

## OptiMOS™ Power-MOSFET

### Features

- Optimized for high performance Buck converter
- Low parasitic inductance
- Low profile (<0.7 mm)
- 100% avalanche tested
- 100%  $R_G$  Tested
- Double-sided cooling
- Compatible with DirectFET® package SQ footprint and outline <sup>1)</sup>
- Qualified according to JEDEC <sup>2)</sup> for target applications



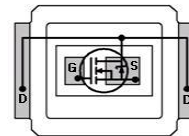
### Product Summary

|                  |     |    |
|------------------|-----|----|
| $V_{DS}$         | 25  | V  |
| $R_{DS(on),max}$ | 3.5 | mΩ |
| $I_D$            | 69  | A  |
| $Q_{OSS}$        | 13  | nC |
| $Q_g(0V..10V)$   | 19  | nC |

CanPAK™ S  
MG-WDSO-2



| Type        | Package   | Outline | Marking |
|-------------|-----------|---------|---------|
| BSF035NE2LQ | MG-WDSO-2 | SQ      | 04E2    |



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

| Parameter                                     | Symbol        | Conditions                                                                   | Value | Unit |
|-----------------------------------------------|---------------|------------------------------------------------------------------------------|-------|------|
| Continuous drain current                      | $I_D$         | $V_{GS}=10\text{ V}$ , $T_C=25\text{ °C}$                                    | 69    | A    |
|                                               |               | $V_{GS}=10\text{ V}$ , $T_C=100\text{ °C}$                                   | 44    |      |
|                                               |               | $V_{GS}=10\text{ V}$ , $T_A=25\text{ °C}$ ,<br>$R_{thJA}=45\text{ K/W}^{3)}$ | 22    |      |
| Pulsed drain current <sup>4)</sup>            | $I_{D,pulse}$ | $T_C=25\text{ °C}$                                                           | 276   |      |
| Avalanche current, single pulse <sup>5)</sup> | $I_{AS}$      | $T_C=25\text{ °C}$                                                           | 40    |      |
| Avalanche energy, single pulse                | $E_{AS}$      | $I_D=35\text{ A}$ , $R_{GS}=25\text{ Ω}$                                     | 50    | mJ   |
| Gate source voltage                           | $V_{GS}$      |                                                                              | ±20   | V    |

<sup>1)</sup> CanPAK™ uses DirectFET® technology licensed from International Rectifier Corporation. DirectFET® is a registered trademark of International Rectifier Corporation.

<sup>2)</sup> J-STD20 and JESD22

<sup>3)</sup> Device on 40 mm x 40 mm x 1.5 mm epoxy PCB FR4 with 6 cm<sup>2</sup> (one layer, 70 μm thick) copper area for drain connection. PCB is vertical in still air.

<sup>4)</sup> See figure 3 for more detailed information

<sup>5)</sup> See figure 13 for more detailed information

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

| Parameter                           | Symbol                | Conditions                                              | Value       | Unit |
|-------------------------------------|-----------------------|---------------------------------------------------------|-------------|------|
| Power dissipation                   | $P_{\text{tot}}$      | $T_C=25\text{ °C}$                                      | 28          | W    |
|                                     |                       | $T_A=25\text{ °C}$ ,<br>$R_{\text{thJA}}=58\text{ K/W}$ | 2.2         |      |
| Operating and storage temperature   | $T_j, T_{\text{stg}}$ |                                                         | -40 ... 150 | °C   |
| IEC climatic category; DIN IEC 68-1 |                       |                                                         |             |      |

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

#### Thermal characteristics

|                                     |                   |                                              |   |     |     |     |
|-------------------------------------|-------------------|----------------------------------------------|---|-----|-----|-----|
| Thermal resistance, junction - case | $R_{\text{thJC}}$ | bottom                                       | - | 1.0 | -   | K/W |
|                                     |                   | top                                          | - | -   | 4.5 |     |
| Device on PCB                       | $R_{\text{thJA}}$ | 6 cm <sup>2</sup> cooling area <sup>5)</sup> | - | -   | 58  |     |

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

#### Static characteristics

|                                  |                             |                                                                                        |     |     |     |               |
|----------------------------------|-----------------------------|----------------------------------------------------------------------------------------|-----|-----|-----|---------------|
| Drain-source breakdown voltage   | $V_{(\text{BR})\text{DSS}}$ | $V_{\text{GS}}=0\text{ V}$ , $I_{\text{D}}=1\text{ mA}$                                | 25  | -   | -   | V             |
| Gate threshold voltage           | $V_{\text{GS(th)}}$         | $V_{\text{DS}}=V_{\text{GS}}$ , $I_{\text{D}}=250\text{ }\mu\text{A}$                  | 1.2 | -   | 2   |               |
| Zero gate voltage drain current  | $I_{\text{DSS}}$            | $V_{\text{DS}}=25\text{ V}$ , $V_{\text{GS}}=0\text{ V}$ ,<br>$T_j=25\text{ °C}$       | -   | 0.1 | 10  | $\mu\text{A}$ |
|                                  |                             | $V_{\text{DS}}=25\text{ V}$ , $V_{\text{GS}}=0\text{ V}$ ,<br>$T_j=125\text{ °C}$      | -   | 10  | 100 |               |
| Gate-source leakage current      | $I_{\text{GSS}}$            | $V_{\text{GS}}=20\text{ V}$ , $V_{\text{DS}}=0\text{ V}$                               |     | 10  | 100 | nA            |
| Drain-source on-state resistance | $R_{\text{DS(on)}}$         | $V_{\text{GS}}=4.5\text{ V}$ , $I_{\text{D}}=30\text{ A}$                              | -   | 3.7 | 4.6 | m $\Omega$    |
|                                  |                             | $V_{\text{GS}}=10\text{ V}$ , $I_{\text{D}}=30\text{ A}$                               | -   | 2.9 | 3.5 |               |
| Gate resistance                  | $R_{\text{G}}$              |                                                                                        | 0.3 | 0.6 | 1.2 | $\Omega$      |
| Transconductance                 | $g_{\text{fs}}$             | $ V_{\text{DS}} >2 I_{\text{D}} /R_{\text{DS(on)max}}$ ,<br>$I_{\text{D}}=30\text{ A}$ | 55  | 110 | -   | S             |

