

## CoolMOS™ Power Transistor



### Product Summary

|                  |       |          |
|------------------|-------|----------|
| $V_{DS}$         | 600   | V        |
| $R_{DS(on),max}$ | 0.105 | $\Omega$ |
| $Q_{g,typ}$      | 60    | nC       |

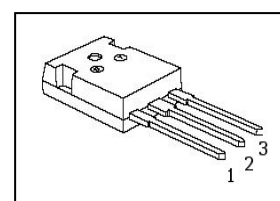
### Features

- Lowest figure-of-merit  $R_{ON} \times Q_g$
- Ultra low gate charge
- Extreme dv/dt rated
- High peak current capability
- Automotive AEC Q101 qualified
- Green package (RoHS compliant)

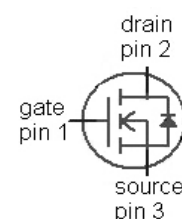
### CoolMOS CPA is specially designed for:

- DC/DC converters for Automotive Applications

PG-TO247-3



| Type         | Package    | Marking |
|--------------|------------|---------|
| IPW60R099CPA | PG-TO247-3 | 6R099A  |



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

| Parameter                                      | Symbol        | Conditions                               | Value       | Unit |
|------------------------------------------------|---------------|------------------------------------------|-------------|------|
| Continuous drain current                       | $I_D$         | $T_C=25\text{ °C}$                       | 31          | A    |
|                                                |               | $T_C=100\text{ °C}$                      | 19          |      |
| Pulsed drain current <sup>1)</sup>             | $I_{D,pulse}$ | $T_C=25\text{ °C}$                       | 93          |      |
| Avalanche energy, single pulse                 | $E_{AS}$      | $I_D=11\text{ A}$ , $V_{DD}=50\text{ V}$ | 800         | mJ   |
| Avalanche energy, repetitive $t_{AR}^{1),2)}$  | $E_{AR}$      | $I_D=11\text{ A}$ , $V_{DD}=50\text{ V}$ | 1.2         |      |
| Avalanche current, repetitive $t_{AR}^{1),2)}$ | $I_{AR}$      |                                          | 11          | A    |
| MOSFET dv/dt ruggedness                        | dv/dt         | $V_{DS}=0\ldots480\text{ V}$             | 50          | V/ns |
| Gate source voltage                            | $V_{GS}$      | static                                   | $\pm 20$    | V    |
| Power dissipation                              | $P_{tot}$     | $T_C=25\text{ °C}$                       | 255         | W    |
| Operating temperature                          | $T_j$         |                                          | -40 ... 150 | °C   |
| Storage temperature                            | $T_{stg}$     |                                          | -40 ... 150 |      |
| Mounting torque                                |               | M3 and M3.5 screws                       | 60          | Ncm  |

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

| Parameter                           | Symbol        | Conditions                       | Value | Unit |
|-------------------------------------|---------------|----------------------------------|-------|------|
| Continuous diode forward current    | $I_S$         | $T_C=25\text{ }^{\circ}\text{C}$ | 18    | A    |
| Diode pulse current <sup>1)</sup>   | $I_{S,pulse}$ |                                  | 93    |      |
| Reverse diode $dv/dt$ <sup>3)</sup> | $dv/dt$       |                                  | 15    | V/ns |

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

#### Thermal characteristics

|                                                            |            |                                       |   |   |     |                    |
|------------------------------------------------------------|------------|---------------------------------------|---|---|-----|--------------------|
| Thermal resistance, junction - case                        | $R_{thJC}$ |                                       | - | - | 0.5 | K/W                |
| Thermal resistance, junction - ambient                     | $R_{thJA}$ | leaded                                | - | - | 62  |                    |
| Soldering temperature, wavesoldering only allowed at leads | $T_{sold}$ | 1.6 mm (0.063 in.) from case for 10 s | - | - | 260 | $^{\circ}\text{C}$ |

Electrical characteristics, at  $T_j=25\text{ }^{\circ}\text{C}$ , 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             |
| Gate threshold voltage           | $V_{GS(th)}$  | $V_{DS}=V_{GS}$ , $I_D=1.2\text{ mA}$                                          | 2.5 | 3    | 3.5   |               |
| Zero gate voltage drain current  | $I_{DSS}$     | $V_{DS}=600\text{ V}$ , $V_{GS}=0\text{ V}$ , $T_j=25\text{ }^{\circ}\text{C}$ | -   | -    | 5     | $\mu\text{A}$ |
| Gate-source leakage current      | $I_{GSS}$     | $V_{GS}=20\text{ V}$ , $V_{DS}=0\text{ V}$                                     | -   | -    | 100   | nA            |
| Drain-source on-state resistance | $R_{DS(on)}$  | $V_{GS}=10\text{ V}$ , $I_D=18\text{ A}$ , $T_j=25\text{ }^{\circ}\text{C}$    | -   | 0.09 | 0.105 | $\Omega$      |
|                                  |               | $V_{GS}=10\text{ V}$ , $I_D=18\text{ A}$ , $T_j=150\text{ }^{\circ}\text{C}$   | -   | 0.24 | -     |               |
| Gate resistance                  | $R_G$         | $f=1\text{ MHz}$ , open drain                                                  | -   | 1.3  | -     | $\Omega$      |

