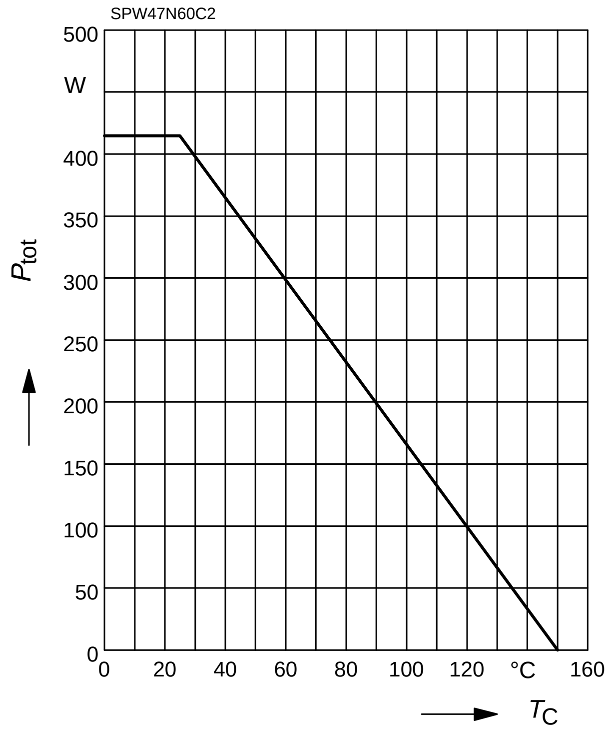
**Transient Thermal Characteristics**

| Symbol | Value typ. | Unit | Symbol | Value typ. | Unit |
|---|---|---|---|---|---|
| **Transient thermal impedance** | | | | | |
| Thermal resistance | | | Thermal capacitance | | |
| $R_{th1}$ | 0.002694 | K/W | $C_{th1}$ | 0.001219 | Ws/K |
| $R_{th2}$ | 0.006036 | | $C_{th2}$ | 0.004011 | |
| $R_{th3}$ | 0.00791 | | $C_{th3}$ | 0.006484 | |
| $R_{th4}$ | 0.023 | | $C_{th4}$ | 0.008028 | |
| $R_{th5}$ | 0.035 | | $C_{th5}$ | 0.05 | |
| $R_{th6}$ | 0.018 | | $C_{th6}$ | 0.316 | |