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

### Dynamic characteristics

|                              |              |                                                                                       |   |      |      |    |
|------------------------------|--------------|---------------------------------------------------------------------------------------|---|------|------|----|
| Input capacitance            | $C_{iss}$    | $V_{GS}=0\text{ V}, V_{DS}=12\text{ V},$<br>$f=1\text{ MHz}$                          | - | 1400 | 1862 | pF |
| Output capacitance           | $C_{oss}$    |                                                                                       | - | 630  | 838  |    |
| Reverse transfer capacitance | $C_{rss}$    |                                                                                       | - | 59   | -    |    |
| Turn-on delay time           | $t_{d(on)}$  | $V_{DD}=12\text{ V}, V_{GS}=10\text{ V},$<br>$I_D=30\text{ A}, R_{G,ext}=1.6\ \Omega$ | - | 1.8  | -    | ns |
| Rise time                    | $t_r$        |                                                                                       | - | 3.2  | -    |    |
| Turn-off delay time          | $t_{d(off)}$ |                                                                                       | - | 16   | -    |    |
| Fall time                    | $t_f$        |                                                                                       | - | 2.2  | -    |    |

### Gate Charge Characteristics<sup>6)</sup>

|                              |               |                                                                             |   |     |     |    |
|------------------------------|---------------|-----------------------------------------------------------------------------|---|-----|-----|----|
| Gate to source charge        | $Q_{gs}$      | $V_{DD}=12\text{ V}, I_D=30\text{ A},$<br>$V_{GS}=0\text{ to }4.5\text{ V}$ | - | 3.1 | 4.1 | nC |
| Gate charge at threshold     | $Q_{g(th)}$   |                                                                             | - | 2.2 | -   |    |
| Gate to drain charge         | $Q_{gd}$      |                                                                             | - | 2.0 | 3.0 |    |
| Switching charge             | $Q_{sw}$      |                                                                             | - | 3.0 | -   |    |
| Gate charge total            | $Q_g$         |                                                                             | - | 9.1 | 12  |    |
| Gate plateau voltage         | $V_{plateau}$ |                                                                             | - | 2.3 | -   | V  |
| Gate charge total            | $Q_g$         | $V_{DD}=12\text{ V}, I_D=30\text{ A},$<br>$V_{GS}=0\text{ to }10\text{ V}$  | - | 19  | 25  | nC |
| Gate charge total, sync. FET | $Q_{g(sync)}$ | $V_{DS}=0.1\text{ V},$<br>$V_{GS}=0\text{ to }4.5\text{ V}$                 | - | 7.9 | -   |    |
| Output charge                | $Q_{oss}$     | $V_{DD}=12\text{ V}, V_{GS}=0\text{ V}$                                     | - | 13  | 17  |    |

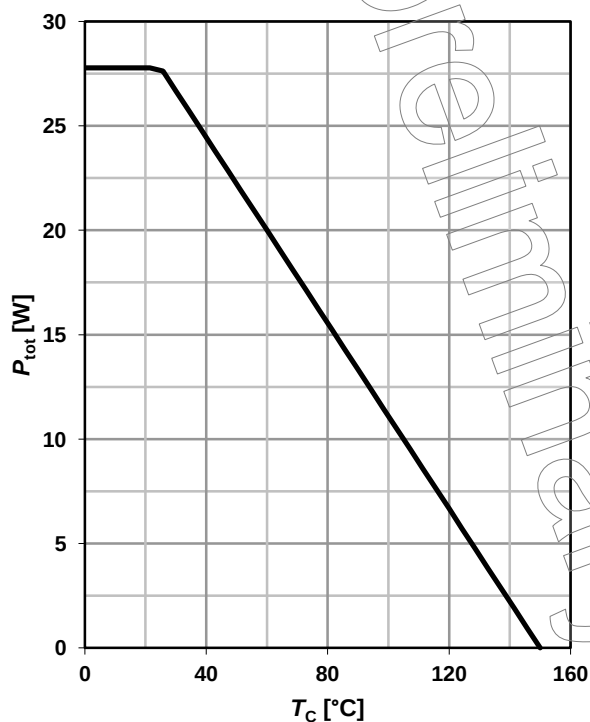
### Reverse Diode

|                                  |               |                                                                   |   |      |     |    |
|----------------------------------|---------------|-------------------------------------------------------------------|---|------|-----|----|
| Diode continuous forward current | $I_S$         | $T_C=25\text{ °C}$                                                | - | -    | 28  | A  |
| Diode pulse current              | $I_{S,pulse}$ |                                                                   | - | -    | 112 |    |
| Diode forward voltage            | $V_{SD}$      | $V_{GS}=0\text{ V}, I_F=30\text{ A},$<br>$T_j=25\text{ °C}$       | - | 0.84 | -   | V  |
| Reverse recovery charge          | $Q_{rr}$      | $V_R=15\text{ V}, I_F=I_S,$<br>$di_F/dt=400\text{ A}/\mu\text{s}$ | - | 10   | -   | nC |