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

### Dynamic characteristics

|                                                            |              |                                                                                       |   |      |   |    |
|------------------------------------------------------------|--------------|---------------------------------------------------------------------------------------|---|------|---|----|
| Input capacitance                                          | $C_{iss}$    | $V_{GS}=0\text{ V}, V_{DS}=100\text{ V},$<br>$f=1\text{ MHz}$                         | - | 2800 | - | pF |
| Output capacitance                                         | $C_{oss}$    |                                                                                       | - | 130  | - |    |
| Effective output capacitance, energy related <sup>4)</sup> | $C_{o(er)}$  | $V_{GS}=0\text{ V}, V_{DS}=0\text{ V}$<br>to 480 V                                    | - | 130  | - |    |
| Effective output capacitance, time related <sup>5)</sup>   | $C_{o(tr)}$  |                                                                                       | - | 340  | - |    |
| Turn-on delay time                                         | $t_{d(on)}$  | $V_{DD}=400\text{ V},$<br>$V_{GS}=10\text{ V}, I_D=18\text{ A},$<br>$R_G=3.3\ \Omega$ | - | 10   | - | ns |
| Rise time                                                  | $t_r$        |                                                                                       | - | 5    | - |    |
| Turn-off delay time                                        | $t_{d(off)}$ |                                                                                       | - | 60   | - |    |
| Fall time                                                  | $t_f$        |                                                                                       | - | 5    | - |    |

### Gate Charge Characteristics

|                       |               |                                                                             |   |     |    |    |
|-----------------------|---------------|-----------------------------------------------------------------------------|---|-----|----|----|
| Gate to source charge | $Q_{gs}$      | $V_{DD}=400\text{ V}, I_D=18\text{ A},$<br>$V_{GS}=0\text{ to }10\text{ V}$ | - | 14  | -  | nC |
| Gate to drain charge  | $Q_{gd}$      |                                                                             | - | 20  | -  |    |
| Gate charge total     | $Q_g$         |                                                                             | - | 60  | 80 |    |
| Gate plateau voltage  | $V_{plateau}$ |                                                                             | - | 5.0 | -  | V  |

### Reverse Diode

|                               |           |                                                                    |   |     |     |               |
|-------------------------------|-----------|--------------------------------------------------------------------|---|-----|-----|---------------|
| Diode forward voltage         | $V_{SD}$  | $V_{GS}=0\text{ V}, I_F=18\text{ A},$<br>$T_j=25\text{ °C}$        | - | 0.9 | 1.2 | V             |
| Reverse recovery time         | $t_{rr}$  | $V_R=400\text{ V}, I_F=I_S,$<br>$di_F/dt=100\text{ A}/\mu\text{s}$ | - | 450 | -   | ns            |
| Reverse recovery charge       | $Q_{rr}$  |                                                                    | - | 12  | -   | $\mu\text{C}$ |
| Peak reverse recovery current | $I_{rrm}$ |                                                                    | - | 70  | -   | A             |

<sup>1)</sup> Pulse width  $t_p$  limited by  $T_{j,max}$

<sup>2)</sup> Repetitive avalanche causes additional power losses that can be calculated as  $P_{AV}=E_{AR} \cdot f$ .