### 1 Power dissipation

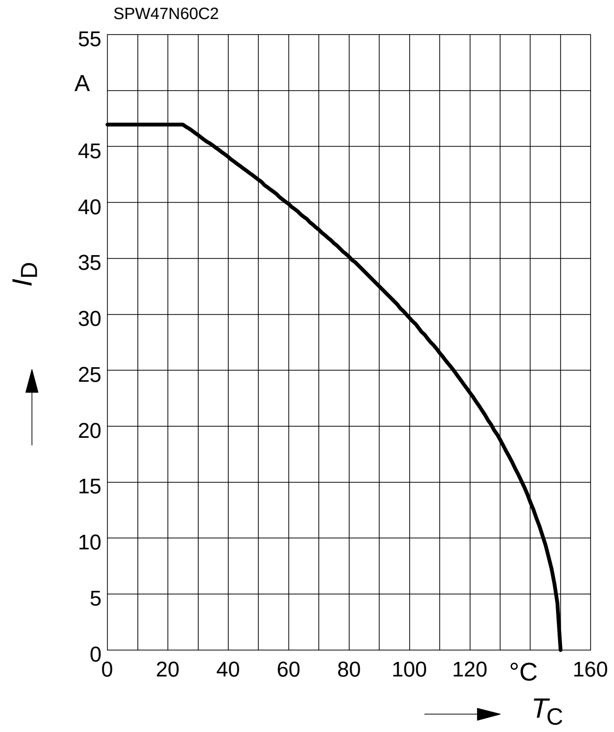
$P_{tot} = f(T_C)$




### 2 Drain current

$I_D = f(T_C)$

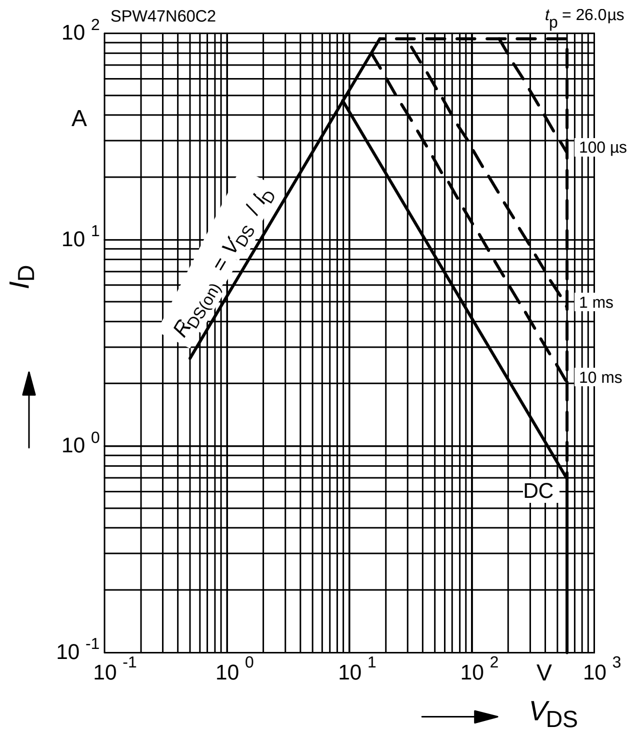
parameter: $V_{GS} \geq 10$ V




### 3 Safe operating area

$I_D = f(V_{DS})$

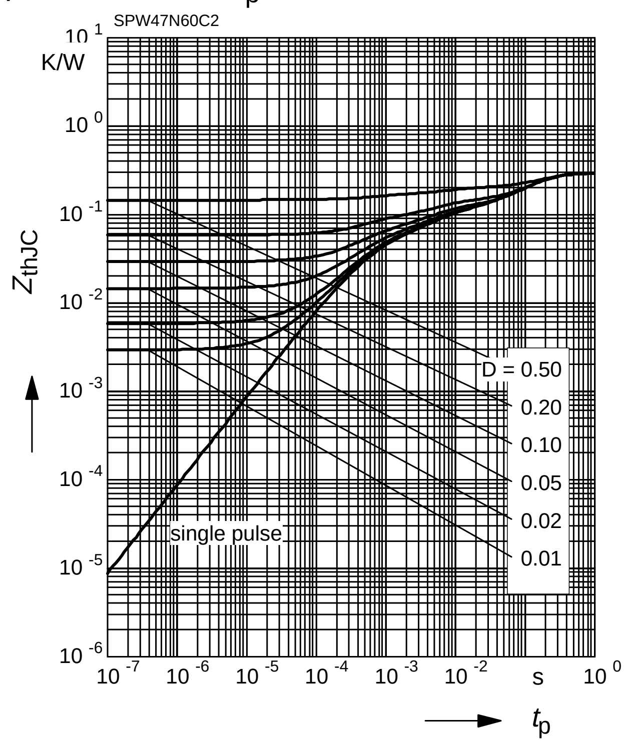
parameter : $D = 0$ , $T_C$=25°C




### 4 Transient thermal impedance

$Z_{thJC} = f(t_p)$

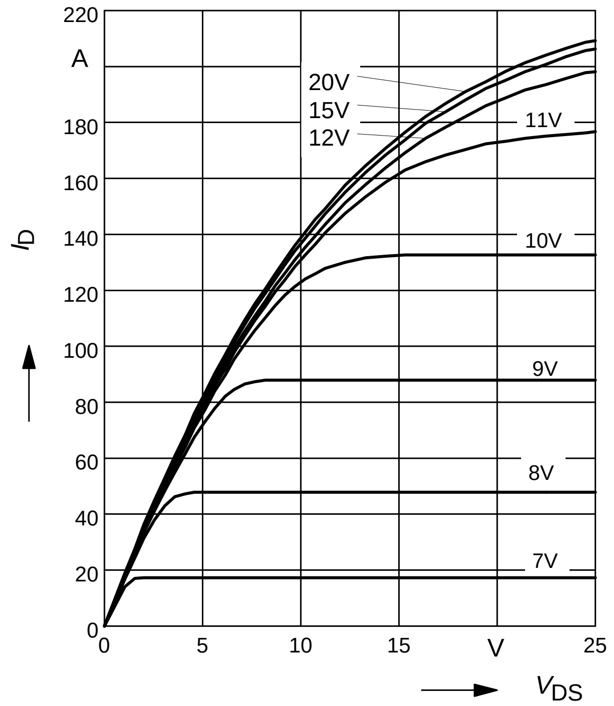
parameter : $D = t_p/T$



**5 Typ. output characteristic**

$I_D = f(V_{DS})$; $T_j$=25°C

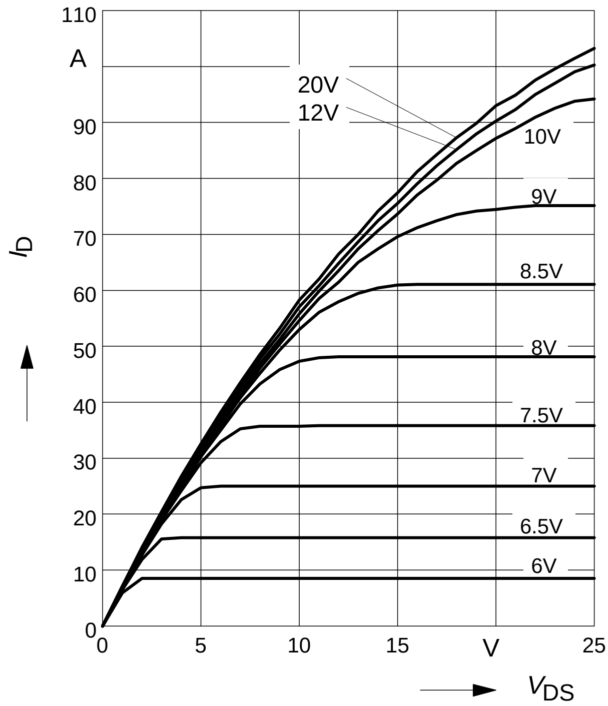
