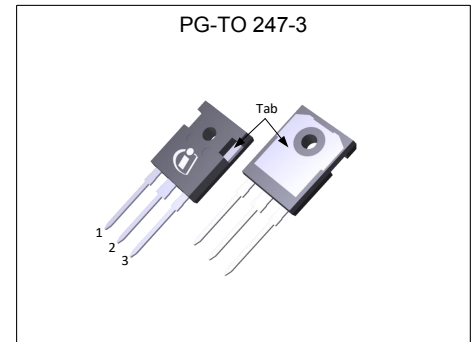


# MOSFET

## 650V CoolMOS™ CFD7 SJ Power Device

The latest 650 V CoolMOS™ CFD7 extends the voltage class offering of the CFD7 family and is a successor to the 650 V CoolMOS™ CFD2. Resulting from improved switching performance and excellent thermal behavior, 650 V CoolMOS™ CFD7 offers highest efficiency in resonant switching topologies, such as LLC and phase-shift-full-bridge (ZVS). As part of Infineon's fast body diode portfolio, this new product series blends all advantages of a fast switching technology together with superior hard commutation robustness. The CoolMOS™ CFD7 technology meets highest efficiency and reliability standards and furthermore supports high power density solutions.



## Features

- Ultra-fast body diode
- 650V break down voltage
- Best-in-class  $R_{DS(on)}$
- Reduced switching losses
- Low  $R_{DS(on)}$  dependency over temperature

## Benefits

- Excellent hard commutation ruggedness
- Extra safety margin for designs with increased bus voltage
- Enabling increased power density solutions
- Outstanding light load efficiency in industrial SMPS applications
- Improved full load efficiency in industrial SMPS applications
- Price competitiveness over previous CoolMOS™ families

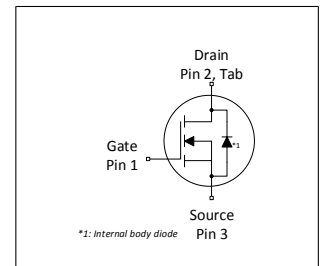
## Potential applications

Suitable for Soft Switching topologies  
Optimized for phase-shift full-bridge (ZVS), LLC Applications – Server, Telecom, EV Charging, Solar

## Product validation

Fully qualified according to JEDEC for Industrial Applications

*Please note: For MOSFET paralleling the use of ferrite beads on the gate or separate totem poles is generally recommended.*



RoHS

**Table 1 Key Performance Parameters**

| Parameter            | Value | Unit |
|----------------------|-------|------|
| $V_{DS} @ T_{j,max}$ | 700   | V    |
| $R_{DS(on),max}$     | 90    | mΩ   |
| $Q_{g,typ}$          | 53    | nC   |
| $I_{D,pulse}$        | 107   | A    |
| $E_{oss} @ 400V$     | 7.4   | μJ   |
| Body diode $di_F/dt$ | 1300  | A/μs |

| Type / Ordering Code | Package    | Marking  | Related Links  |
|----------------------|------------|----------|----------------|
| IPW65R090CFD7        | PG-TO247-3 | 65R090F7 | see Appendix A |

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## 1 Maximum ratings

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

**Table 2 Maximum ratings**

| Parameter                                      | Symbol        | Values |      |          | Unit             | Note / Test Condition                                                                          |
|------------------------------------------------|---------------|--------|------|----------|------------------|------------------------------------------------------------------------------------------------|
|                                                |               | Min.   | Typ. | Max.     |                  |                                                                                                |
| Continuous drain current <sup>1)</sup>         | $I_D$         | -      | -    | 25<br>16 | A                | $T_C=25^\circ\text{C}$<br>$T_C=100^\circ\text{C}$                                              |
| Pulsed drain current <sup>2)</sup>             | $I_{D,pulse}$ | -      | -    | 107      | A                | $T_C=25^\circ\text{C}$                                                                         |
| Avalanche energy, single pulse                 | $E_{AS}$      | -      | -    | 125      | mJ               | $I_D=5.0\text{A}$ ; $V_{DD}=50\text{V}$ ; see table 10                                         |
| Avalanche energy, repetitive                   | $E_{AR}$      | -      | -    | 0.63     | mJ               | $I_D=5.0\text{A}$ ; $V_{DD}=50\text{V}$ ; see table 10                                         |
| Avalanche current, single pulse                | $I_{AS}$      | -      | -    | 5.0      | A                | -                                                                                              |
| MOSFET dv/dt ruggedness                        | dv/dt         | -      | -    | 120      | V/ns             | $V_{DS}=0\dots400\text{V}$                                                                     |
| Gate source voltage (static)                   | $V_{GS}$      | -20    | -    | 20       | V                | static;                                                                                        |
| Gate source voltage (dynamic)                  | $V_{GS}$      | -30    | -    | 30       | V                | AC ( $f>1\text{ Hz}$ )                                                                         |
| Power dissipation                              | $P_{tot}$     | -      | -    | 127      | W                | $T_C=25^\circ\text{C}$                                                                         |
| Storage temperature                            | $T_{stg}$     | -55    | -    | 150      | $^\circ\text{C}$ | -                                                                                              |
| Operating junction temperature                 | $T_j$         | -55    | -    | 150      | $^\circ\text{C}$ | -                                                                                              |
| Mounting torque                                | -             | -      | -    | 60       | Ncm              | M3 and M3.5 screws                                                                             |
| Continuous diode forward current <sup>1)</sup> | $I_S$         | -      | -    | 25       | A                | $T_C=25^\circ\text{C}$                                                                         |
| Diode pulse current <sup>2)</sup>              | $I_{S,pulse}$ | -      | -    | 107      | A                | $T_C=25^\circ\text{C}$                                                                         |
| Reverse diode dv/dt <sup>3)</sup>              | dv/dt         | -      | -    | 70       | V/ns             | $V_{DS}=0\dots400\text{V}$ , $I_{SD}\leq 12.5\text{A}$ , $T_j=25^\circ\text{C}$<br>see table 8 |
| Maximum diode commutation speed                | di/dt         | -      | -    | 1300     | A/ $\mu\text{s}$ | $V_{DS}=0\dots400\text{V}$ , $I_{SD}\leq 12.5\text{A}$ , $T_j=25^\circ\text{C}$<br>see table 8 |
| Insulation withstand voltage                   | $V_{ISO}$     | -      | -    | n.a.     | V                | $V_{rms}$ , $T_C=25^\circ\text{C}$ , $t=1\text{min}$                                           |

<sup>1)</sup> Limited by  $T_{j,max}$ .

