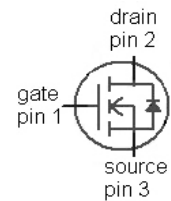
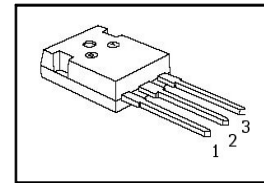


CoolMOS™ Power Transistor
Features

- New revolutionary high voltage technology
- Intrinsic fast-recovery body diode
- Extremely low reverse recovery charge
- Ultra low gate charge
- Extreme dv/dt rated
- High peak current capability
- Periodic avalanche rated
- Qualified for industrial grade applications according to JEDEC¹⁾
- Pb-free lead plating; RoHS compliant

Product Summary

| | | |
|------------------|-------|----------|
| V_{DS} | 600 | V |
| $R_{DS(on),max}$ | 0.083 | Ω |
| I_D | 46 | A |

PG-TO247


| Type | Package | Ordering Code | Marking |
|-------------|----------|---------------|----------|
| SPW47N60CFD | PG-TO247 | Q67045A5051 | 47N60CFD |

Maximum ratings, at $T_j=25\text{ °C}$, unless otherwise specified

| Parameter | Symbol | Conditions | Value | Unit |
|---|----------------|---|-------------|--------------------|
| Continuous drain current | I_D | $T_C=25\text{ °C}$ | 46 | A |
| | | $T_C=100\text{ °C}$ | 29 | |
| Pulsed drain current ¹⁾ | $I_{D,pulse}$ | $T_C=25\text{ °C}$ | 115 | |
| Avalanche energy, single pulse | E_{AS} | $I_D=10\text{ A}, V_{DD}=50\text{ V}$ | 1800 | mJ |
| Avalanche energy, repetitive t_{AR} ^{2),3)} | E_{AR} | $I_D=20\text{ A}, V_{DD}=50\text{ V}$ | 1 | |
| Avalanche current, repetitive t_{AR} ^{2),3)} | I_{AR} | | 20 | A |
| Drain source voltage slope | dv/dt | $I_D=46\text{ A}, V_{DS}=480\text{ V}, T_j=125\text{ °C}$ | 80 | V/ns |
| Reverse diode dv/dt | dv/dt | $I_S=46\text{ A}, V_{DS}=480\text{ V}, T_j=125\text{ °C}$ | 40 | V/ns |
| Maximum diode commutation speed | di/dt | | 600 | A/ μ s |
| Gate source voltage | V_{GS} | static | ± 20 | V |
| | | AC ($f>1\text{ Hz}$) | ± 30 | |
| Power dissipation | P_{tot} | $T_C=25\text{ °C}$ | 417 | W |
| Operating and storage temperature | T_j, T_{stg} | | -55 ... 150 | $^{\circ}\text{C}$ |

| Parameter | Symbol | Conditions | Values | | | Unit |
|-----------|--------|------------|--------|------|------|------|
| | | | min. | typ. | max. | |

Thermal characteristics

| | | | | | | |
|--|------------|--|---|---|-----|-----|
| Thermal resistance, junction - case | R_{thJC} | | - | - | 0.3 | K/W |
| Thermal resistance, junction - ambient | R_{thJA} | leaded | - | - | 62 | |
| Soldering temperature, wave soldering | T_{sold} | 1.6 mm (0.063 in.) from case for 10 s | - | - | 260 | °C |

Electrical characteristics, at $T_j=25\text{ °C}$, unless otherwise specified
Static characteristics

| | | | | | | |
|----------------------------------|---------------|---|-----|------|-------|---------------|
| Drain-source breakdown voltage | $V_{(BR)DSS}$ | $V_{GS}=0\text{ V}, I_D=250\text{ }\mu\text{A}$ | 600 | - | - | V |
| Avalanche breakdown voltage | $V_{(BR)DS}$ | $V_{GS}=0\text{ V}, I_D=46\text{ A}$ | - | 700 | - | |
| Gate threshold voltage | $V_{GS(th)}$ | $V_{DS}=V_{GS}, I_D=2.9\text{ mA}$ | 3 | 4 | 5 | |
| Zero gate voltage drain current | I_{DSS} | $V_{DS}=600\text{ V}, V_{GS}=0\text{ V}, T_j=25\text{ °C}$ | - | 6 | - | μA |
| | | $V_{DS}=600\text{ V}, V_{GS}=0\text{ V}, T_j=150\text{ °C}$ | - | 5000 | - | |
| Gate-source leakage current | I_{GSS} | $V_{GS}=20\text{ V}, V_{DS}=0\text{ V}$ | - | - | 100 | nA |
| Drain-source on-state resistance | $R_{DS(on)}$ | $V_{GS}=10\text{ V}, I_D=29\text{ A}, T_j=25\text{ °C}$ | - | 0.07 | 0.083 | Ω |
| | | $V_{GS}=10\text{ V}, I_D=29\text{ A}, T_j=150\text{ °C}$ | - | 0.15 | - | |
| Gate resistance | R_G | $f=1\text{ MHz}$, open drain | - | 0.62 | - | |
| Transconductance | g_{fs} | $ V_{DS} >2 I_D R_{DS(on)max}, I_D=29\text{ A}$ | - | 30 | - | S |

| Parameter | Symbol | Conditions | Values | | | Unit |
|-----------|--------|------------|--------|------|------|------|
| | | | min. | typ. | max. | |