<sup>6)</sup> See figure 16 for gate charge parameter definition

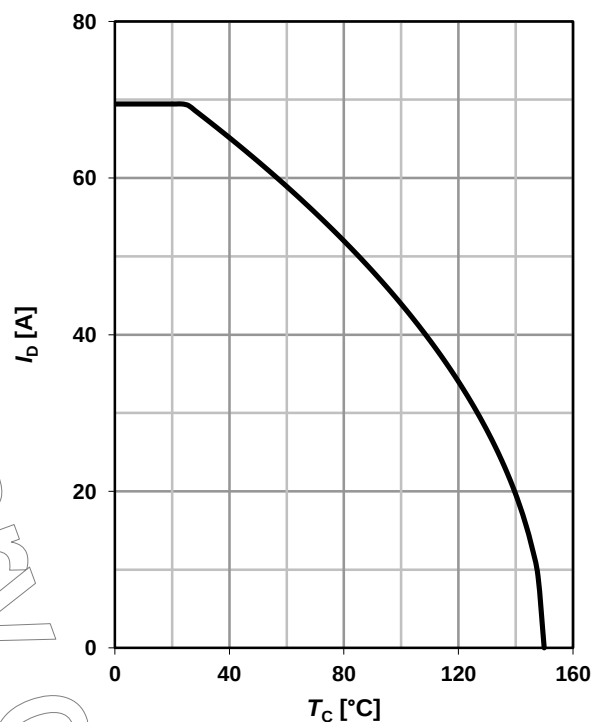
### 1 Power dissipation

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



### 2 Drain current

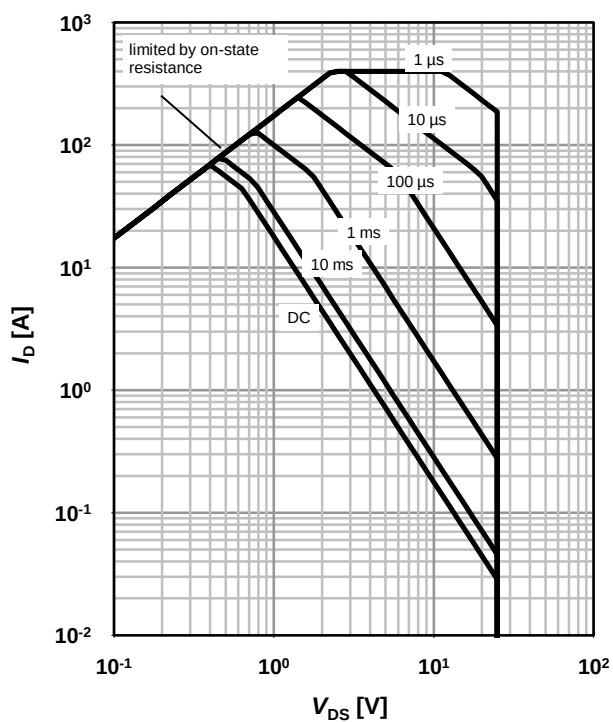
$$I_D = f(T_C); V_{GS} \geq 10 \text{ V}$$