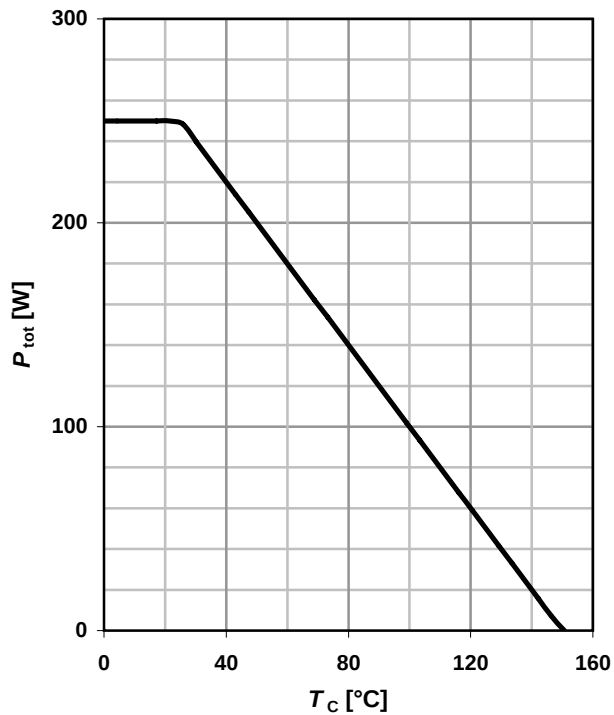
<sup>3)</sup>  $I_{SD} \leq I_D$ ,  $di/dt \leq 100\text{ A}/\mu\text{s}$ ,  $V_{DCLink}=400\text{ V}$ ,  $V_{peak} < V_{(BR)DSS}$ ,  $T_j < T_{j,max}$ , identical low side and high side switch

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

<sup>5)</sup>  $C_{o(tr)}$  is a fixed capacitance that gives the same charging time as  $C_{oss}$  while  $V_{DS}$  is rising from 0 to 80%  $V_{DSS}$ .