Dynamic characteristics

| | | | | | | |
|--|--------------|---|---|------|---|----|
| Input capacitance | C_{iss} | $V_{GS}=0\text{ V}, V_{DS}=25\text{ V},$ $f=1\text{ MHz}$ | - | 7700 | - | pF |
| Output capacitance | C_{oss} | | - | 2200 | - | |
| Reverse transfer capacitance | C_{rss} | | - | 77 | - | |
| Effective output capacitance, energy related ⁴⁾ | $C_{o(er)}$ | $V_{GS}=0\text{ V}, V_{DS}=0\text{ V}$ to 480 V | - | 245 | - | |
| Effective output capacitance, time related ⁵⁾ | $C_{o(tr)}$ | | - | 453 | - | |
| Turn-on delay time | $t_{d(on)}$ | $V_{DD}=400\text{ V},$ $V_{GS}=10\text{ V}, I_D=46\text{ A},$ $R_G=3.3\ \Omega$ | - | 30 | - | ns |
| Rise time | t_r | | - | 30 | - | |
| Turn-off delay time | $t_{d(off)}$ | | - | 100 | - | |
| Fall time | t_f | | - | 15 | - | |

Gate Charge Characteristics

| | | | | | | |
|-----------------------|---------------|---|---|-----|-----|----|
| Gate to source charge | Q_{gs} | $V_{DD}=480\text{ V}, I_D=46\text{ A},$ $V_{GS}=0\text{ to }10\text{ V}$ | - | 54 | - | nC |
| Gate to drain charge | Q_{gd} | | - | 130 | - | |
| Gate charge total | Q_g | | - | 248 | 322 | |
| Gate plateau voltage | $V_{plateau}$ | | - | 7.1 | - | V |

¹⁾ J-STD20 and JESD22

²⁾ Pulse width t_p limited by $T_{j,max}$

³⁾ Repetitive avalanche causes additional power losses that can be calculated as $P_{AV}=E_{AR} \cdot f$.

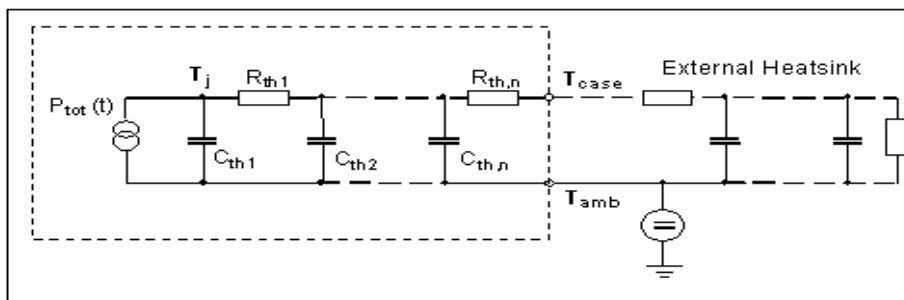
⁴⁾ $C_{o(er)}$ is a fixed capacitance that gives the same stored energy as C_{oss} while V_{DS} is rising from 0 to 80% V_{DSS} .

⁵⁾ $C_{o(tr)}$ 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 | $T_C=25\text{ }^\circ\text{C}$ | - | - | 46 | A |
| Diode pulse current | $I_{S,pulse}$ | | - | - | 115 | |
| Diode forward voltage | V_{SD} | $V_{GS}=0\text{ V}, I_F=46\text{ A}, T_j=25\text{ }^\circ\text{C}$ | - | 1.0 | 1.2 | V |
| Reverse recovery time | t_{rr} | $V_R=480\text{ V}, I_F=I_S, di_F/dt=100\text{ A}/\mu\text{s}$ | - | 210 | - | ns |
| Reverse recovery charge | Q_{rr} | | - | 2 | - | μC |
| Peak reverse recovery current | I_{rrm} | | - | 18 | - | A |