### 3 Safe operating area

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

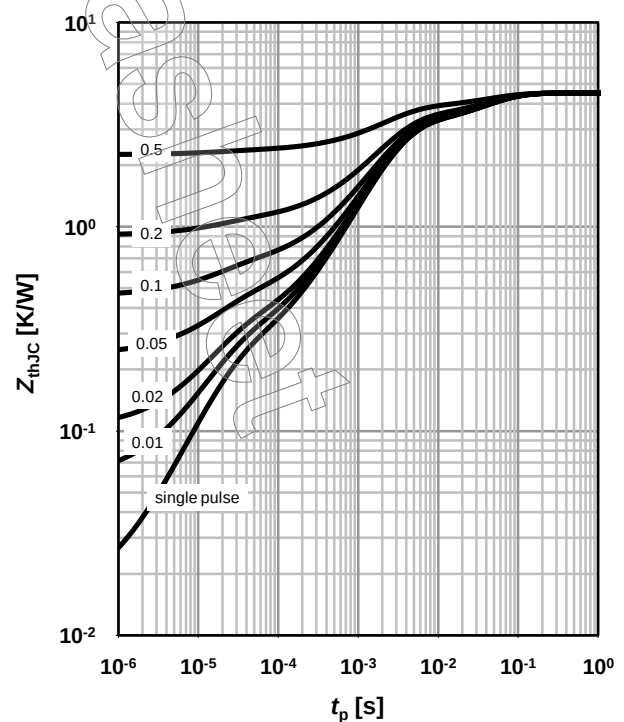
parameter:  $t_p$



### 4 Max. transient thermal impedance

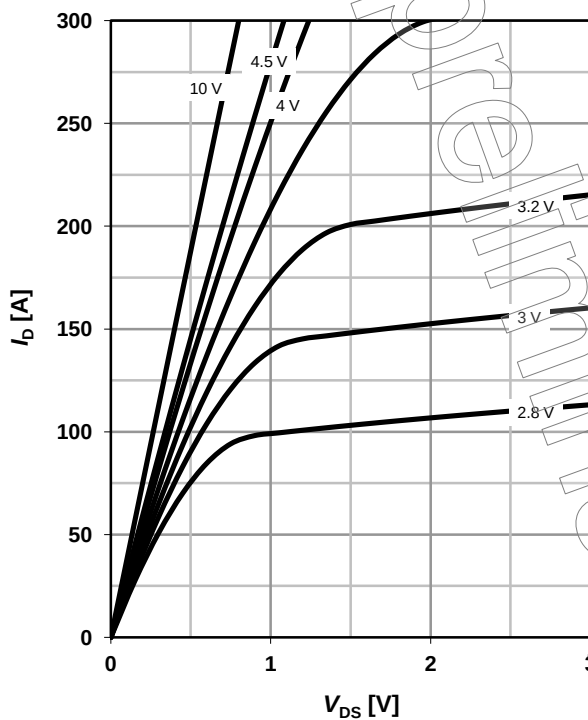
$$Z_{\text{thJC}} = f(t_p)$$

parameter:  $D = t_p/T$



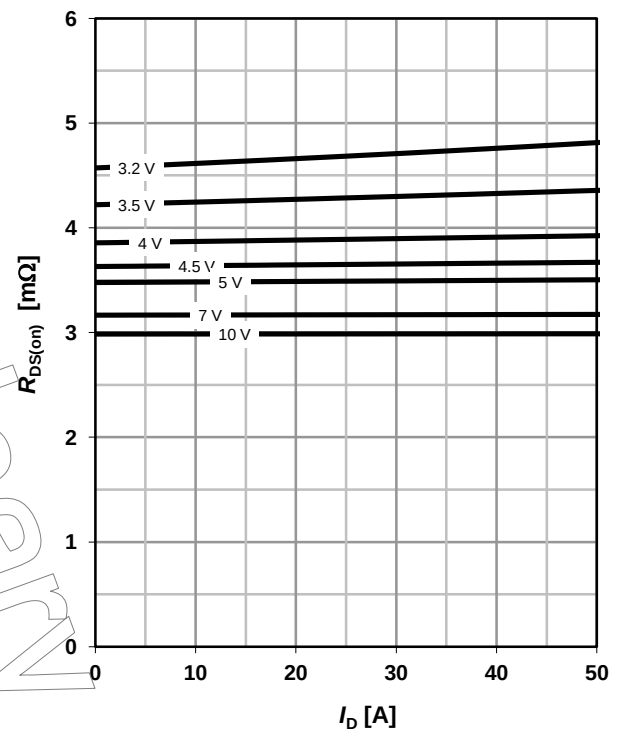
## 5 Typ. output characteristics

 $I_D = f(V_{DS}); T_j = 25^\circ\text{C}$ 

parameter:  $V_{GS}$ 


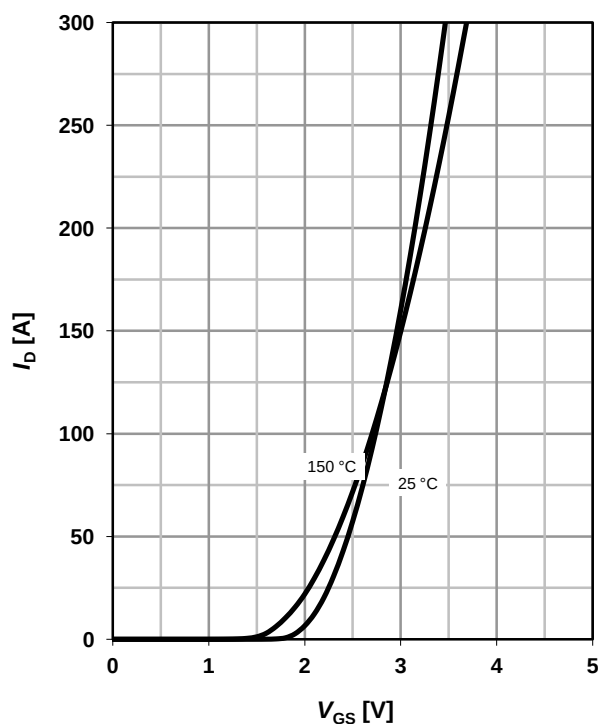
## 6 Typ. drain-source on resistance

 $R_{DS(on)} = f(I_D); T_j = 25^\circ\text{C}$ 

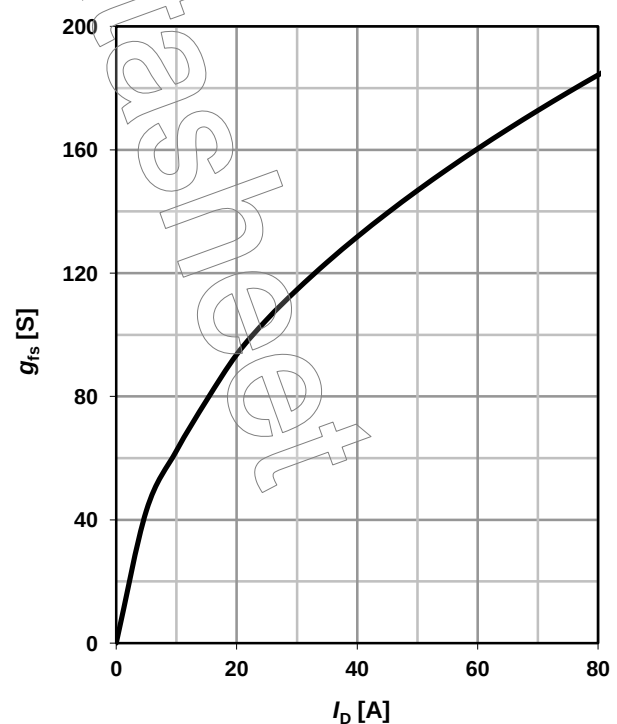
parameter:  $V_{GS}$ 