parameter: $t_p$ = 10 µs, $V_{GS}$




**6 Typ. output characteristic**

$I_D = f(V_{DS})$; $T_j$=150°C

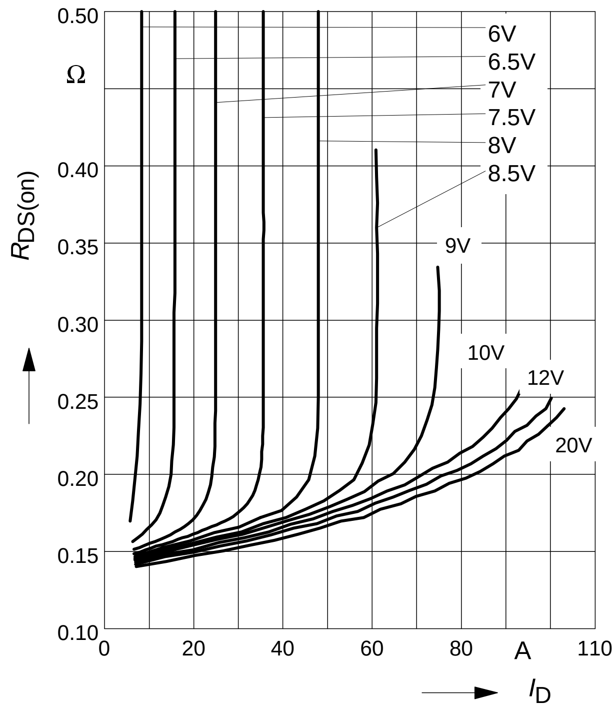
parameter: $t_p$ = 10 µs, $V_{GS}$




**7 Typ. drain-source on resistance**

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

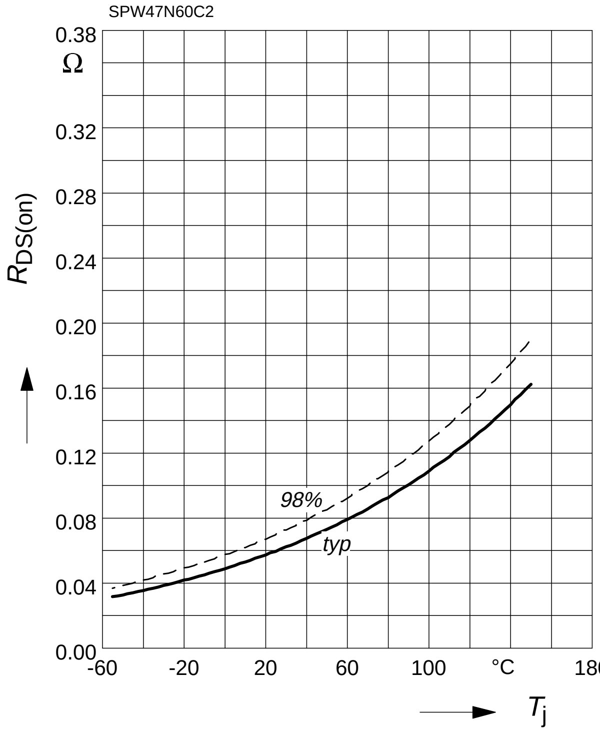
parameter: $T_j$=150°C, $V_{GS}$




**8 Drain-source on-state resistance**

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

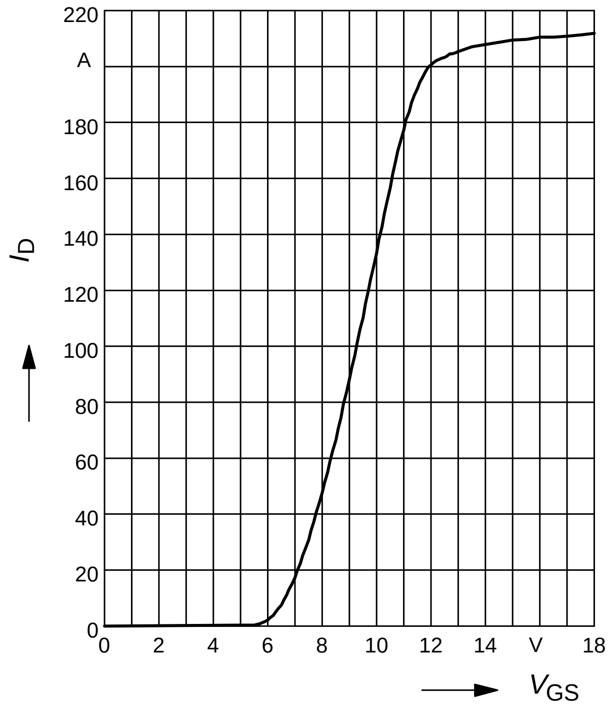
parameter : $I_D$ = 30 A, $V_{GS}$ = 10 V