<sup>2)</sup> Pulse width  $t_p$  limited by  $T_{j,max}$ .

<sup>3)</sup> Identical low side and high side switch with identical  $R_\theta$ .

## 2 Thermal characteristics

**Table 3 Thermal characteristics**

| Parameter                                                  | Symbol     | Values |      |      | Unit | Note / Test Condition               |
|------------------------------------------------------------|------------|--------|------|------|------|-------------------------------------|
|                                                            |            | Min.   | Typ. | Max. |      |                                     |
| Thermal resistance, junction - case                        | $R_{thJC}$ | -      | -    | 0.98 | °C/W | -                                   |
| Thermal resistance, junction - ambient                     | $R_{thJA}$ | -      | -    | 62   | °C/W | leaded                              |
| Thermal resistance, junction - ambient for SMD version     | $R_{thJA}$ | -      | -    | -    | °C/W | n.a.                                |
| Soldering temperature, wavesoldering only allowed at leads | $T_{sold}$ | -      | -    | 260  | °C   | 1.6mm (0.063 in.) from case for 10s |

### 3 Electrical characteristics

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

**Table 4 Static characteristics**

| Parameter                                     | Symbol        | Values |               |            | Unit     | Note / Test Condition                                                                                         |
|-----------------------------------------------|---------------|--------|---------------|------------|----------|---------------------------------------------------------------------------------------------------------------|
|                                               |               | Min.   | Typ.          | Max.       |          |                                                                                                               |
| Drain-source breakdown voltage                | $V_{(BR)DSS}$ | 650    | -             | -          | V        | $V_{GS}=0V$ , $I_D=1mA$                                                                                       |
| Gate threshold voltage                        | $V_{(GS)th}$  | 3.5    | 4             | 4.5        | V        | $V_{DS}=V_{GS}$ , $I_D=0.63mA$                                                                                |
| Zero gate voltage drain current <sup>1)</sup> | $I_{DSS}$     | -      | -             | 1          | $\mu A$  | $V_{DS}=650V$ , $V_{GS}=0V$ , $T_j=25^\circ\text{C}$<br>$V_{DS}=650V$ , $V_{GS}=0V$ , $T_j=125^\circ\text{C}$ |
| Gate-source leakage current                   | $I_{GSS}$     | -      | -             | 100        | nA       | $V_{GS}=20V$ , $V_{DS}=0V$                                                                                    |
| Drain-source on-state resistance              | $R_{DS(on)}$  | -      | 0.068<br>0.15 | 0.090<br>- | $\Omega$ | $V_{GS}=10V$ , $I_D=12.5A$ , $T_j=25^\circ\text{C}$<br>$V_{GS}=10V$ , $I_D=12.5A$ , $T_j=150^\circ\text{C}$   |
| Gate resistance                               | $R_G$         | -      | 5.9           | -          | $\Omega$ | $f=1MHz$ , open drain                                                                                         |

**Table 5 Dynamic characteristics**

| Parameter                                                  | Symbol       | Values |      |      | Unit | Note / Test Condition                                                         |
|------------------------------------------------------------|--------------|--------|------|------|------|-------------------------------------------------------------------------------|
|                                                            |              | Min.   | Typ. | Max. |      |                                                                               |
| Input capacitance                                          | $C_{iss}$    | -      | 2513 | -    | pF   | $V_{GS}=0V$ , $V_{DS}=400V$ , $f=250kHz$                                      |
| Output capacitance                                         | $C_{oss}$    | -      | 40   | -    | pF   | $V_{GS}=0V$ , $V_{DS}=400V$ , $f=250kHz$                                      |
| Effective output capacitance, energy related <sup>2)</sup> | $C_{o(er)}$  | -      | 92   | -    | pF   | $V_{GS}=0V$ , $V_{DS}=0...400V$                                               |
| Effective output capacitance, time related <sup>3)</sup>   | $C_{o(tr)}$  | -      | 955  | -    | pF   | $I_D=\text{constant}$ , $V_{GS}=0V$ , $V_{DS}=0...400V$                       |
| Turn-on delay time                                         | $t_{d(on)}$  | -      | 25   | -    | ns   | $V_{DD}=400V$ , $V_{GS}=13V$ , $I_D=12.5A$ ,<br>$R_G=5.3\Omega$ ; see table 9 |
| Rise time                                                  | $t_r$        | -      | 11   | -    | ns   | $V_{DD}=400V$ , $V_{GS}=13V$ , $I_D=12.5A$ ,<br>$R_G=5.3\Omega$ ; see table 9 |
| Turn-off delay time                                        | $t_{d(off)}$ | -      | 92   | -    | ns   | $V_{DD}=400V$ , $V_{GS}=13V$ , $I_D=12.5A$ ,<br>$R_G=5.3\Omega$ ; see table 9 |
| Fall time                                                  | $t_f$        | -      | 5    | -    | ns   | $V_{DD}=400V$ , $V_{GS}=13V$ , $I_D=12.5A$ ,<br>$R_G=5.3\Omega$ ; see table 9 |

**Table 6 Gate charge characteristics**

| Parameter             | Symbol        | Values |      |      | Unit | Note / Test Condition                             |
|-----------------------|---------------|--------|------|------|------|---------------------------------------------------|
|                       |               | Min.   | Typ. | Max. |      |                                                   |
| Gate to source charge | $Q_{gs}$      | -      | 14   | -    | nC   | $V_{DD}=400V$ , $I_D=12.5A$ , $V_{GS}=0$ to $10V$ |
| Gate to drain charge  | $Q_{gd}$      | -      | 17   | -    | nC   | $V_{DD}=400V$ , $I_D=12.5A$ , $V_{GS}=0$ to $10V$ |
| Gate charge total     | $Q_g$         | -      | 53   | -    | nC   | $V_{DD}=400V$ , $I_D=12.5A$ , $V_{GS}=0$ to $10V$ |
| Gate plateau voltage  | $V_{plateau}$ | -      | 5.7  | -    | V    | $V_{DD}=400V$ , $I_D=12.5A$ , $V_{GS}=0$ to $10V$ |

<sup>1)</sup> Maximum specification is defined by calculated six sigma upper confidence bound