## 7 Typ. transfer characteristics

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

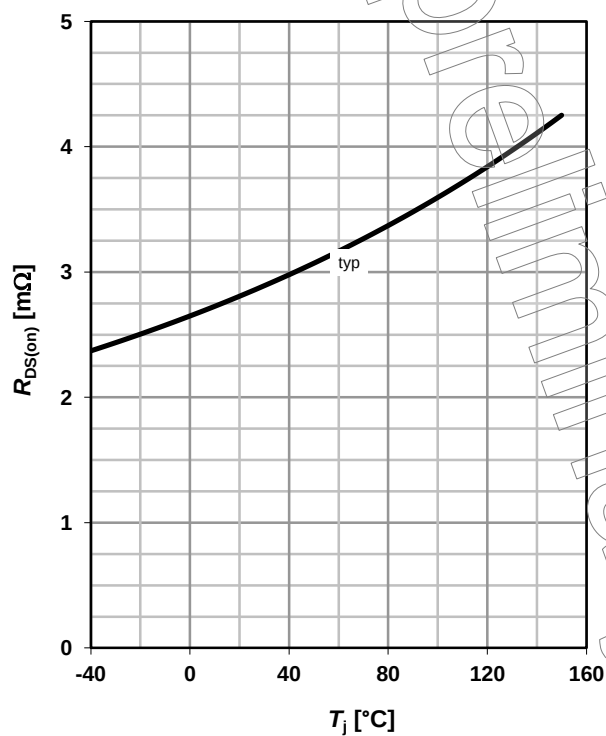
parameter:  $T_j$ 


## 8 Typ. forward transconductance

 $g_{fs} = f(I_D); T_j = 25^\circ\text{C}$ 


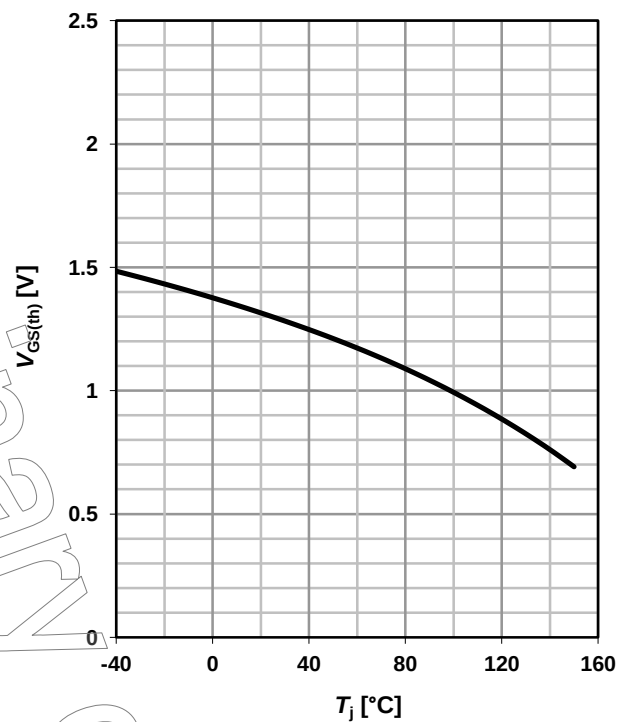
## 9 Drain-source on-state resistance

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



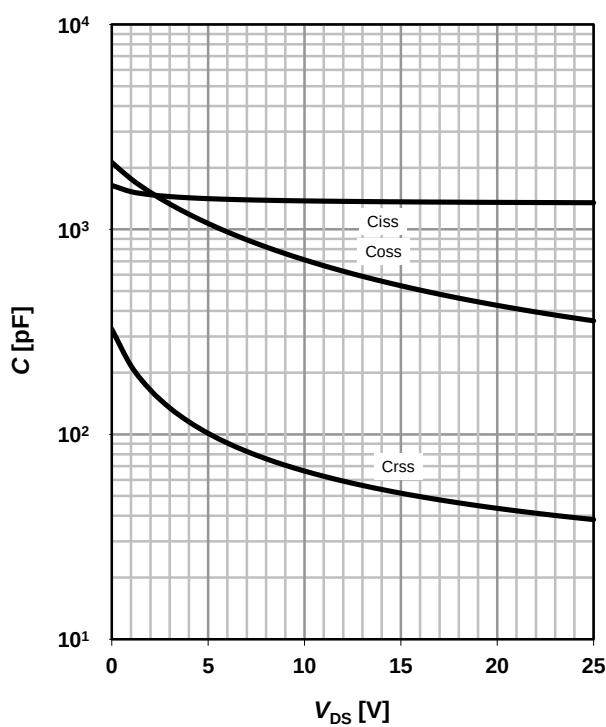
## 10 Typ. gate threshold voltage

$$V_{GS(th)} = f(T_j); V_{GS} = V_{DS}; I_D = 250 \mu\text{A}$$



## 11 Typ. capacitances

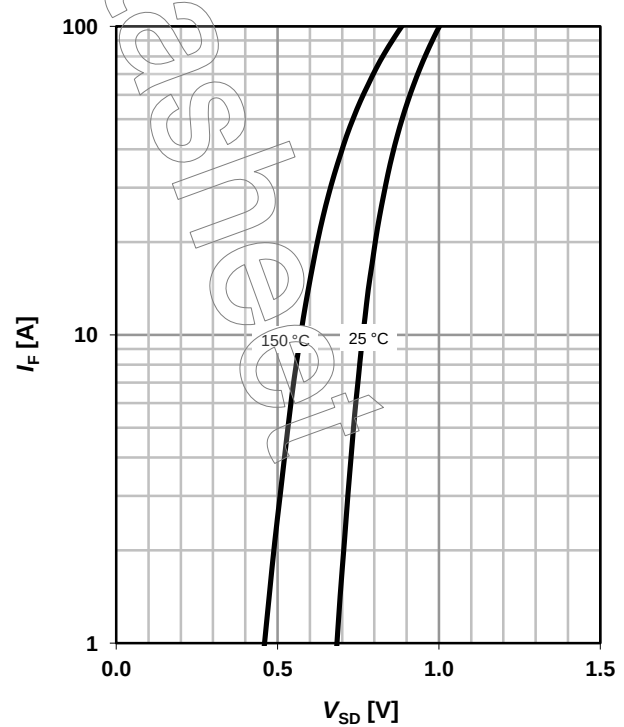
$$C = f(V_{DS}); V_{GS} = 0 \text{ V}; f = 1 \text{ MHz}$$