## 1 Power dissipation

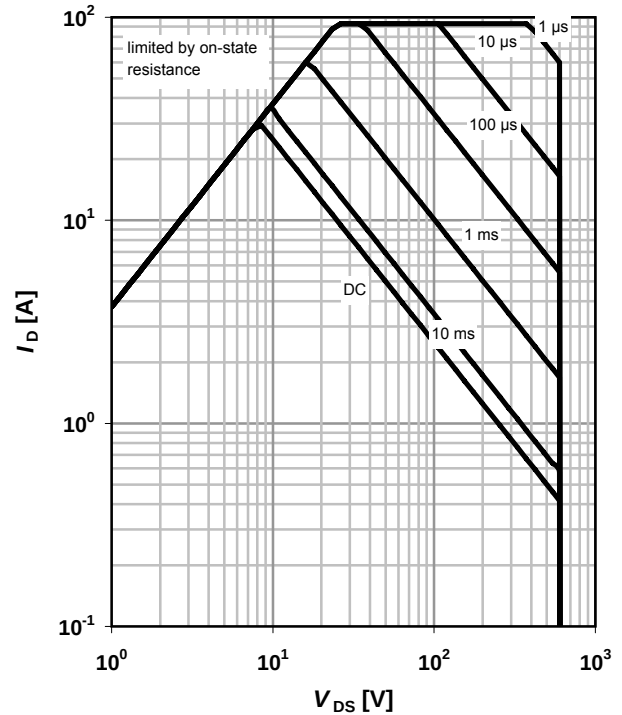
$$P_{\text{tot}} = f(T_C)$$



## 2 Safe operating area

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

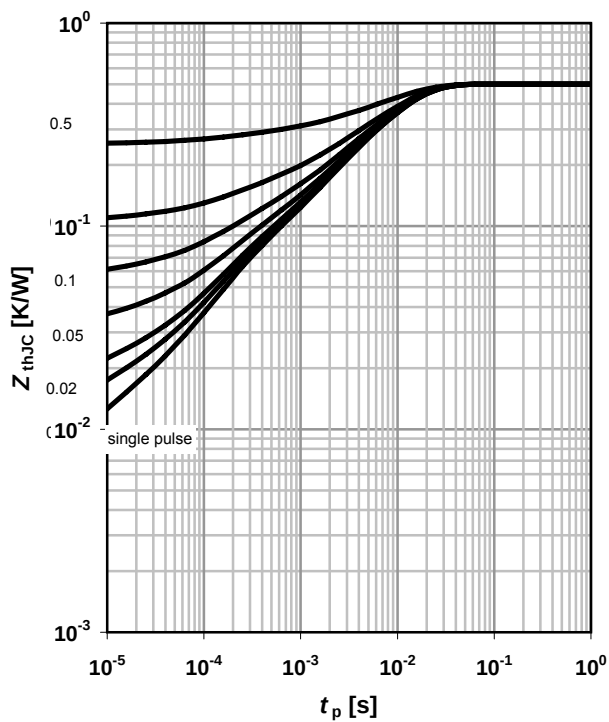
parameter:  $t_p$



## 3 Max. transient thermal impedance

$$Z_{\text{thJC}} = f(t_p)$$

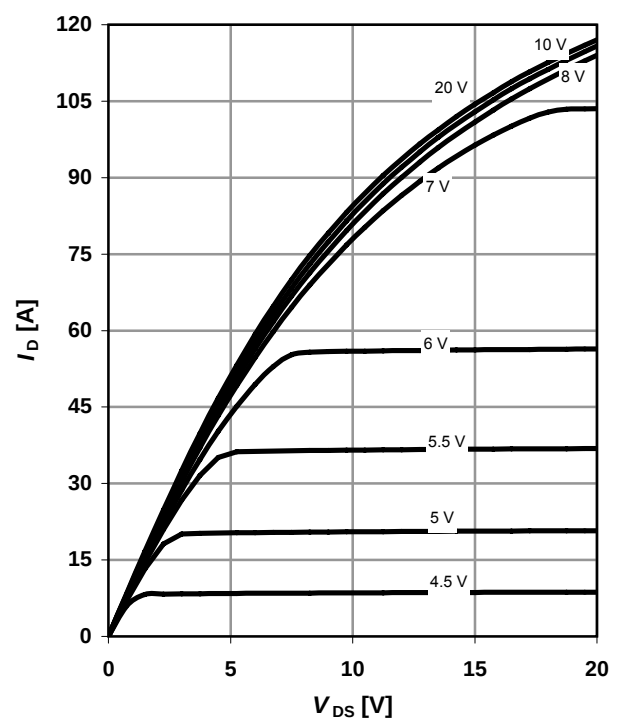
parameter:  $D = t_p / T$



## 4 Typ. output characteristics

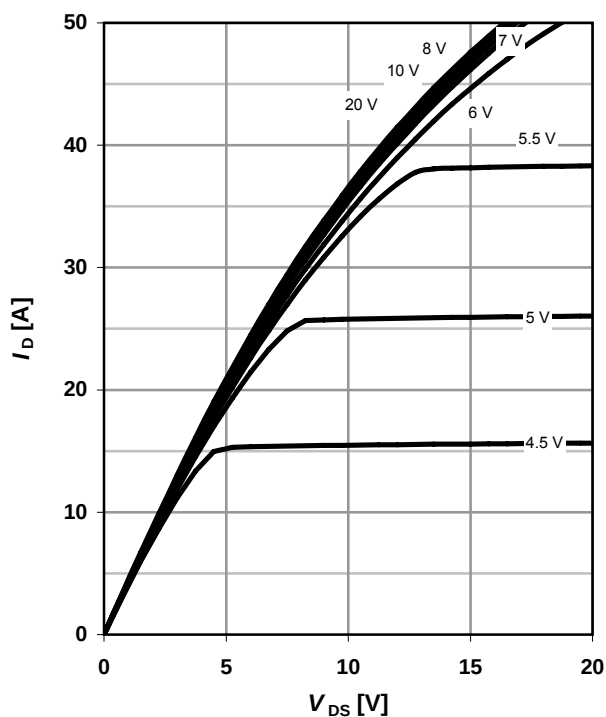
$$I_D = f(V_{DS}); T_J = 25 \text{ °C}$$