Typical Transient Thermal Characteristics

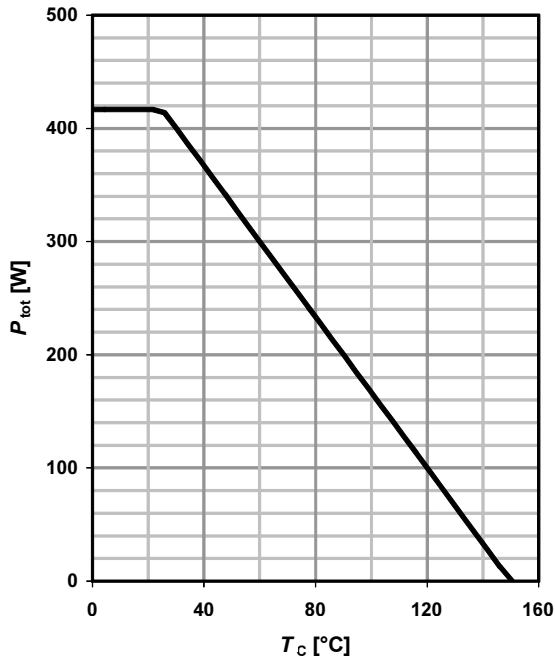
| Symbol | Value | Unit | Symbol | Value | Unit |
|-----------|---------|------|-----------|-------------------|------|
| | typ. | | | typ. | |
| R_{th1} | 0.00289 | K/W | C_{th1} | 0.000564 | Ws/K |
| R_{th2} | 0.00399 | | C_{th2} | 0.0034 | |
| R_{th3} | 0.0224 | | C_{th3} | 0.0048 | |
| R_{th4} | 0.0421 | | C_{th4} | 0.0273 | |
| R_{th5} | 0.0619 | | C_{th5} | 0.149 | |
| | | | 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 $R_{thCA}=0\text{ K/W}$.