<sup>2)</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 400V

<sup>3)</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 400V

**Table 7 Reverse diode characteristics**

| Parameter                     | Symbol    | Values |      |       | Unit    | Note / Test Condition                                         |
|-------------------------------|-----------|--------|------|-------|---------|---------------------------------------------------------------|
|                               |           | Min.   | Typ. | Max.  |         |                                                               |
| Diode forward voltage         | $V_{SD}$  | -      | 1.0  | -     | V       | $V_{GS}=0V$ , $I_F=12.5A$ , $T_J=25^{\circ}C$                 |
| Reverse recovery time         | $t_{rr}$  | -      | 147  | 220.5 | ns      | $V_R=400V$ , $I_F=12.5A$ , $di_F/dt=100A/\mu s$ ; see table 8 |
| Reverse recovery charge       | $Q_{rr}$  | -      | 0.78 | 1.56  | $\mu C$ | $V_R=400V$ , $I_F=12.5A$ , $di_F/dt=100A/\mu s$ ; see table 8 |
| Peak reverse recovery current | $I_{rrm}$ | -      | 9.8  | -     | A       | $V_R=400V$ , $I_F=12.5A$ , $di_F/dt=100A/\mu s$ ; see table 8 |

## 4 Electrical characteristics diagrams

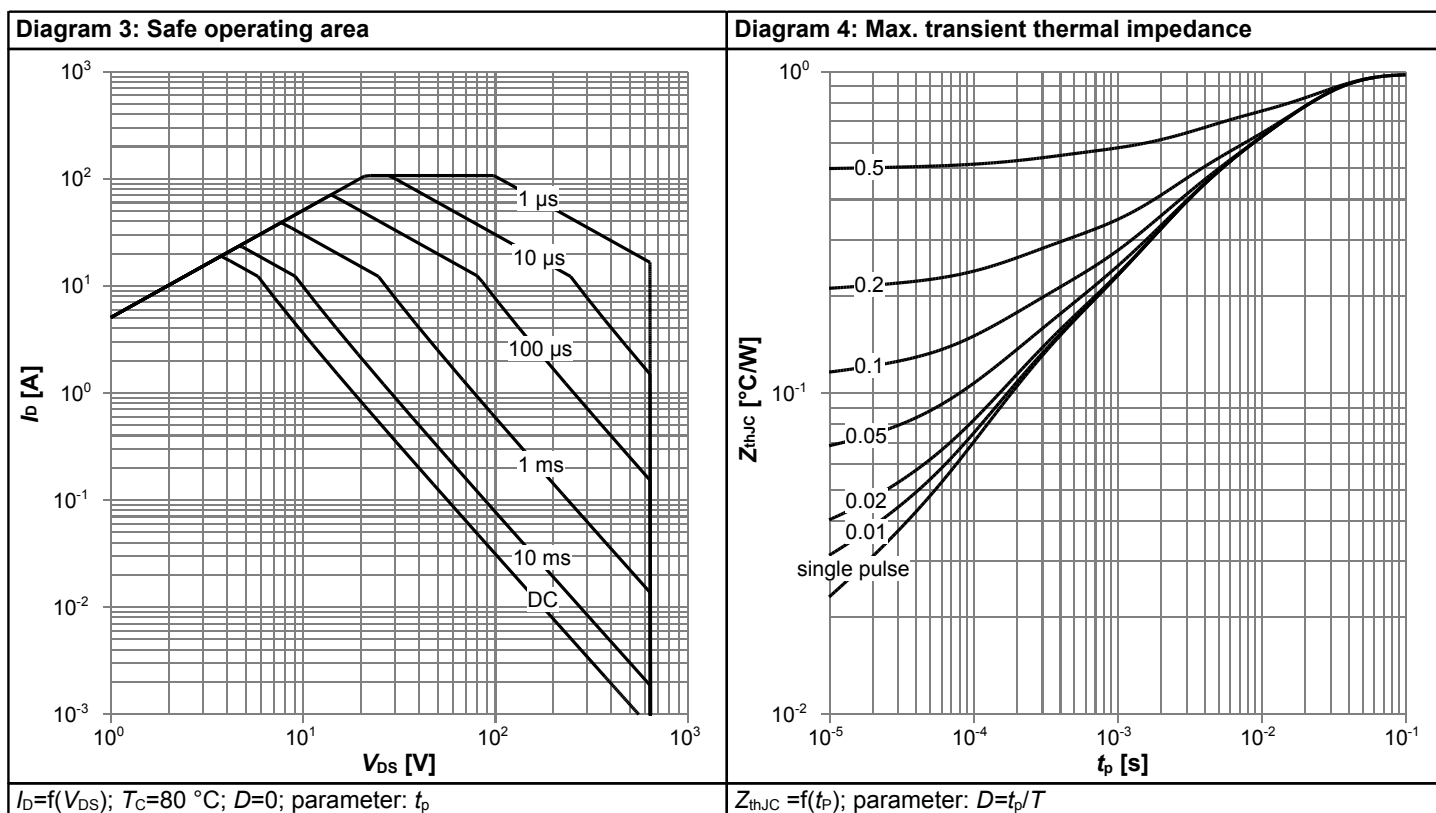
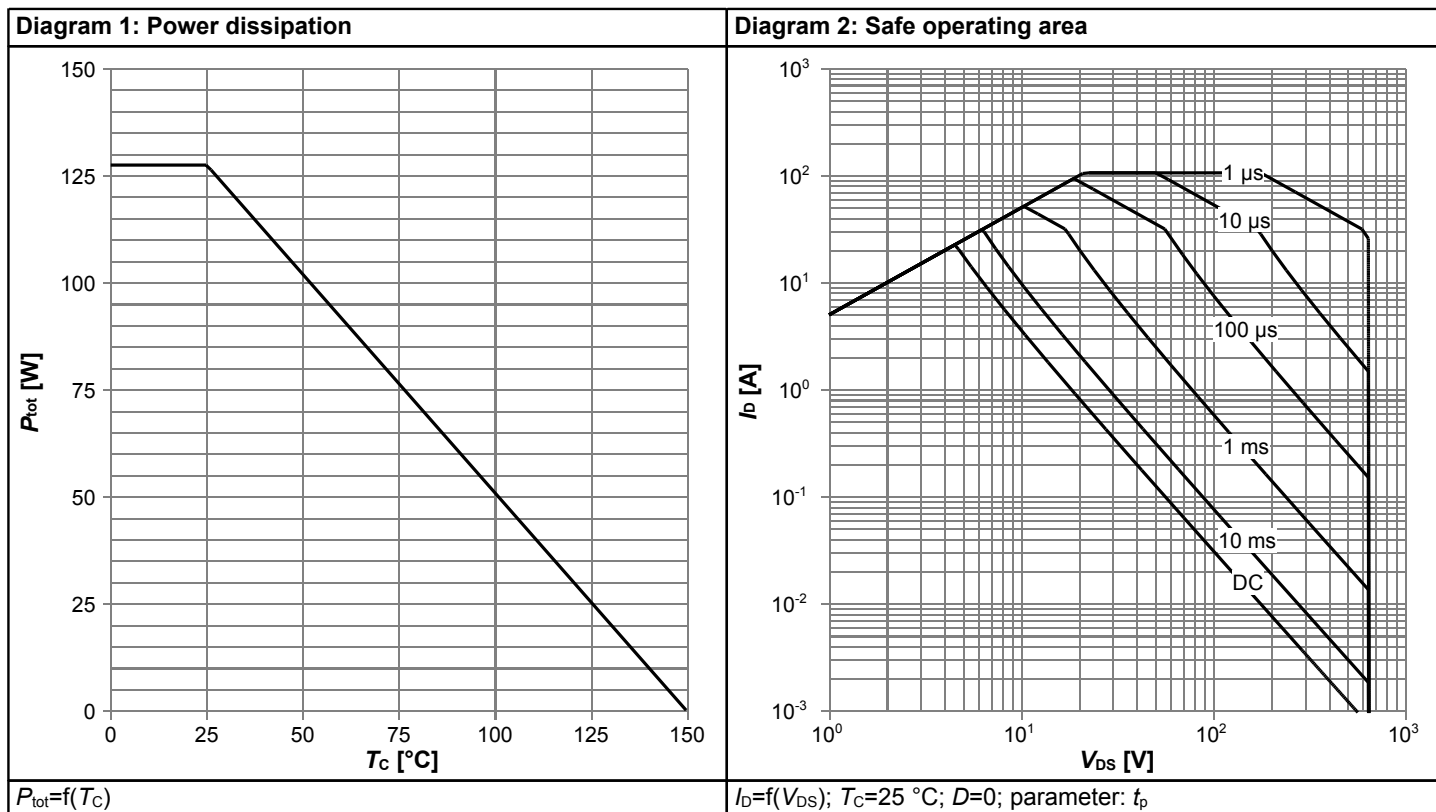
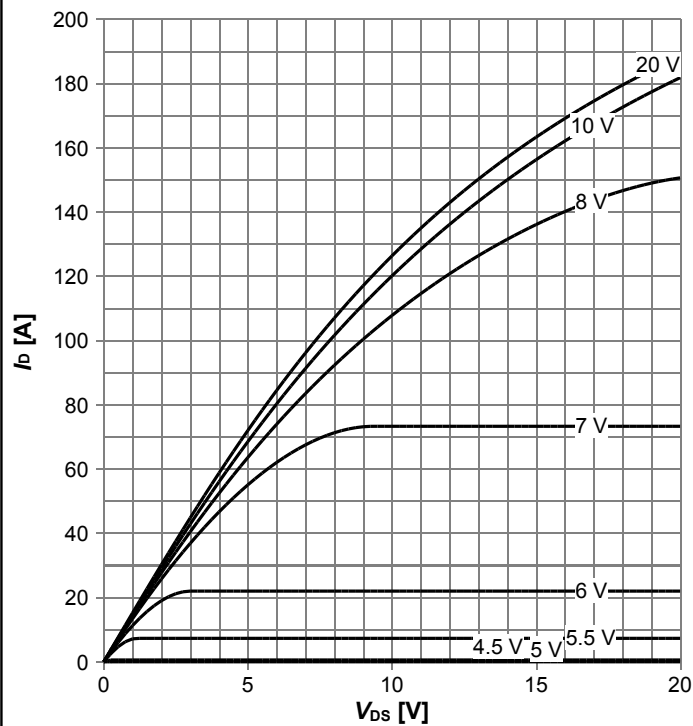
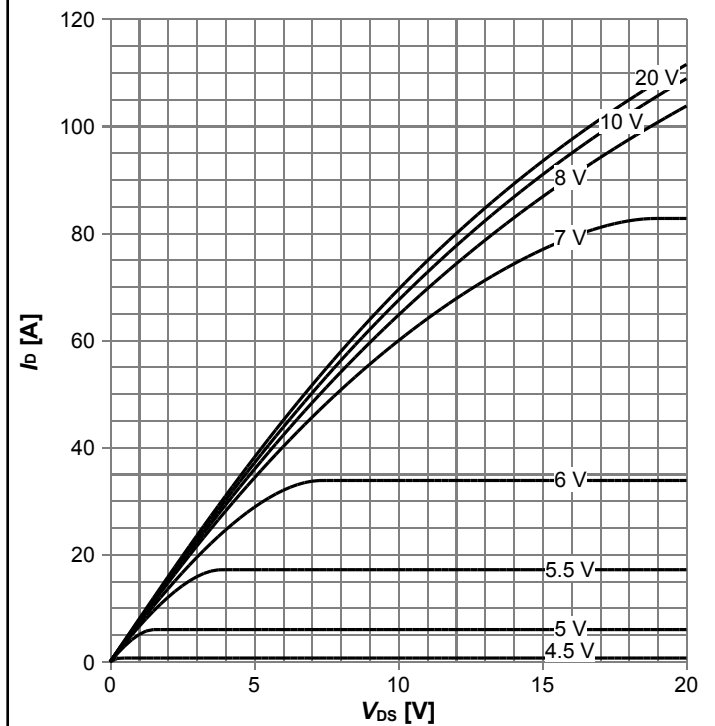