parameter:  $V_{GS}$



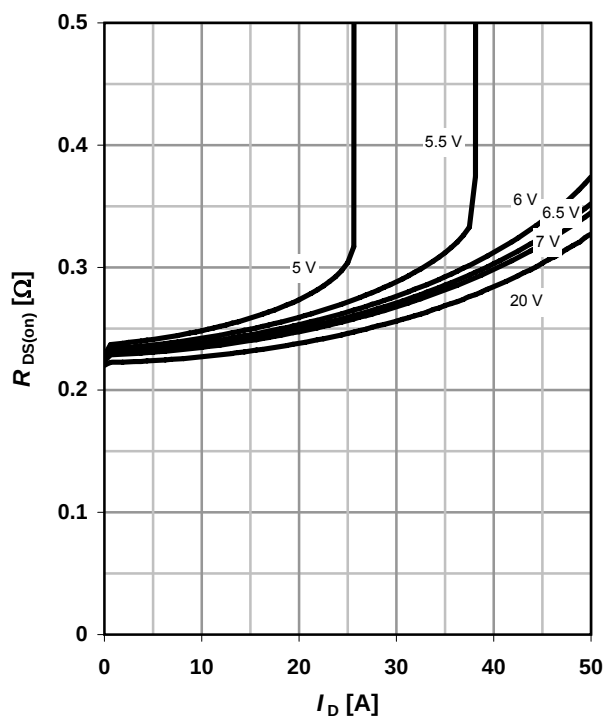
## 5 Typ. output characteristics

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

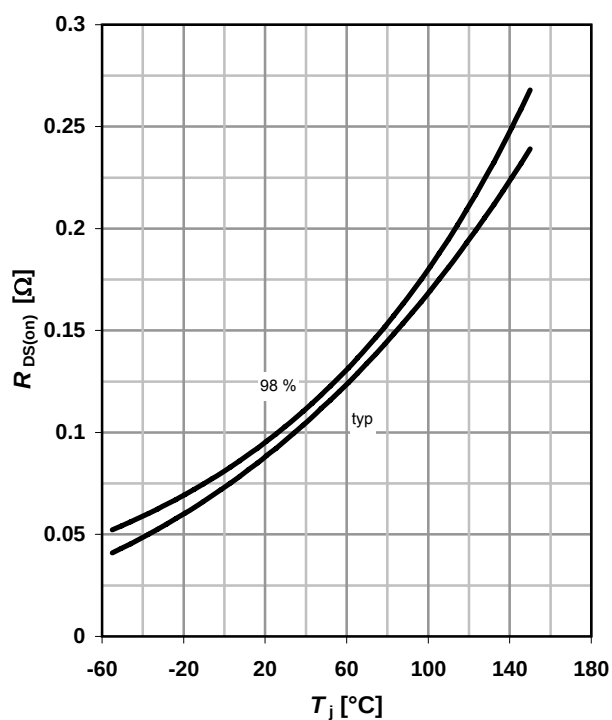
parameter:  $V_{GS}$ 


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

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

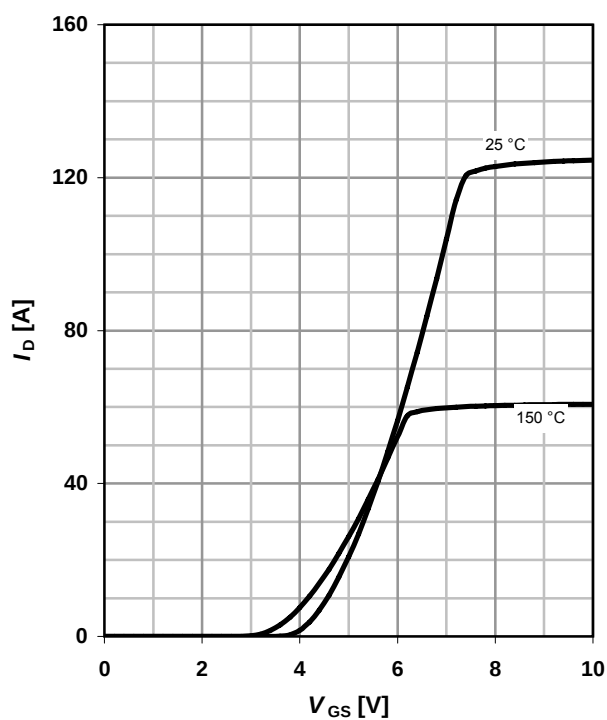