1 Power dissipation

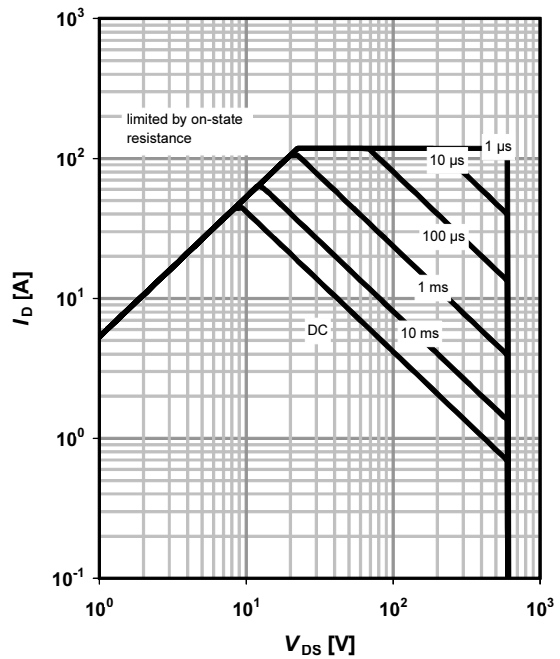
$P_{tot}=f(T_C)$



2 Safe operating area

$I_D=f(V_{DS}); T_C=25\text{ °C}; D=0$

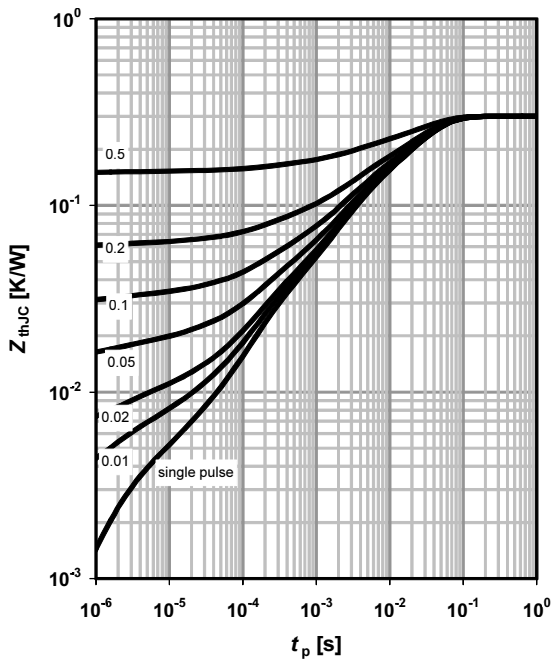
parameter: t_p



3 Max. transient thermal impedance

$I_D=f(V_{DS}); T_j=25\text{ °C}$

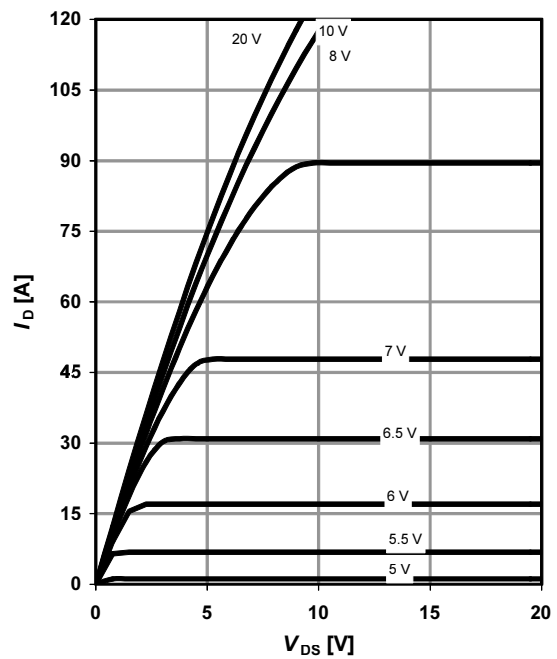
parameter: $D=t_p/T$



4 Typ. output characteristics

$I_D=f(V_{DS}); T_j=25\text{ °C}$

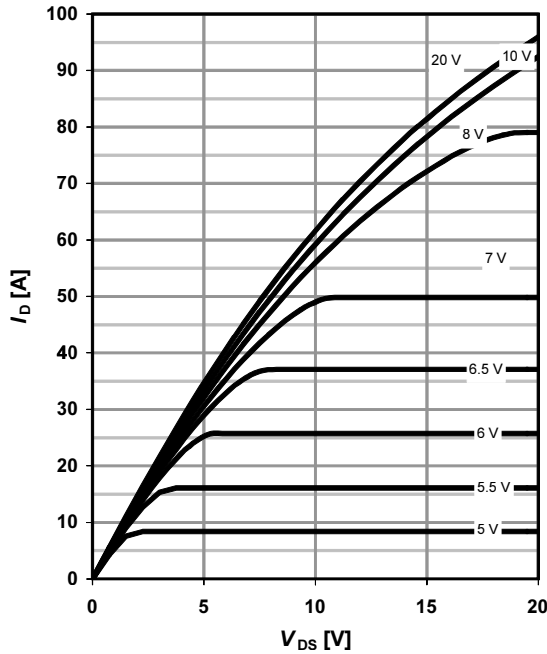
parameter: V_{GS}



5 Typ. output characteristics

$I_D = f(V_{DS}); T_j = 150\text{ °C}$

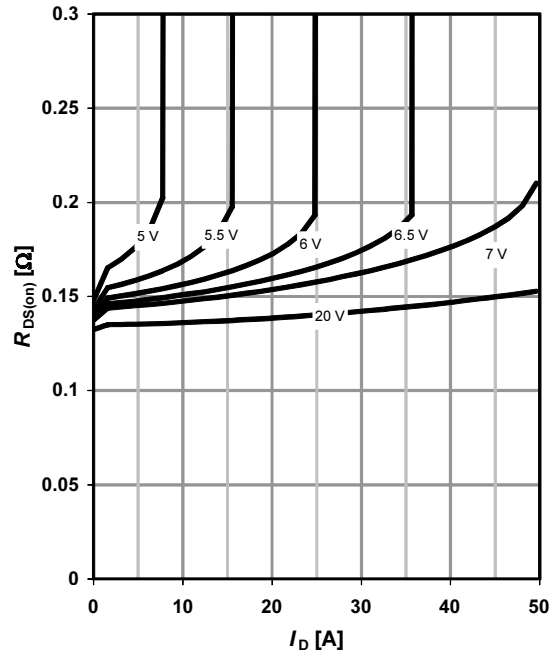
parameter: V_{GS}



6 Typ. drain-source on-state resistance

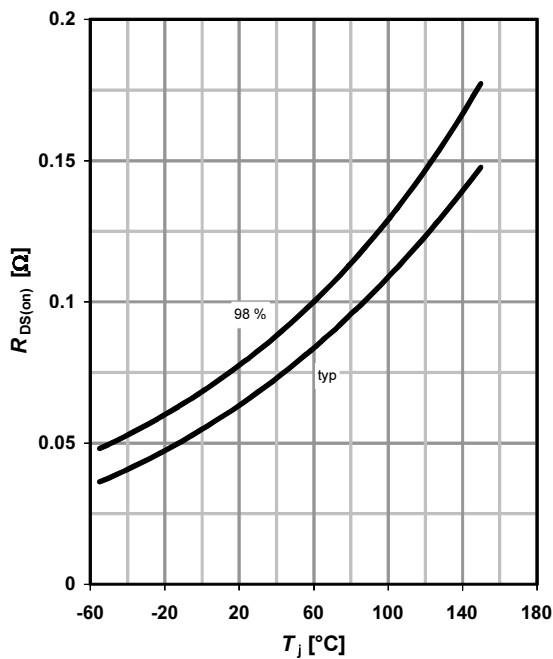
$R_{DS(on)} = f(I_D); T_j = 150\text{ °C}$