Diagram 5: Typ. output characteristics



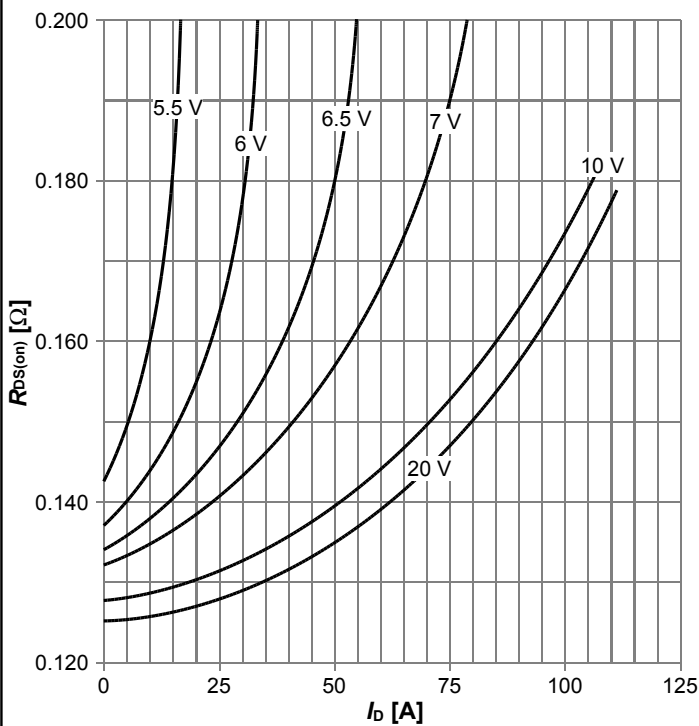
$I_D = f(V_{DS})$ ;  $T_J = 25\text{ °C}$ ; parameter:  $V_{GS}$