## 12 Forward characteristics of reverse diode

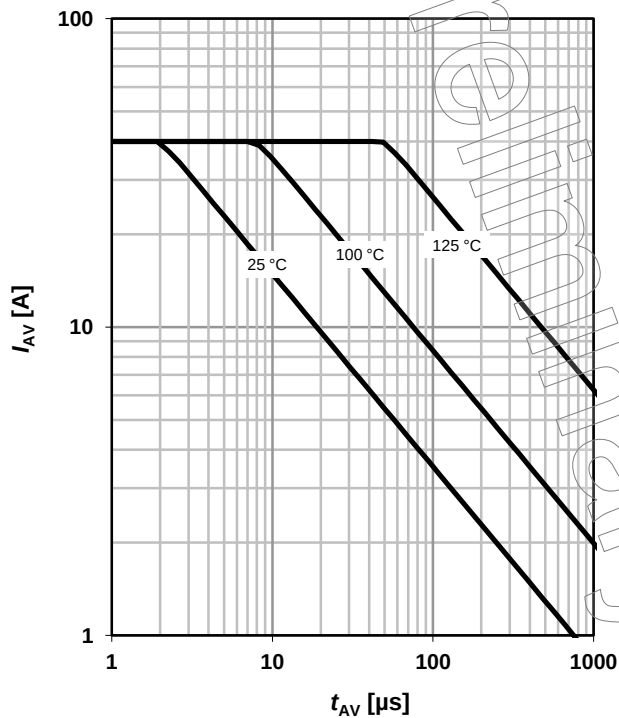
$$I_F = f(V_{SD})$$

parameter:  $T_j$



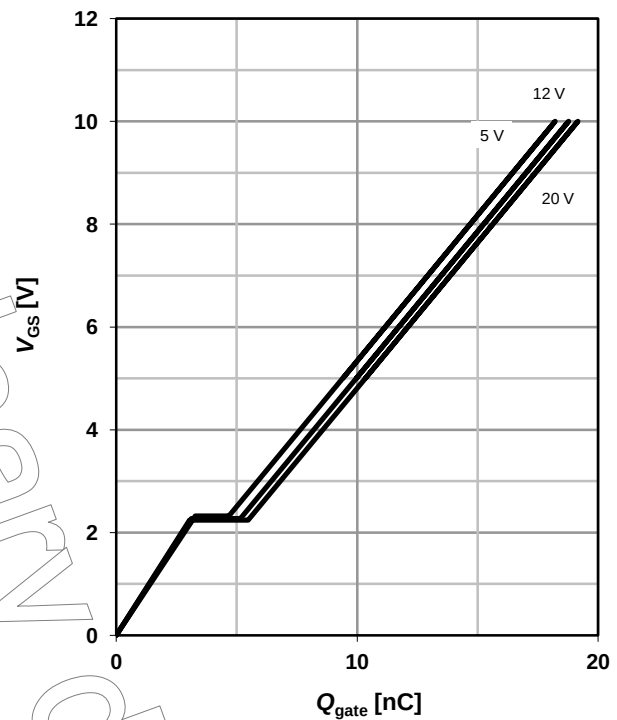
### 13 Avalanche characteristics

 $I_{AS}=f(t_{AV}); R_{GS}=25\ \Omega$ 

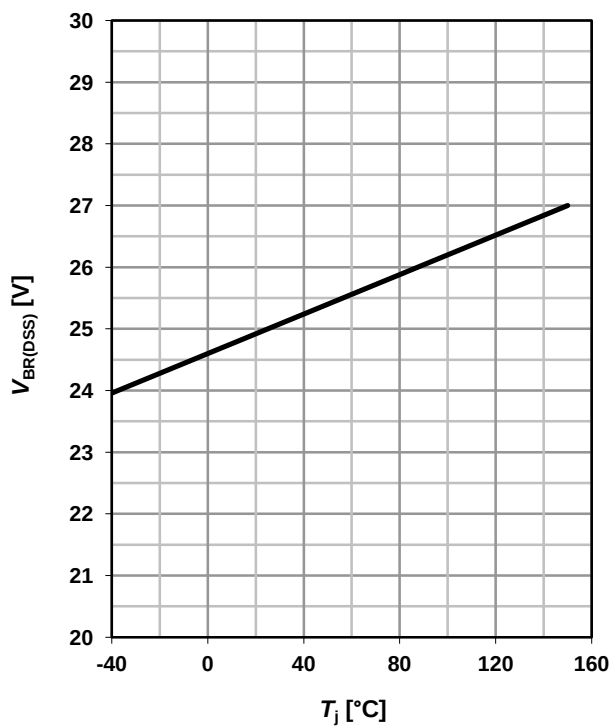
parameter:  $T_{j(\text{start})}$ 


### 14 Typ. gate charge

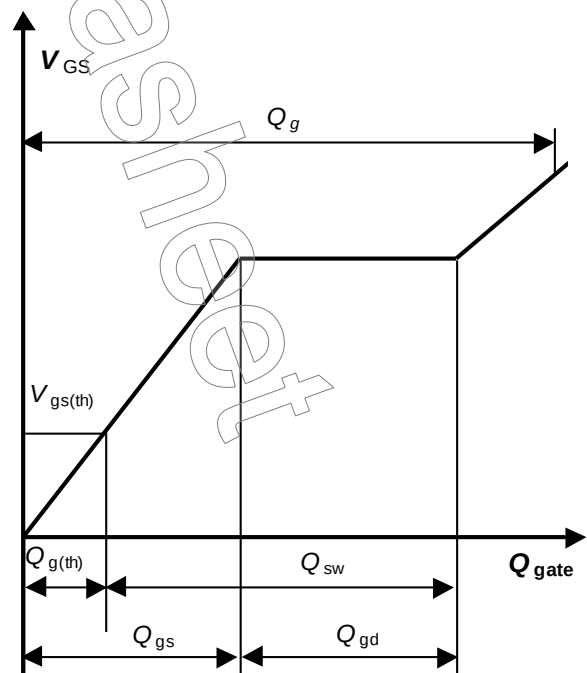
 $V_{GS}=f(Q_{\text{gate}}); I_D=30\ \text{A pulsed}$ 