## 9 Typ. transfer characteristics

$I_D = f(V_{GS})$; $V_{DS} \geq 2 \times I_D \times R_{DS(on)max}$

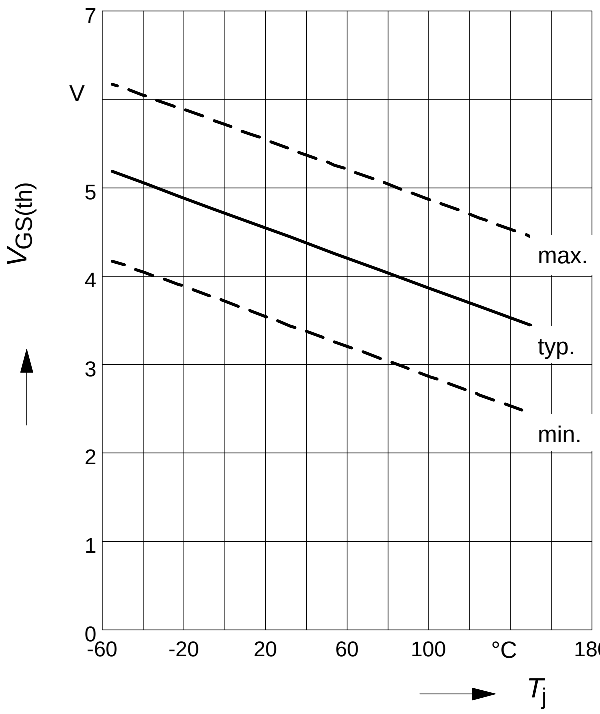
parameter: $t_p = 10\ \mu s$




## 10 Gate threshold voltage

$V_{GS(th)} = f(T_j)$

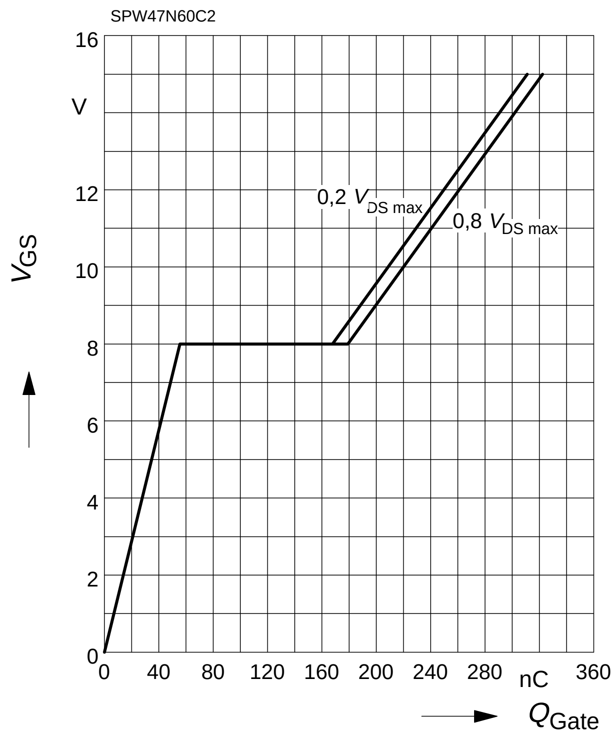
parameter: $V_{GS} = V_{DS}$, $I_D = 2.7$ mA