Diagram 6: Typ. output characteristics



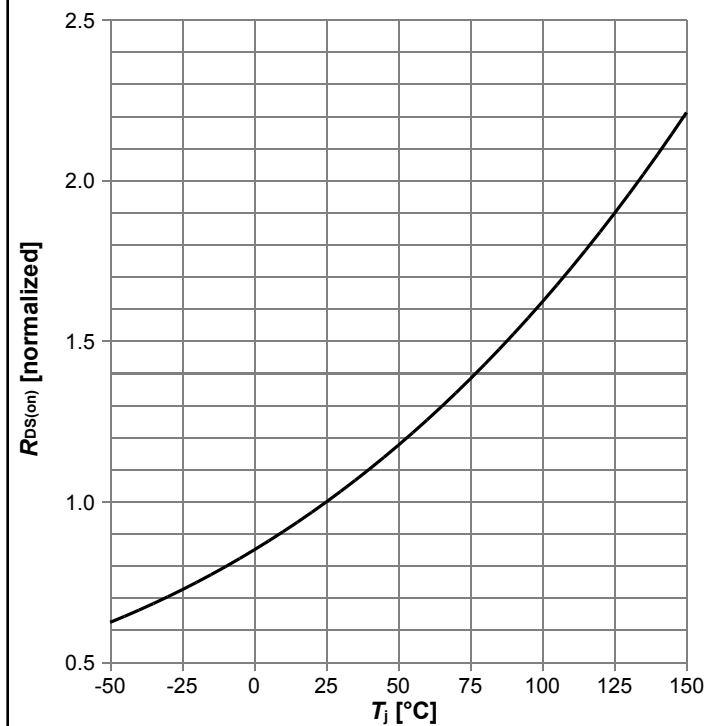
$I_D = f(V_{DS})$ ;  $T_J = 125\text{ °C}$ ; parameter:  $V_{GS}$

Diagram 7: Typ. drain-source on-state resistance



$R_{DS(on)} = f(I_D)$ ;  $T_J = 125\text{ °C}$ ; parameter:  $V_{GS}$

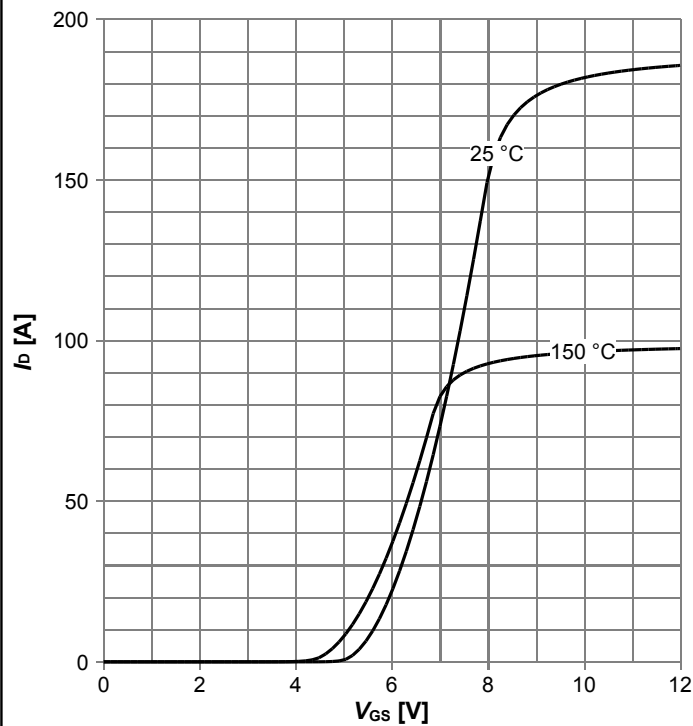
Diagram 8: Drain-source on-state resistance