parameter:  $V_{GS}$ 


## 7 Drain-source on-state resistance

 $R_{DS(on)} = f(T_j); I_D = 18\text{ A}; V_{GS} = 10\text{ V}$ 


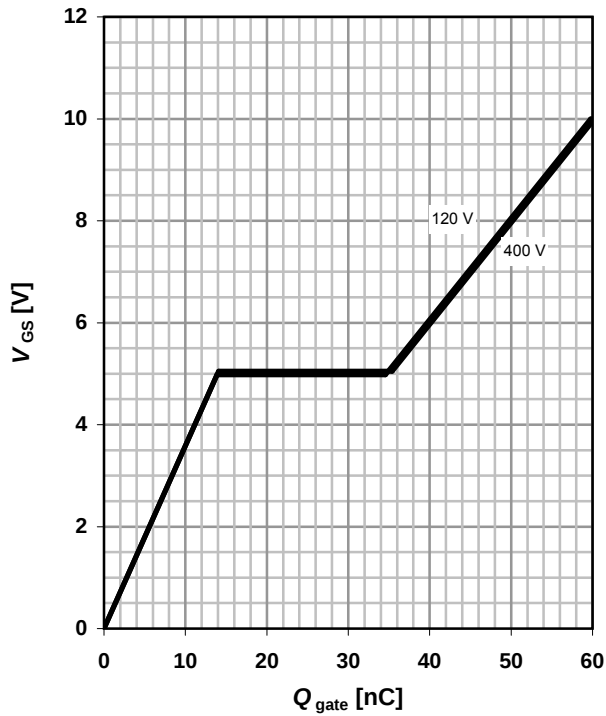
## 8 Typ. transfer characteristics

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

parameter:  $T_j$ 


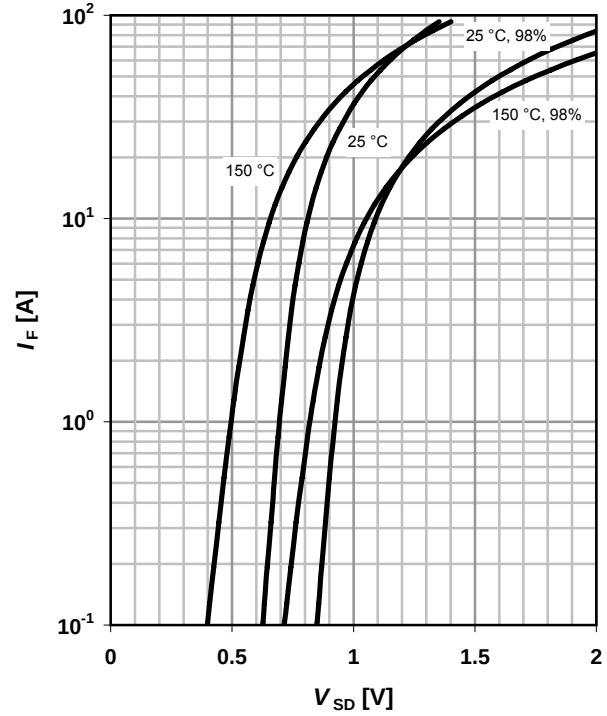