parameter: V_{GS}



7 Drain-source on-state resistance

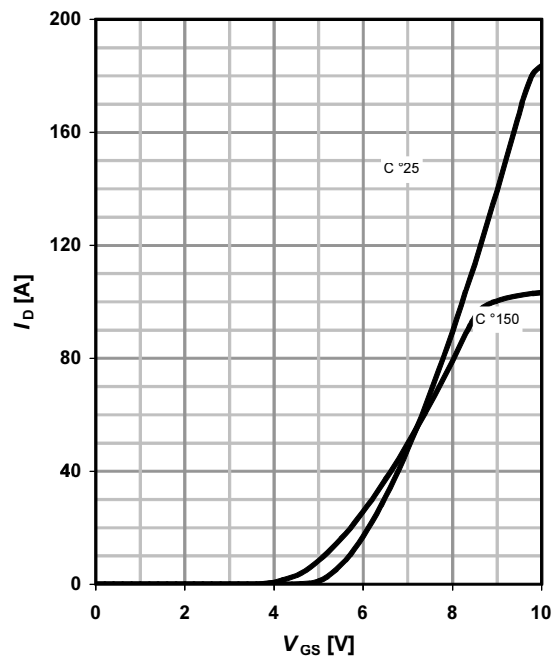
$R_{DS(on)} = f(T_j); I_D = 30\text{ A}; V_{GS} = 10\text{ V}$