$R_{DS(on)} = f(T_J)$ ;  $I_D = 12.5\text{ A}$ ;  $V_{GS} = 10\text{ V}$

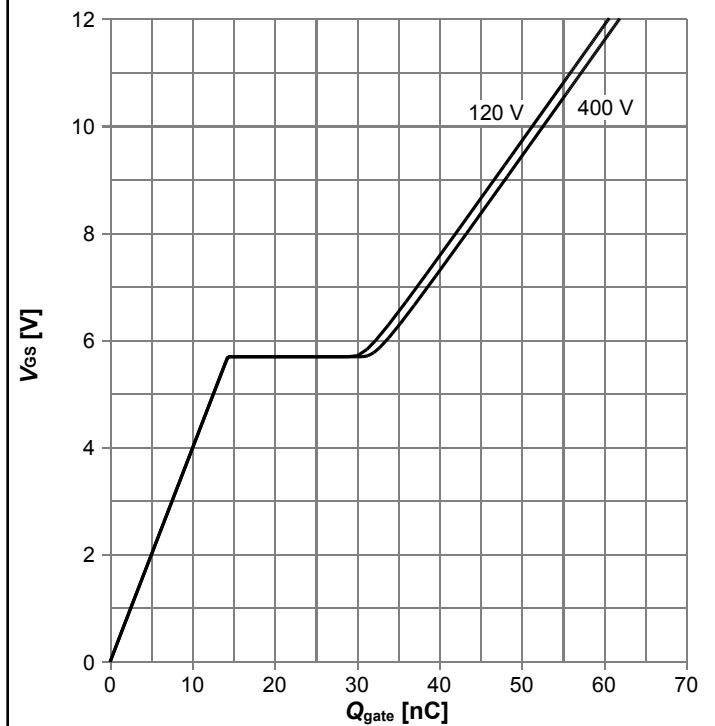


**Diagram 9: Typ. transfer characteristics**



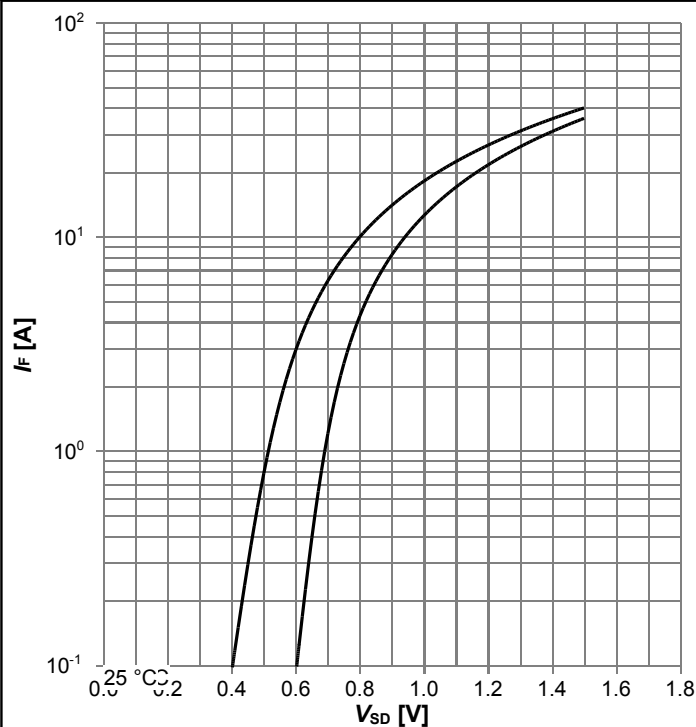
$I_D=f(V_{GS})$ ;  $V_{DS}=20V$ ; parameter:  $T_j$

**Diagram 10: Typ. gate charge**



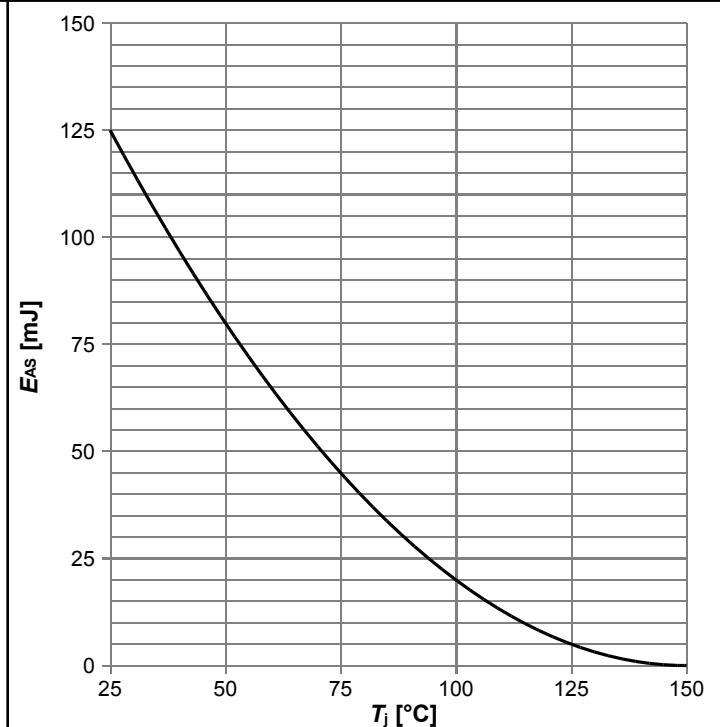
$V_{GS}=f(Q_{gate})$ ;  $I_D=12.5\text{ A}$  pulsed; parameter:  $V_{DD}$

**Diagram 11: Forward characteristics of reverse diode**



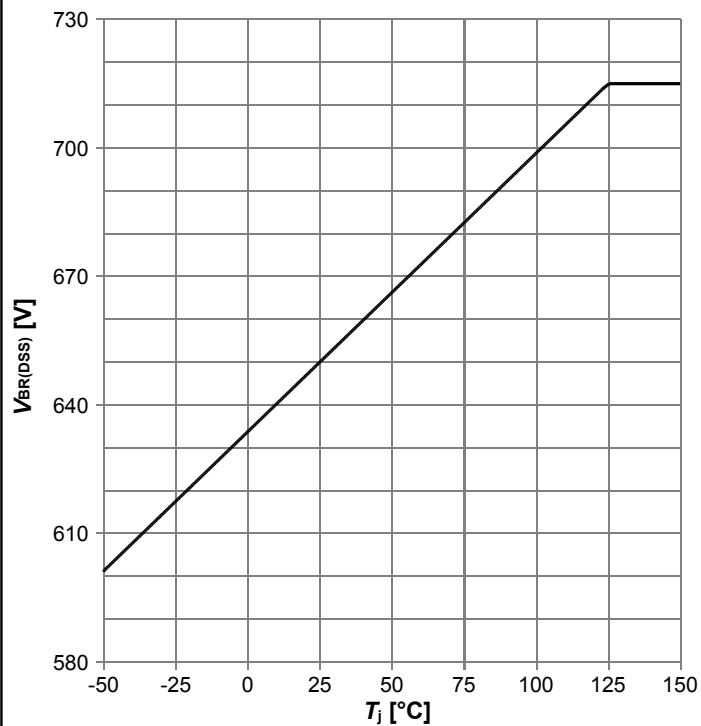
$I_F=f(V_{SD})$ ; parameter:  $T_j$

**Diagram 12: Avalanche energy**



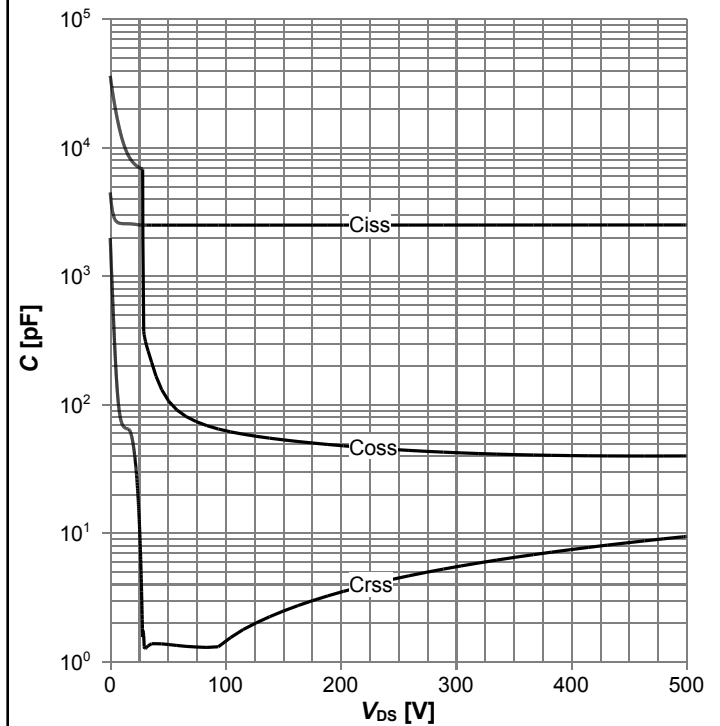
$E_{AS}=f(T_j)$ ;  $I_D=5.0\text{ A}$ ;  $V_{DD}=50\text{ V}$