## 11 Typ. gate charge

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

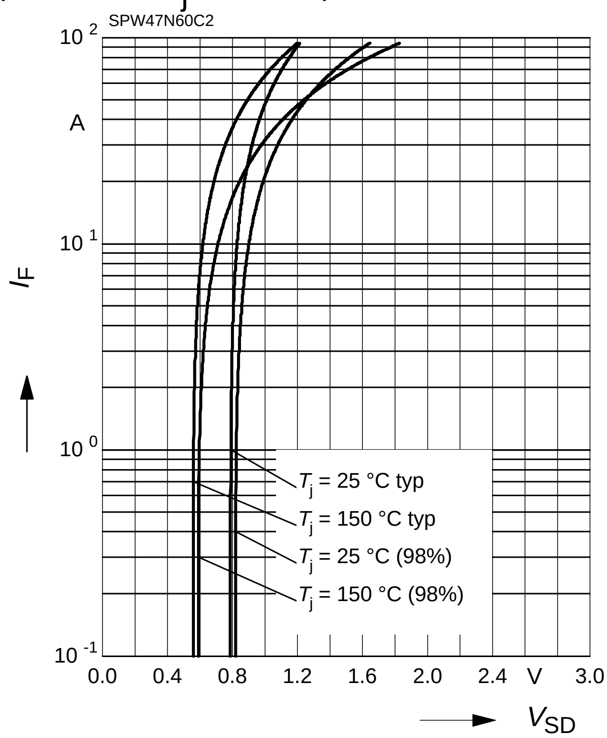
parameter: $I_D = 47$ A pulsed




## 12 Forward characteristics of body diode

$I_F = f(V_{SD})$

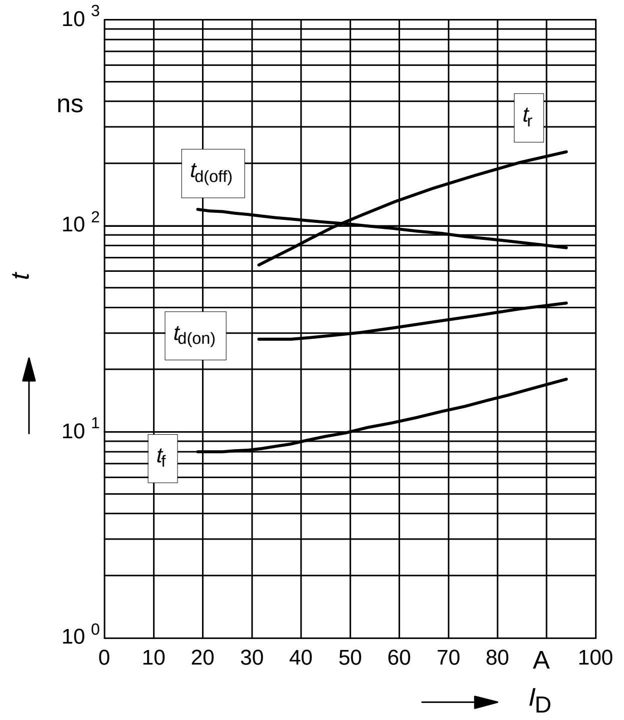
parameter: $T_j$, $t_p = 10\ \mu s$



**13 Typ. switching time**

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

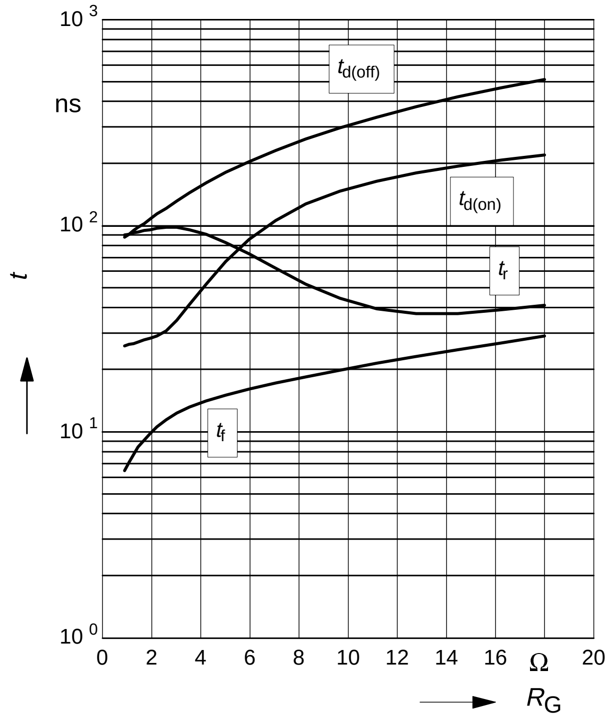
par.: $V_{DS}$=380V, $V_{GS}$=0/+13V, $R_G$=1.8Ω




**14 Typ. switching time**

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

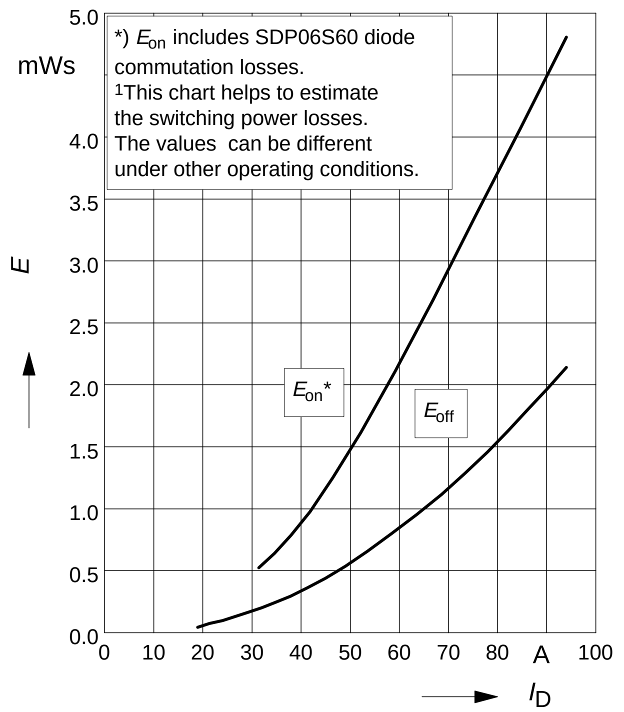
par.: $V_{DS}$=380V, $V_{GS}$=0/+13V, $I_D$=47 A