### 9 Typ. gate charge

 $V_{GS}=f(Q_{gate}); I_D=18\text{ A pulsed}$ 

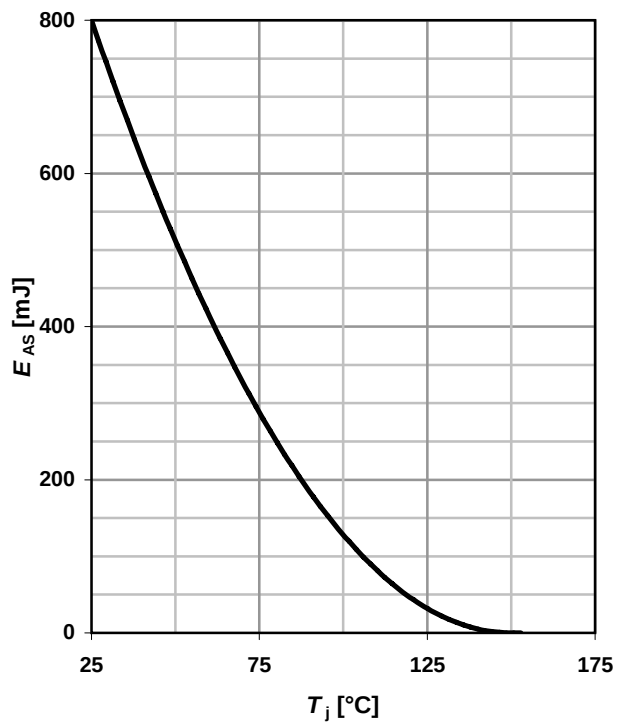
parameter:  $V_{DD}$ 


### 10 Forward characteristics of reverse diode

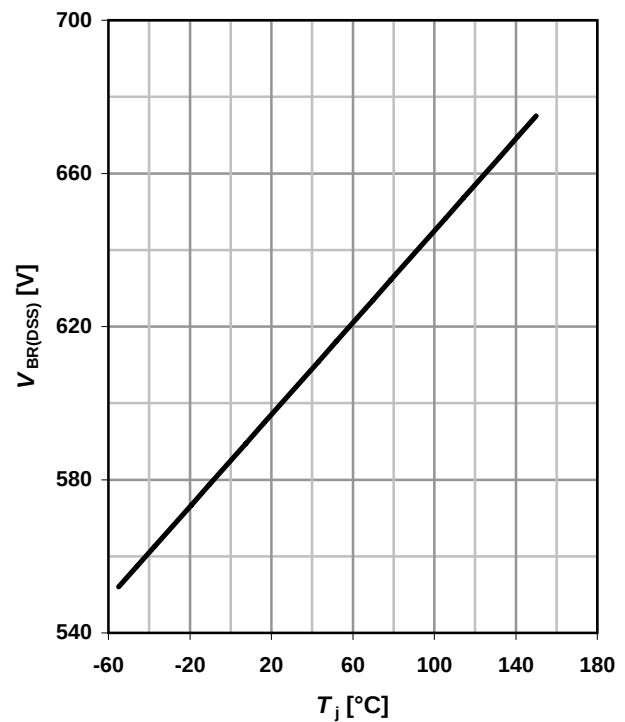
 $I_F=f(V_{SD})$ 

parameter:  $T_j$ 


### 11 Avalanche energy

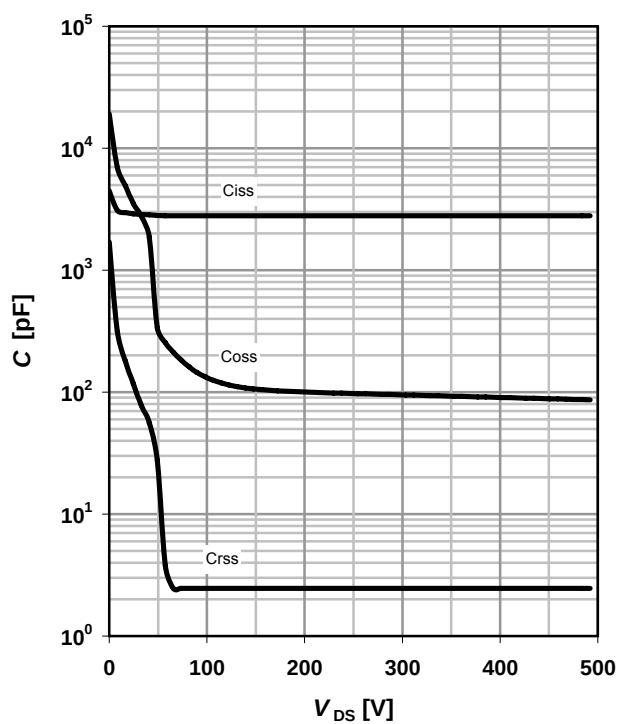
 $E_{AS}=f(T_j); I_D=11\text{ A}; V_{DD}=50\text{ V}$ 