8 Typ. transfer characteristics

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

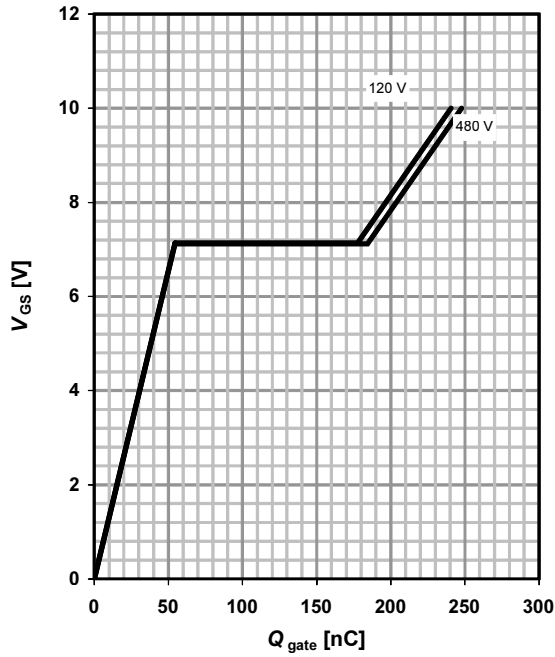
parameter: T_j



9 Typ. gate charge

$V_{GS}=f(Q_{gate}); I_D=47\text{ A pulsed}$

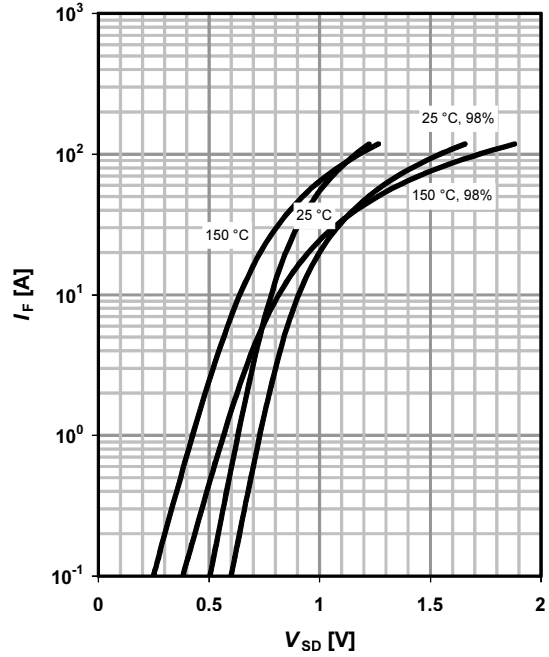
parameter: V_{DD}



10 Forward characteristics of reverse diode

$I_F=f(V_{SD})$

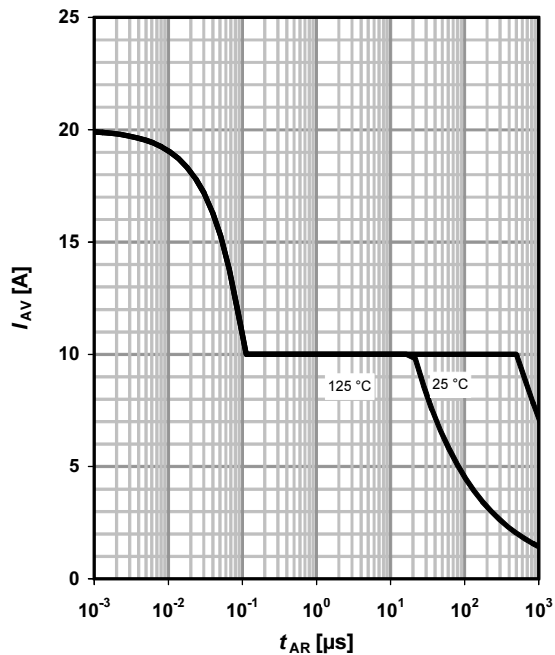
parameter: T_j



11 Avalanche SOA

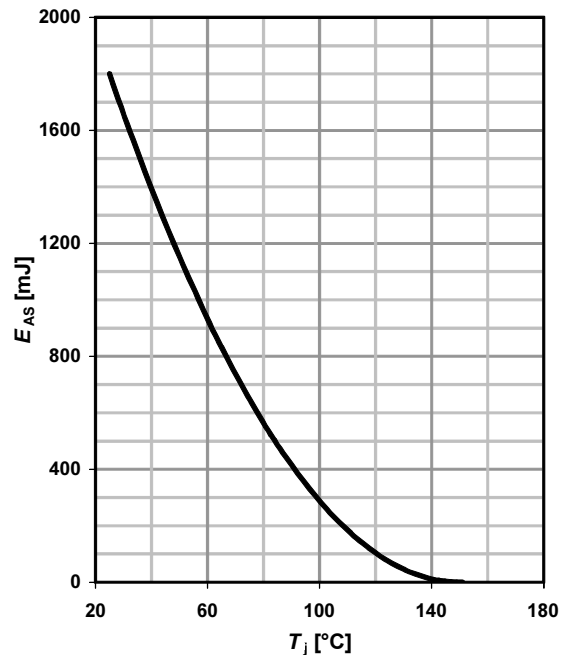
$I_{AR}=f(t_{AR})$

parameter: $T_{j(start)}$



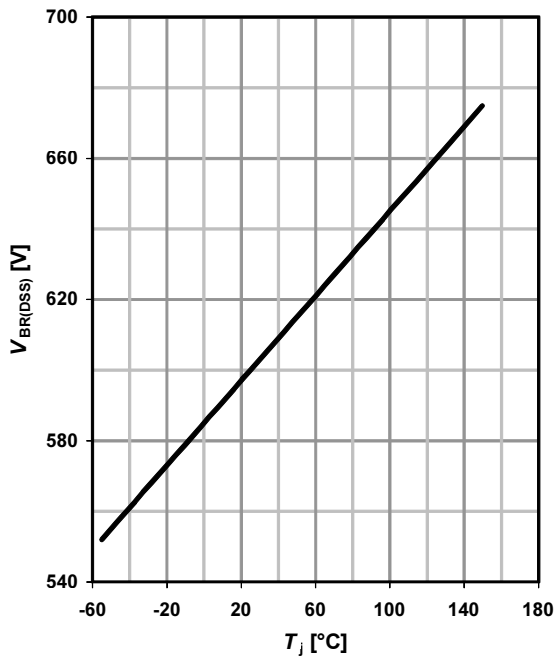
12 Avalanche energy