parameter:  $V_{DD}$ 


### 15 Drain-source breakdown voltage

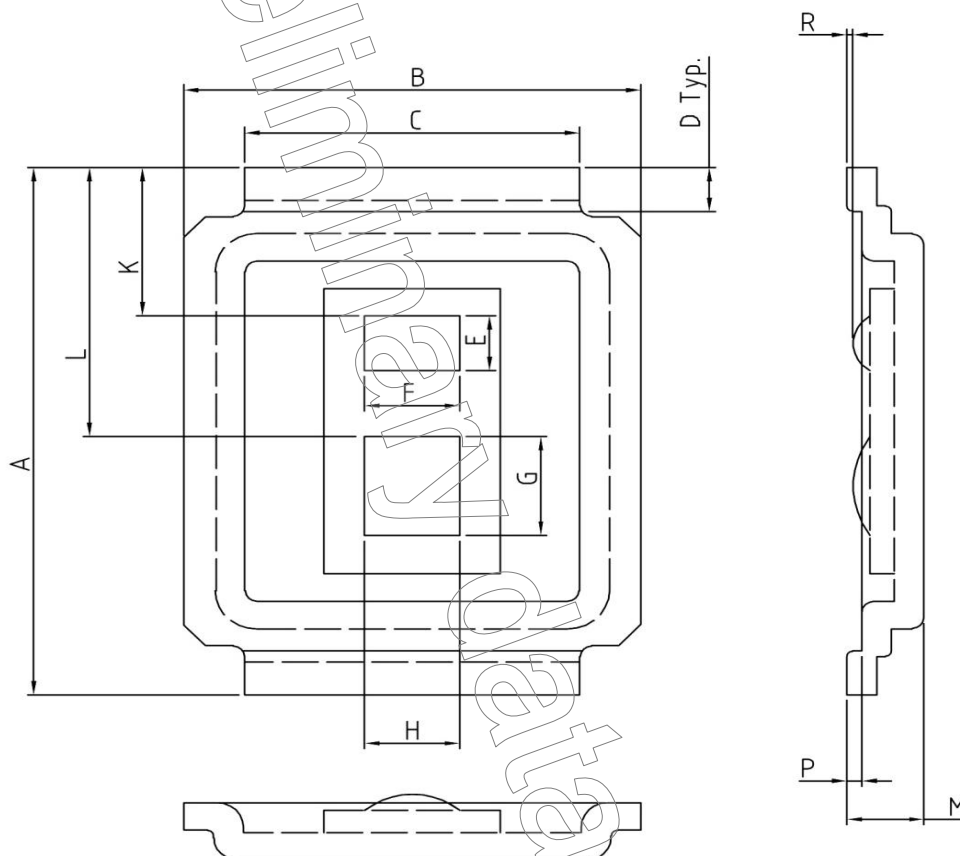
 $V_{BR(DSS)}=f(T_j); I_D=1\ \text{mA}$ 


### 16 Gate charge waveforms

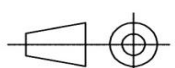


Package Outline

MG-WDSO N-233/-53



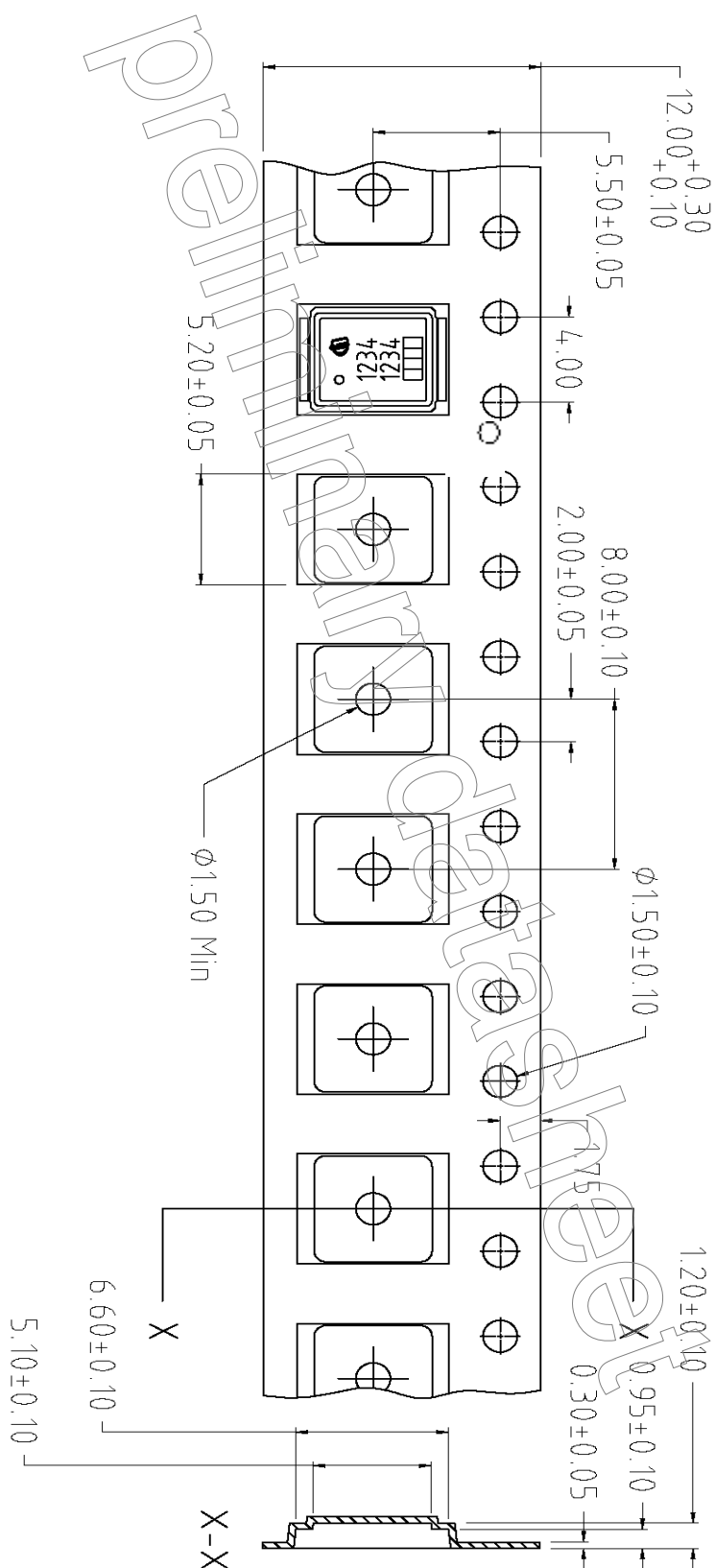
| DIM | MILLIMETERS |      | INCHES |       |
|-----|-------------|------|--------|-------|
|     | MIN         | MAX  | MIN    | MAX   |
| A   | 4.75        | 4.88 | 0.187  | 0.192 |
| B   | 3.70        | 3.95 | 0.146  | 0.156 |
| C   | 2.75        | 2.85 | 0.108  | 0.112 |
| D   | 0.35        | 0.45 | 0.014  | 0.018 |
| E   | 0.48        | 0.52 | 0.019  | 0.020 |
| F   | 0.78        | 0.82 | 0.031  | 0.032 |
| G   | 0.88        | 0.92 | 0.035  | 0.036 |
| H   | 0.78        | 0.82 | 0.031  | 0.032 |
| K   | 1.25        | 1.45 | 0.049  | 0.057 |
| L   | 2.35        | 2.55 | 0.093  | 0.100 |
| M   | 0.60        | 0.70 | 0.024  | 0.028 |
| R   | 0.00        | 0.10 | 0.000  | 0.004 |
| P   | 0.08        | 0.17 | 0.003  | 0.007 |