### 12 Drain-source breakdown voltage

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


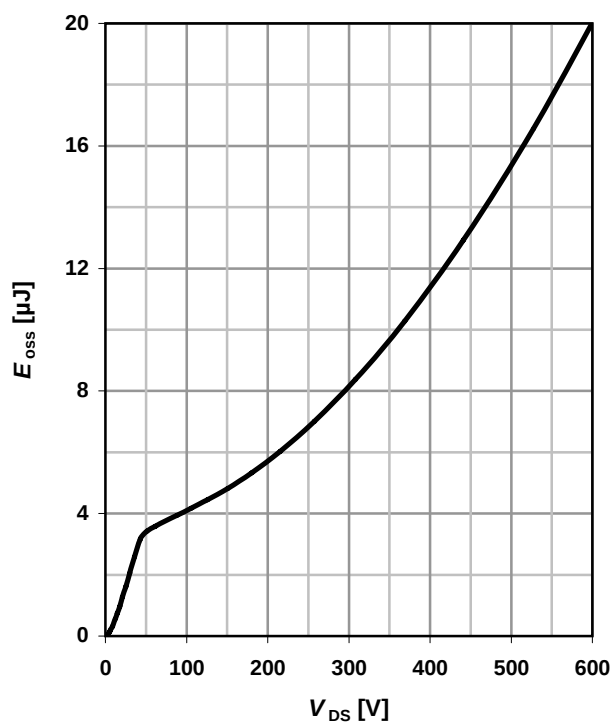
### 13 Typ. capacitances

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

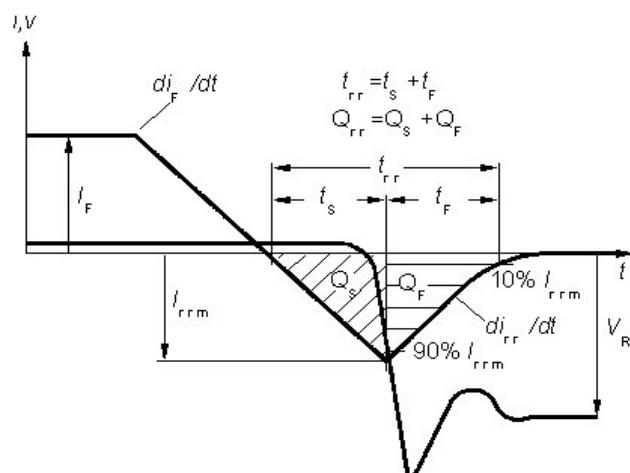


### 14 Typ. Coss stored energy

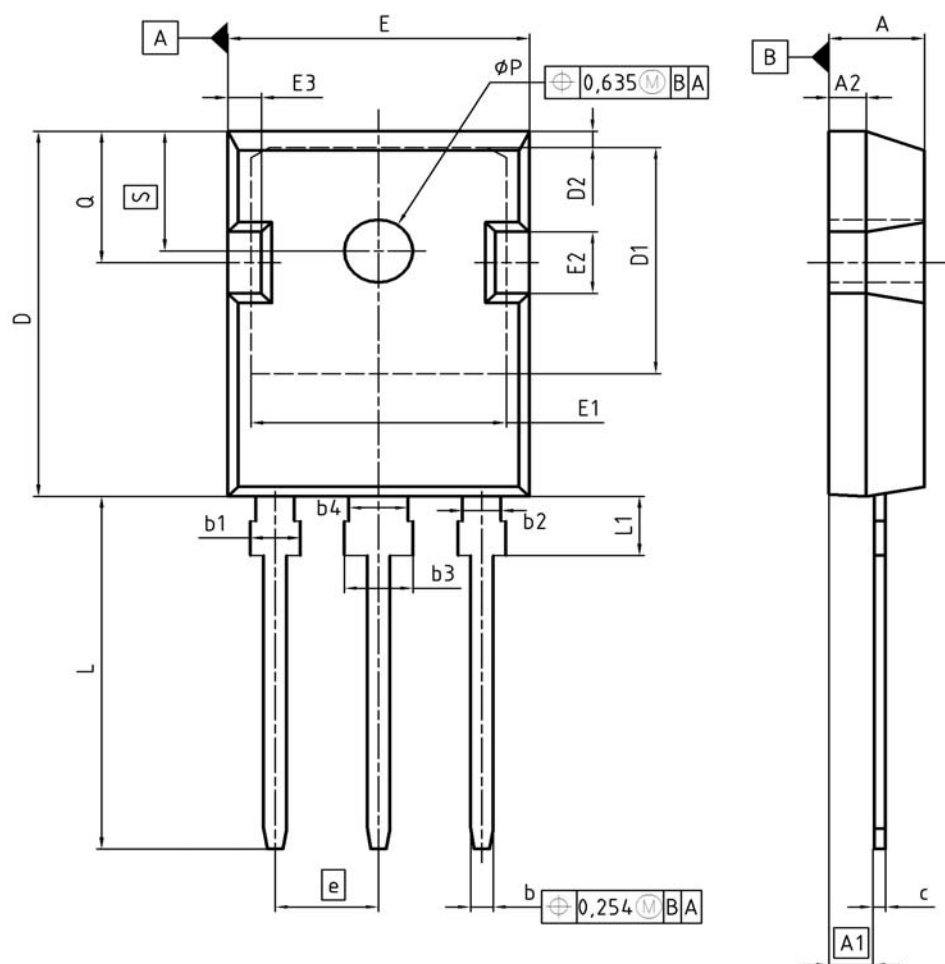
$E_{oss} = f(V_{DS})$



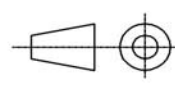
# Definition of diode switching characteristics



## PG-TO247-3: Outlines



| 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 |
| $\phi P$ | 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 |

|                                                                                                              |
|--------------------------------------------------------------------------------------------------------------|
| DOCUMENT NO.<br>Z8B00003327                                                                                  |
| SCALE<br>0 5 5 7.5mm                                                                                         |
| EUROPEAN PROJECTION<br> |
| ISSUE DATE<br>17-12-2007                                                                                     |
| REVISION<br>03                                                                                               |

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# NOTIFICATION



N° 040/10

## Information on N-Channel MOSFET products designed for automotive applications

### Products affected:

| SalesName    | Package       |
|--------------|---------------|
| IPB60R099CPA | PG-TO263-3-2  |
| IPB60R199CPA | PG-TO263-3-2  |
| IPB60R299CPA | PG-TO263-3-2  |
| IPC60R075CPA | Bare Die      |
| IPI60R099CPA | PG-TO262-3-1  |
| IPP60R099CPA | PG-TO220-3-1  |
| IPW60R045CPA | PG-TO247-3-41 |
| IPW60R075CPA | PG-TO247-3-41 |
| IPW60R099CPA | PG-TO247-3-41 |

Dear Customer,

The devices listed for this notification are sensitive to hard commutation of the conducting body diode. This operating condition can occur in half-bridge configurations used in ZVS phase shift and resonant switching PWM converters. Using the device under such conditions may result in violation of the datasheet specification limits and may lead to permanent damage of the device.

Please take care that in the context of the application described above the datasheet limits are not exceeded.

Best Regards

Michael Paulu

If you have any questions, please do not hesitate to contact your local Sales office.