$E_{AS}=f(T_j); I_D=10\text{ A}; V_{DD}=50\text{ V}$



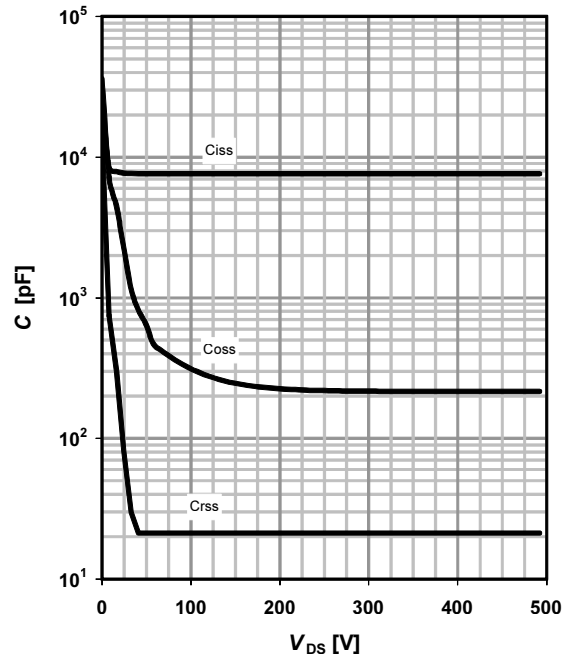
13 Drain-source breakdown voltage

$V_{BR(DSS)} = f(T_j); I_D = 15 \text{ mA}$



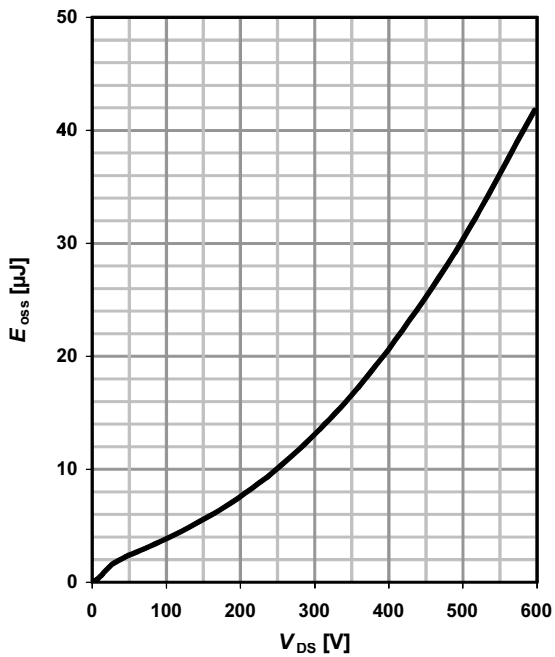
14 Typ. capacitances

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



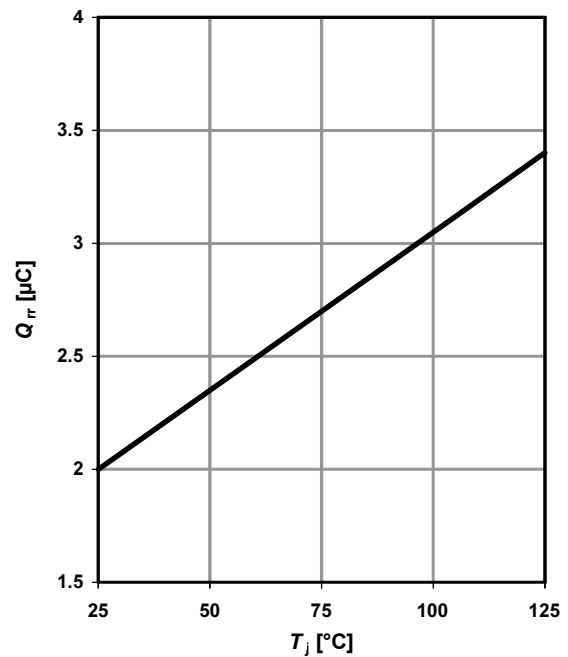
15 Typ. C_{oss} stored energy

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



16 Typ. reverse recovery charge

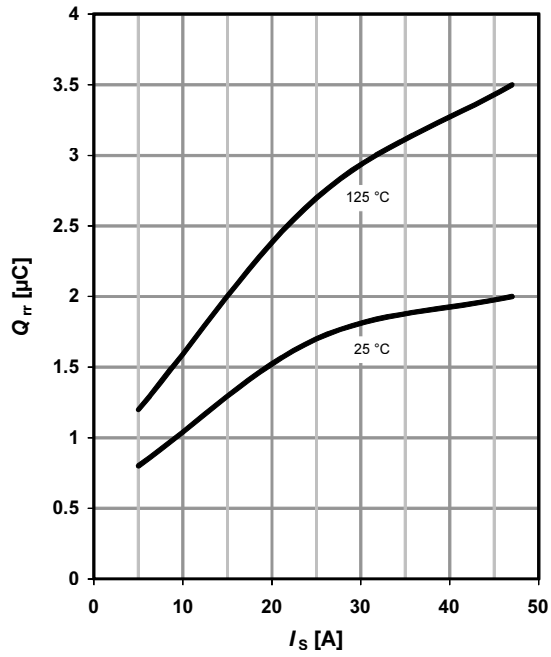
$Q_{rr} = f(T_j); I_S = 47 \text{ A}; di/dt = 100 \text{ A/μs}$