**Diagram 13: Drain-source breakdown voltage**



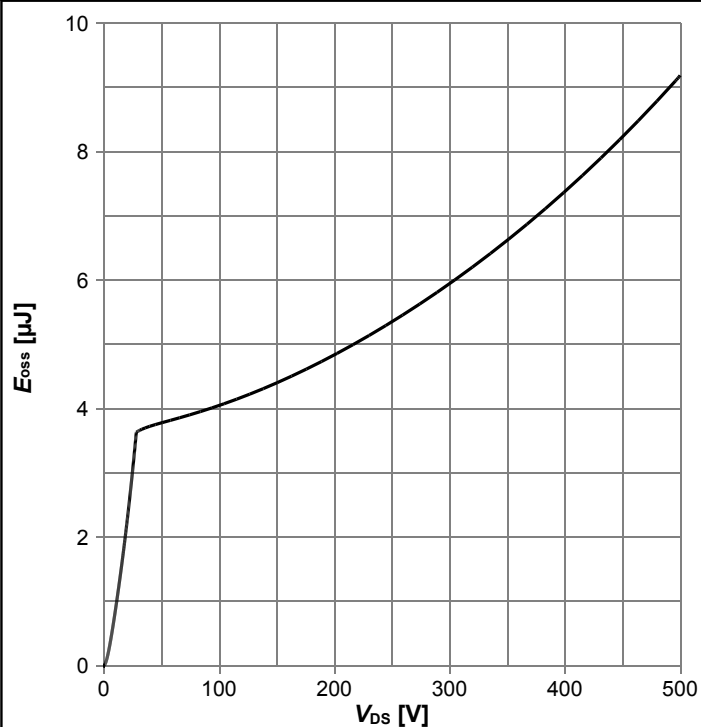
$V_{BR(DSS)} = f(T_J); I_D = 1 \text{ mA}$

**Diagram 14: Typ. capacitances**



$C = f(V_{DS}); V_{GS} = 0 \text{ V}; f = 250 \text{ kHz}$

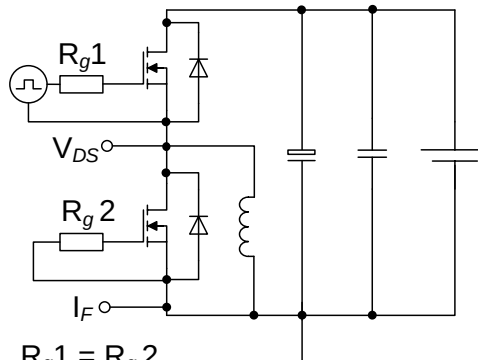
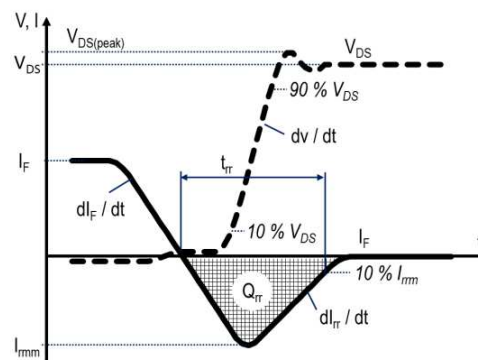
**Diagram 15: Typ. Coss stored energy**



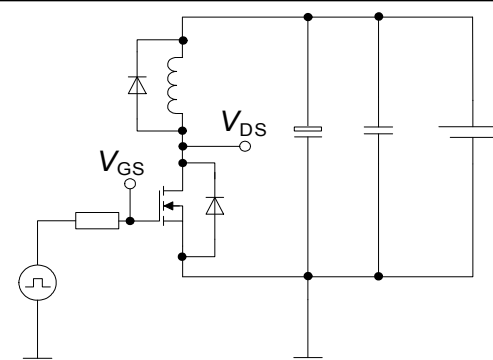
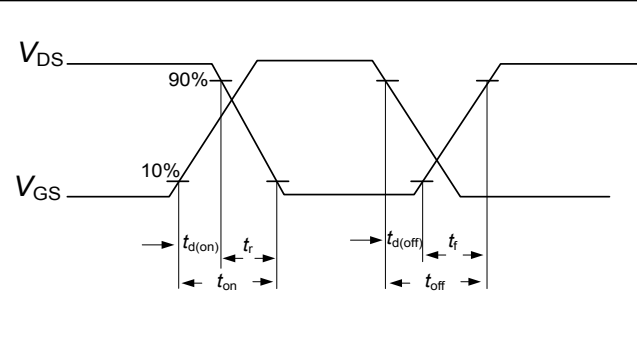
$E_{oss} = f(V_{DS})$

# 5 Test Circuits

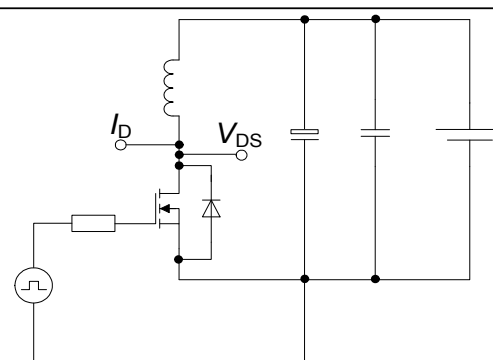
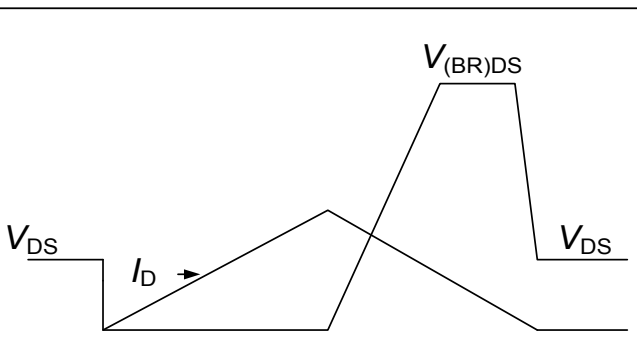
**Table 8 Diode characteristics**

| Test circuit for diode characteristics                                                                                | Diode recovery waveform                                                            |
|-----------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------|
|  <p><math>R_{g1} = R_{g2}</math></p> |  |