**15 Typ. switching losses** 1)

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

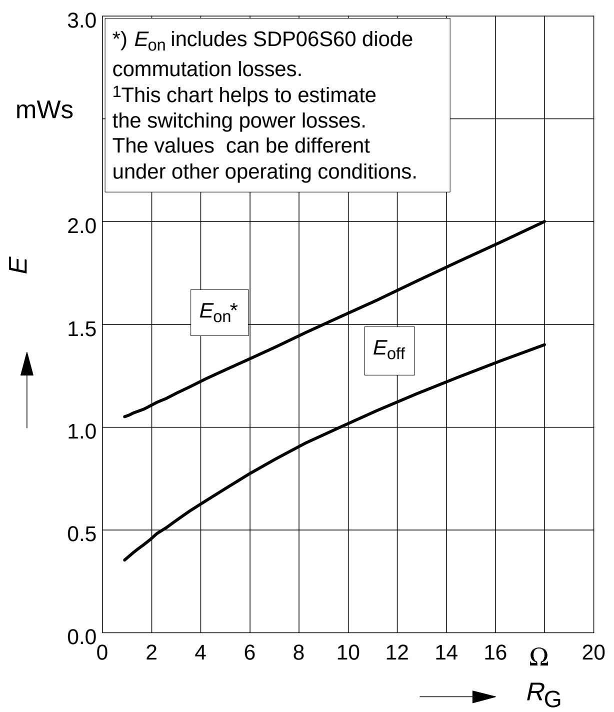
par.: $V_{DS}$=380V, $V_{GS}$=0/+13V, $R_G$=1.8Ω




**16 Typ. switching losses** 1)

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

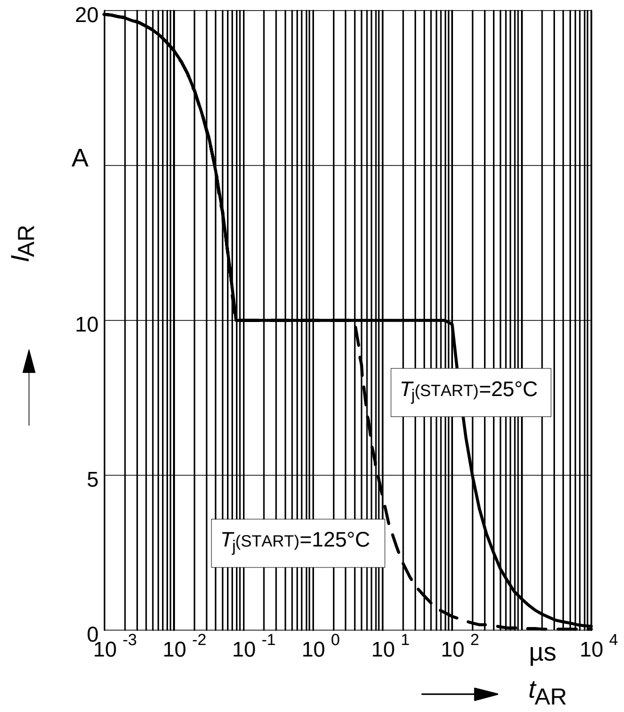
par.: $V_{DS}$=380V, $V_{GS}$=0/+13V, $I_D$=47 A