|                                                                                                              |
|--------------------------------------------------------------------------------------------------------------|
| DOCUMENT NO.<br>Z8B00134584                                                                                  |
| SCALE<br>0 5 5 7.5mm                                                                                         |
| EUROPEAN PROJECTION<br> |
| ISSUE DATE<br>05-05-2009                                                                                     |
| REVISION<br>02                                                                                               |



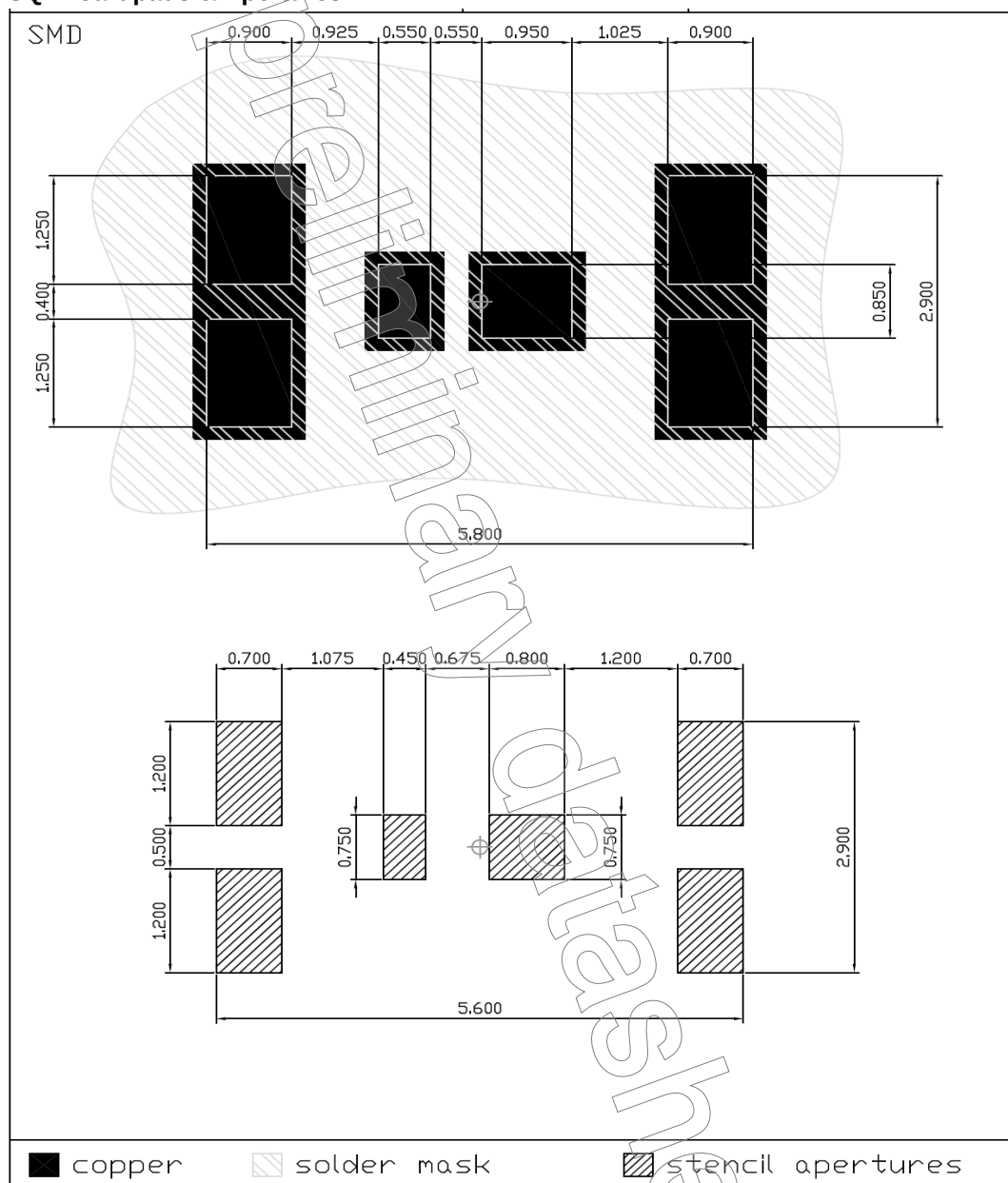
## Package Outline

## MG-WDSO-2



Dimensions in mm

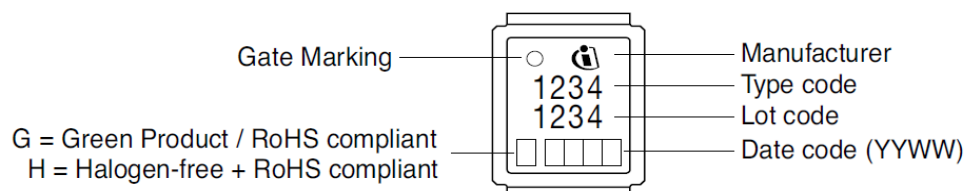
# CanPAK SQ: Boardpads & Apertures



Dimensions in mm

Recommended stencil thickness 150 µm

## Marking Layout



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