

# MOSFET

Metal Oxide Semiconductor Field Effect Transistor

## CoolMOS™ C7

650V CoolMOS™ C7 Power Transistor  
IPZ65R019C7

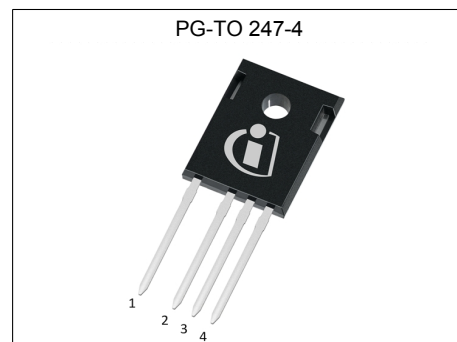
## Data Sheet

Rev. 2.0  
Final

## 1 Description

CoolMOS™ is a revolutionary technology for high voltage power MOSFETs, designed according to the superjunction (SJ) principle and pioneered by Infineon Technologies.

CoolMOS™ C7 series combines the experience of the leading SJ MOSFET supplier with high class innovation. The product portfolio provides all benefits of fast switching superjunction MOSFETs offering better efficiency, reduced gate charge, easy implementation and outstanding reliability.



## Features

- Increased MOSFET dv/dt ruggedness
- Better efficiency due to best in class FOM  $R_{DS(on)} \cdot E_{oss}$  and  $R_{DS(on)} \cdot Q_g$
- Best in class  $R_{DS(on)}$  /package
- Easy to use/drive due to **driver source pin** for better control of the gate.
- Pb-free plating, halogen free mold compound
- Qualified for industrial grade applications according to JEDEC (J-STD20 and JESD22)

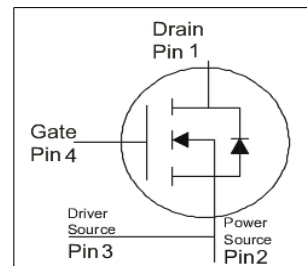
## Benefits

- Enabling higher system efficiency
- Enabling higher frequency / increased power density solutions
- System cost / size savings due to reduced cooling requirements
- Higher system reliability due to lower operating temperatures

## Applications

PFC stages and hard switching PWM stages for e.g. Computing, Server, Telecom, UPS and Solar.

*Please note: The source and sense source pins are not exchangeable. Their exchange might lead to malfunction.*



**Table 1 Key Performance Parameters**

| Parameter            | Value | Unit |
|----------------------|-------|------|
| $V_{DS} @ T_{j,max}$ | 700   | V    |
| $R_{DS(on),max}$     | 19    | mΩ   |
| $Q_{g,typ}$          | 215   | nC   |
| $I_{D,pulse}$        | 496   | A    |
| $E_{oss}@400V$       | 27    | μJ   |
| Body diode di/dt     | 70    | A/μs |

| Type / Ordering Code | Package     | Marking | Related Links  |
|----------------------|-------------|---------|----------------|
| IPZ65R019C7          | PG-TO 247-4 | 65C7019 | see Appendix A |

## Table of Contents

|                                           |    |
|-------------------------------------------|----|
| Description .....                         | 2  |
| Maximum ratings .....                     | 4  |
| Thermal characteristics .....             | 5  |
| Electrical characteristics .....          | 6  |
| Electrical characteristics diagrams ..... | 8  |
| Test Circuits .....                       | 12 |
| Package Outlines .....                    | 13 |
| Appendix A .....                          | 14 |
| Revision History .....                    | 15 |
| Disclaimer .....                          | 15 |