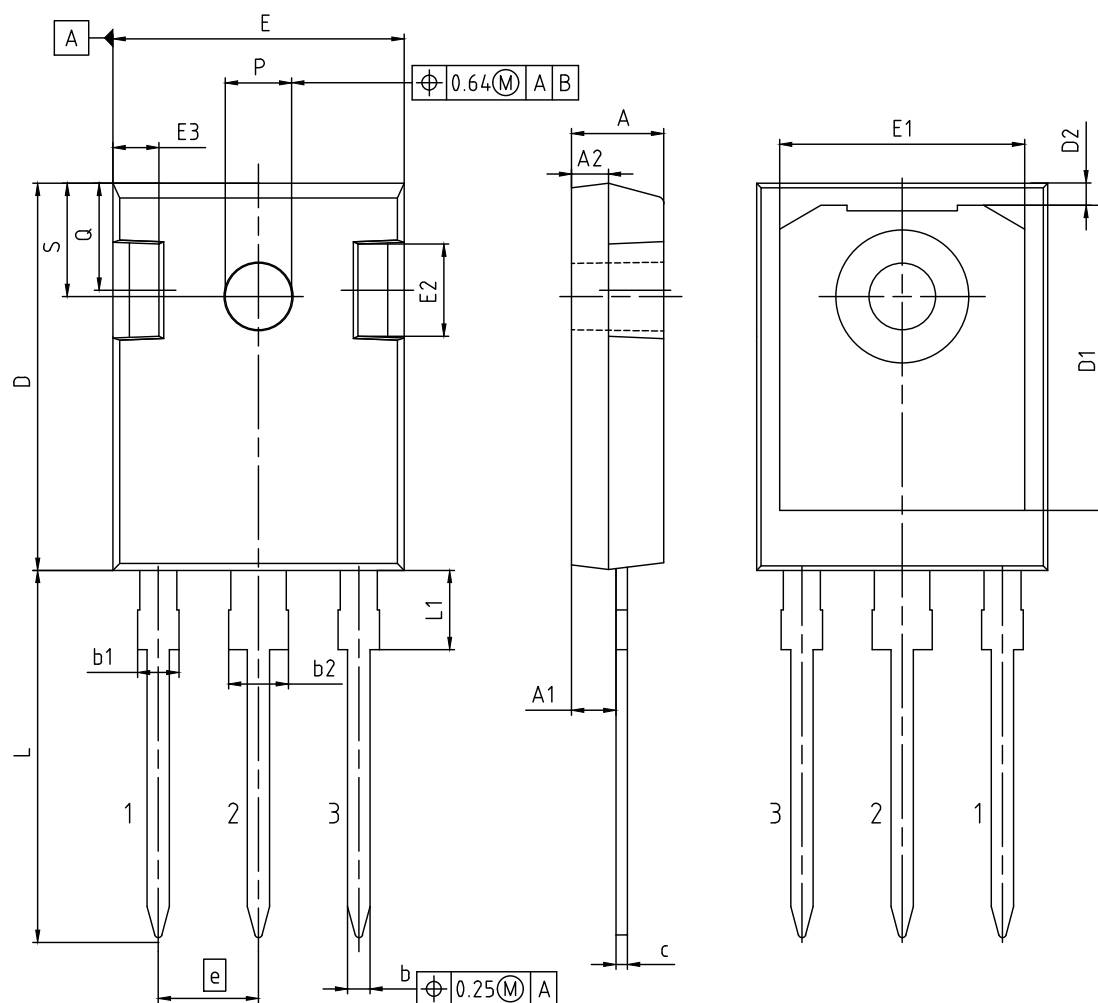
**Table 9 Switching times**

| Switching times test circuit for inductive load                                    | Switching times waveform                                                            |
|------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
|  |  |

**Table 10 Unclamped inductive load**

| Unclamped inductive load test circuit                                               | Unclamped inductive waveform                                                         |
|-------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|
|  |  |

## 6 Package Outlines



| DIMENSIONS | MILLIMETERS |       |
|------------|-------------|-------|
|            | MIN.        | MAX.  |
| A          | 4.70        | 5.30  |
| A1         | 2.20        | 2.60  |
| A2         | 1.50        | 2.50  |
| b          | 1.00        | 1.40  |
| b1         | 1.60        | 2.41  |
| b2         | 2.57        | 3.43  |
| c          | 0.38        | 0.89  |
| D          | 20.70       | 21.50 |
| D1         | 13.08       | 17.65 |
| D2         | 0.51        | 1.35  |
| E          | 15.50       | 16.30 |
| E1         | 12.38       | 14.15 |
| E2         | 3.40        | 5.10  |
| E3         | 1.00        | 2.60  |
| e          | 5.44        |       |
| L          | 19.80       | 20.40 |
| L1         | 3.85        | 4.50  |
| P          | 3.50        | 3.70  |
| Q          | 5.35        | 6.25  |
| S          | 6.04        | 6.30  |

|                                       |
|---------------------------------------|
| <b>DOCUMENT NO.</b><br>Z8B00003327    |
| <b>REVISION</b><br>06                 |
| <b>SCALE 3:1</b><br>0 1 2 3 4 5mm<br> |
| <b>EUROPEAN PROJECTION</b><br>        |
| <b>ISSUE DATE</b><br>25.07.2018       |

Figure 1 Outline PG-TO247-3, dimensions in mm

## **7 Appendix A**

### **Table 11 Related Links**

- **IFX CoolMOS CFD7 650V Webpage:** [www.infineon.com](http://www.infineon.com)
- **IFX CoolMOS CFD7 650V application note:** [www.infineon.com](http://www.infineon.com)
- **IFX CoolMOS CFD7 650V simulation model:** [www.infineon.com](http://www.infineon.com)
- **IFX Design tools:** [www.infineon.com](http://www.infineon.com)

## Revision History

IPW65R090CFD7

**Revision: 2020-10-28, Rev. 2.0**

Previous Revision

| Revision | Date       | Subjects (major changes since last revision) |
|----------|------------|----------------------------------------------|
| 2.0      | 2020-10-28 | Release of final version                     |

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