**17 Avalanche SOA**

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

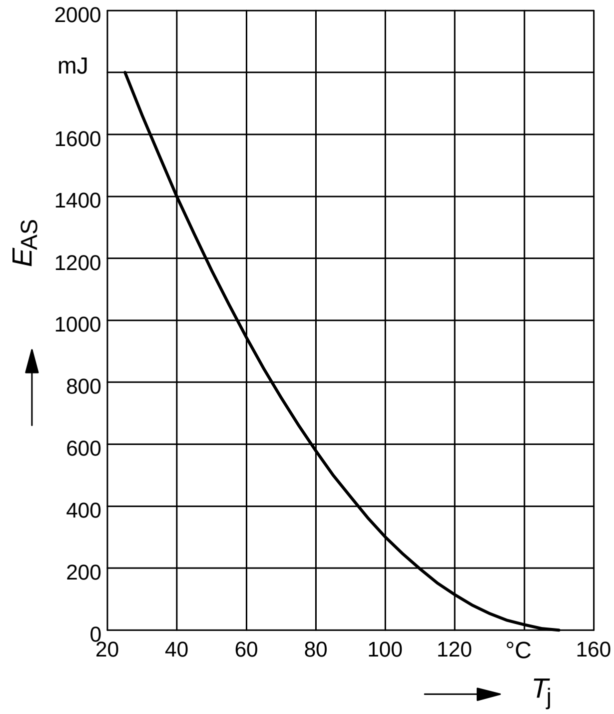
par.: $T_j \leq 150$ °C




**18 Avalanche energy**

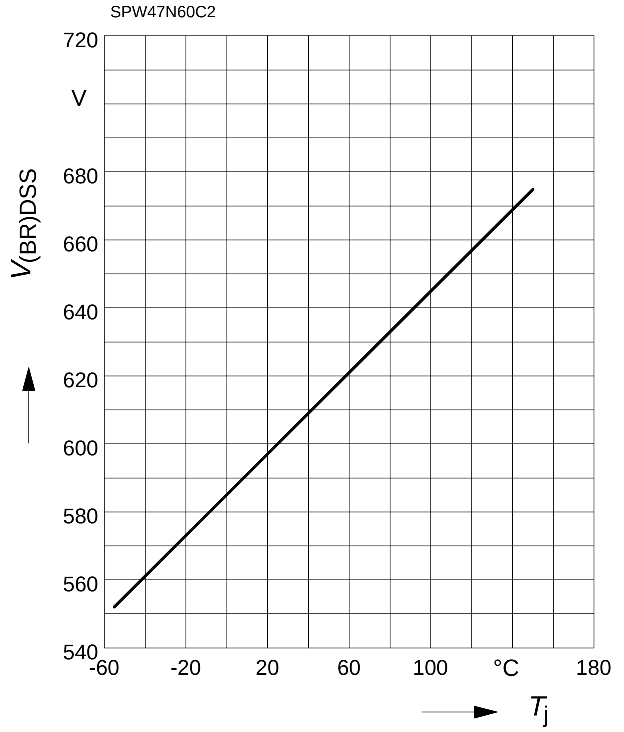
$E_{AS} = f(T_j)$

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




**19 Drain-source breakdown voltage**

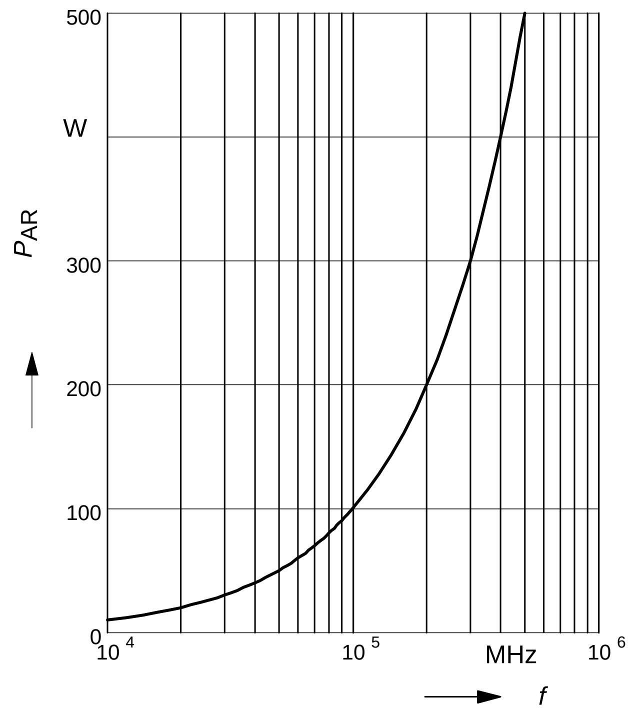
$V_{(BR)DSS} = f(T_j)$




**20 Avalanche power losses**

$P_{AR} = f(f)$

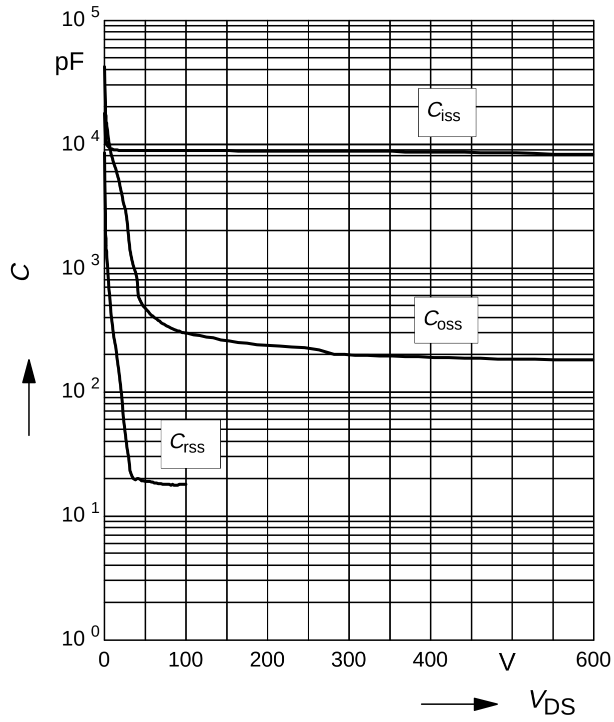
parameter: $E_{AR}$=1mJ



**21 Typ. capacitances**

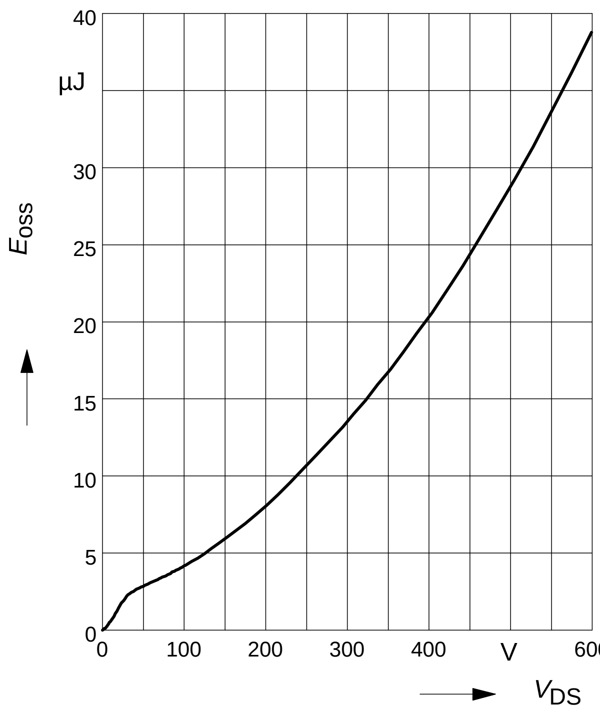
$C = f(V_{DS})$

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

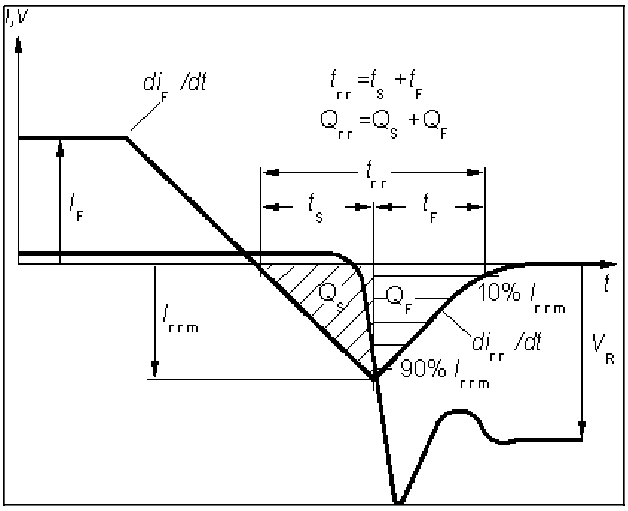


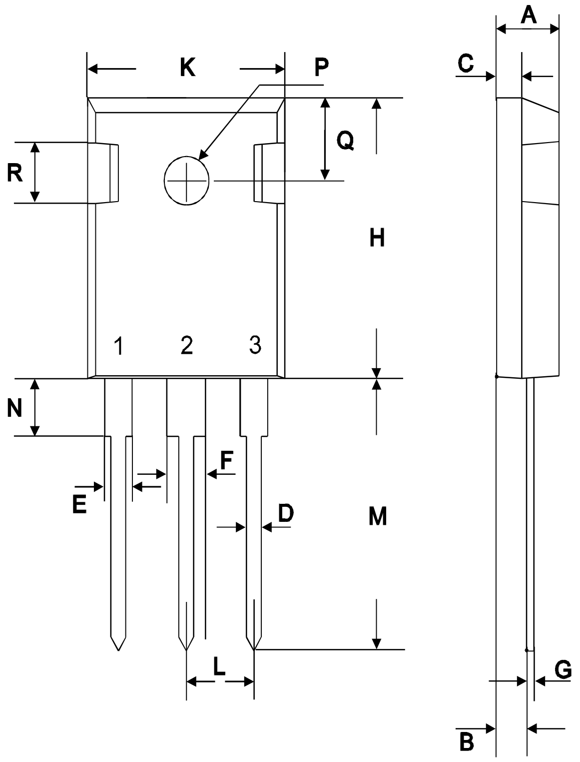

**22 Typ. $C_{oss}$ stored energy**

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




Definition of diodes switching characteristics






TO-247

| symbol | dimensions | | | |
|---|---|---|---|---|
| | [mm] | | [inch] | |
| | min | max | min | max |
| A | 4.78 | 5.28 | 0.1882 | 0.2079 |
| B | 2.29 | 2.51 | 0.0902 | 0.0988 |
| C | 1.78 | 2.29 | 0.0701 | 0.0902 |
| D | 1.09 | 1.32 | 0.0429 | 0.0520 |
| E | 1.73 | 2.06 | 0.0681 | 0.0811 |
| F | 2.67 | 3.18 | 0.1051 | 0.1252 |
| G | 0.76 max | | 0.0299 max | |
| H | 20.80 | 21.16 | 0.8189 | 0.8331 |
| K | 15.65 | 16.15 | 0.6161 | 0.6358 |
| L | 5.21 | 5.72 | 0.2051 | 0.2252 |
| M | 19.81 | 20.68 | 0.7799 | 0.8142 |
| N | 3.560 | 4.930 | 0.1402 | 0.1941 |
| ∅P | 3.61 | | 0.1421 | |
| Q | 6.12 | 6.22 | 0.2409 | 0.2449 |

**Published by**
**Infineon Technologies AG,**
**Bereichs Kommunikation**
**St.-Martin-Strasse 53,**
**D-81541 München**


**Attention please!**
The information herein is given to describe certain components and shall not be considered as warranted characteristics.

Terms of delivery and rights to technical change reserved.

We hereby disclaim any and all warranties, including but not limited to warranties of non-infringement, regarding circuits, descriptions and charts stated herein.

Infineon Technologies is an approved CECC manufacturer.

**Information**
For further information on technology, delivery terms and conditions and prices please contact your nearest Infineon Technologies Office in Germany or our Infineon Technologies Reprensatives worldwide (see address list).

**Warnings**
Due to technical requirements components may contain dangerous substances.
For information on the types in question please contact your nearest Infineon Technologies Office.

Infineon Technologies Components may only be used in life-support devices or systems with the express written approval of Infineon Technologies, if a failure of such components can reasonably be expected to cause the failure of that life-support device or system, or to affect the safety or effectiveness of that device or system Life support devices or systems are intended to be implanted in the human body, or to support and/or maintain and sustain and/or protect human life. If they fail, it is reasonable to assume that the health of the user or other persons may be endangered.