17 Typ. reverse recovery charge

$Q_{rr}=f(I_S); di/dt=100\text{ A}/\mu\text{s}$

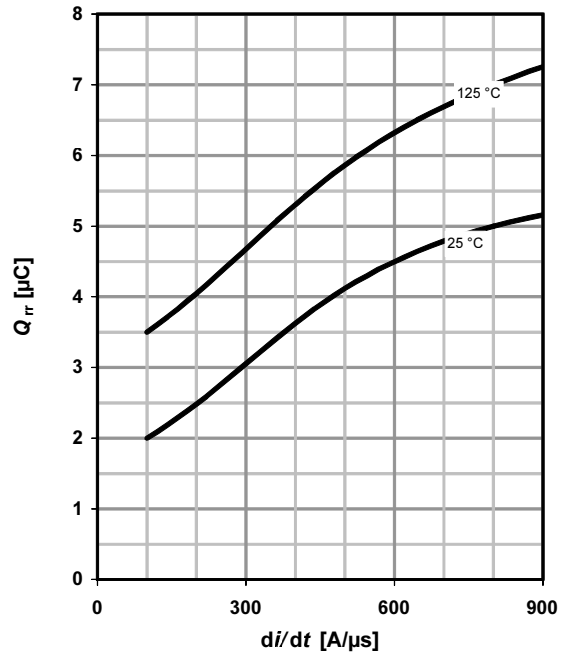
parameter: T_j



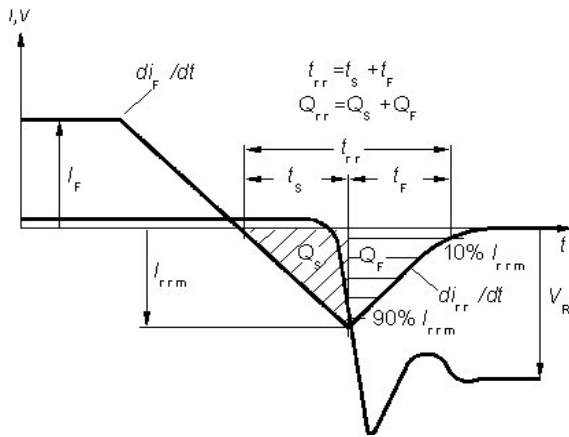
18 Typ. reverse recovery charge

$Q_{rr}=f(di/dt); I_S=47\text{ A}$

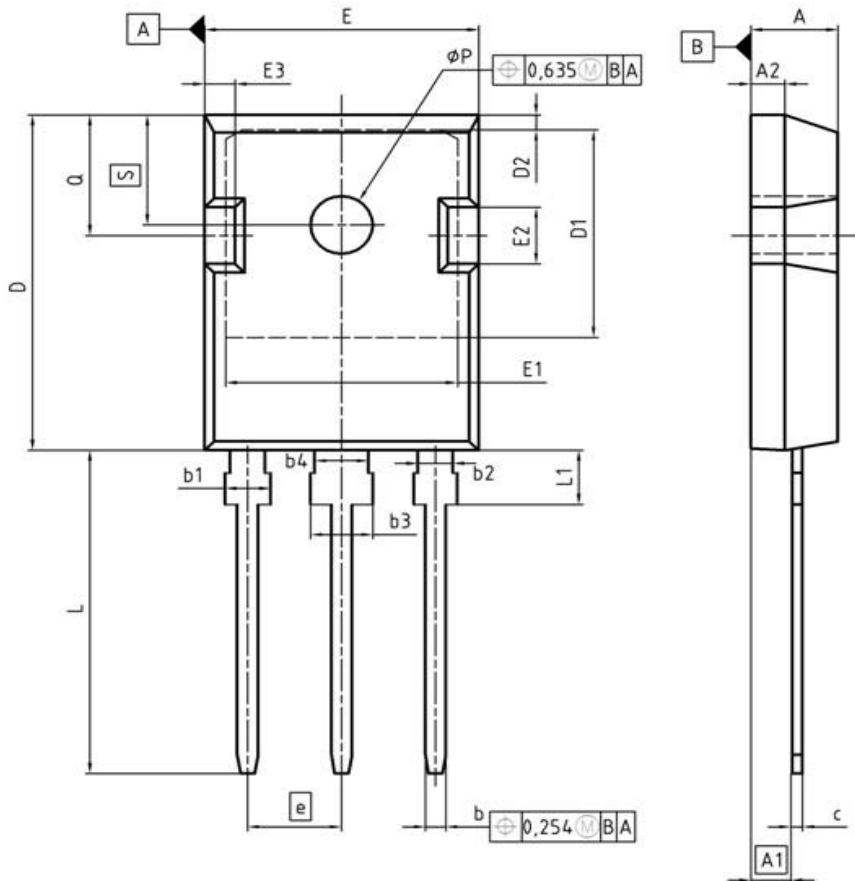
parameter: T_j



Definition of diode switching characteristics



PG-TO247-3-21-41



| DIM | MILLIMETERS | | INCHES | |
|----------|-------------|-------|--------|-------|
| | MIN | MAX | MIN | MAX |
| A | 4.90 | 5.16 | 0.193 | 0.203 |
| A1 | 2.27 | 2.53 | 0.089 | 0.099 |
| A2 | 1.85 | 2.11 | 0.073 | 0.083 |
| b | 1.07 | 1.33 | 0.042 | 0.052 |
| b1 | 1.90 | 2.41 | 0.075 | 0.095 |
| b2 | 1.90 | 2.16 | 0.075 | 0.085 |
| b3 | 2.87 | 3.38 | 0.113 | 0.133 |
| b4 | 2.87 | 3.13 | 0.113 | 0.123 |
| c | 0.55 | 0.68 | 0.022 | 0.027 |
| D | 20.82 | 21.10 | 0.820 | 0.831 |
| D1 | 16.25 | 17.65 | 0.640 | 0.695 |
| D2 | 1.05 | 1.35 | 0.041 | 0.053 |
| E | 15.70 | 16.03 | 0.618 | 0.631 |
| E1 | 13.10 | 14.15 | 0.516 | 0.557 |
| E2 | 3.68 | 5.10 | 0.145 | 0.201 |
| E3 | 1.68 | 2.60 | 0.066 | 0.102 |
| e | 5.44 | | 0.214 | |
| N | 3 | | 3 | |
| L | 19.80 | 20.31 | 0.780 | 0.799 |
| L1 | 4.17 | 4.47 | 0.164 | 0.176 |
| ϕP | 3.50 | 3.70 | 0.138 | 0.146 |
| Q | 5.49 | 6.00 | 0.216 | 0.236 |
| S | 6.04 | 6.30 | 0.238 | 0.248 |

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1 New package outlines TO-247

Assembly capacity extension for CoolMOSTM technology products assembled in lead-free package PG-TO247-3 at subcontractor ASE (Weihai) Inc., China (Changes are marked in blue.)



Figure 1 Outlines TO-247, dimensions in mm/inches

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