## 2 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> | $I_D$         | -      | -    | 75<br>62 | A                | $T_C=25^\circ\text{C}$<br>$T_C=100^\circ\text{C}$                      |
| Pulsed drain current <sup>2)</sup>     | $I_{D,pulse}$ | -      | -    | 496      | A                | $T_C=25^\circ\text{C}$                                                 |
| Avalanche energy, single pulse         | $E_{AS}$      | -      | -    | 583      | mJ               | $I_D=12.4\text{A}$ ; $V_{DD}=50\text{V}$                               |
| Avalanche energy, repetitive           | $E_{AR}$      | -      | -    | 2.92     | mJ               | $I_D=12.4\text{A}$ ; $V_{DD}=50\text{V}$                               |
| Avalanche current, single pulse        | $I_{AS}$      | -      | -    | 12.4     | A                | -                                                                      |
| MOSFET dv/dt ruggedness                | dv/dt         | -      | -    | 100      | 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                      | $P_{tot}$     | -      | -    | 446      | 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       | $I_S$         | -      | -    | 75       | A                | $T_C=25^\circ\text{C}$                                                 |
| Diode pulse current <sup>2)</sup>      | $I_{S,pulse}$ | -      | -    | 496      | A                | $T_C=25^\circ\text{C}$                                                 |
| Reverse diode dv/dt <sup>3)</sup>      | dv/dt         | -      | -    | 1.5      | V/ns             | $V_{DS}=0\dots400\text{V}$ , $I_{SD}\leq I_S$ , $T_j=25^\circ\text{C}$ |
| Maximum diode commutation speed        | di/dt         | -      | -    | 70       | A/ $\mu\text{s}$ | $V_{DS}=0\dots400\text{V}$ , $I_{SD}\leq I_S$ , $T_j=25^\circ\text{C}$ |
| 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  $R_G$ .

### 3 Thermal characteristics

**Table 3 Thermal characteristics**

| Parameter                                                  | Symbol     | Values |      |      | Unit | Note / Test Condition               |
|------------------------------------------------------------|------------|--------|------|------|------|-------------------------------------|
|                                                            |            | Min.   | Typ. | Max. |      |                                     |
| Thermal resistance, junction - case                        | $R_{thJC}$ | -      | -    | 0.28 | °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 |

## 4 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      | 3.5            | 4          | V        | $V_{DS}=V_{GS}$ , $I_D=2.92mA$                                                                              |
| Zero gate voltage drain current  | $I_{DSS}$     | -      | -              | 5          | $\mu A$  | $V_{DS}=650$ , $V_{GS}=0V$ , $T_j=25^\circ\text{C}$<br>$V_{DS}=650$ , $V_{GS}=0V$ , $T_j=150^\circ\text{C}$ |
| Gate-source leakage current      | $I_{GSS}$     | -      | -              | 100        | nA       | $V_{GS}=20V$ , $V_{DS}=0V$                                                                                  |
| Drain-source on-state resistance | $R_{DS(on)}$  | -      | 0.017<br>0.040 | 0.019<br>- | $\Omega$ | $V_{GS}=10V$ , $I_D=58.3A$ , $T_j=25^\circ\text{C}$<br>$V_{GS}=10V$ , $I_D=58.3A$ , $T_j=150^\circ\text{C}$ |
| Gate resistance                  | $R_G$         | -      | 0.45           | -          | $\Omega$ | $f=1MHz$ , open drain                                                                                       |

**Table 5 Dynamic characteristics**

| Parameter                                                  | Symbol       | Values |      |      | Unit | Note / Test Condition                                           |
|------------------------------------------------------------|--------------|--------|------|------|------|-----------------------------------------------------------------|
|                                                            |              | Min.   | Typ. | Max. |      |                                                                 |
| Input capacitance                                          | $C_{iss}$    | -      | 9900 | -    | pF   | $V_{GS}=0V$ , $V_{DS}=400V$ , $f=250kHz$                        |
| Output capacitance                                         | $C_{oss}$    | -      | 160  | -    | pF   | $V_{GS}=0V$ , $V_{DS}=400V$ , $f=250kHz$                        |
| Effective output capacitance, energy related <sup>1)</sup> | $C_{o(er)}$  | -      | 338  | -    | pF   | $V_{GS}=0V$ , $V_{DS}=0...400V$                                 |
| Effective output capacitance, time related <sup>2)</sup>   | $C_{o(tr)}$  | -      | 3320 | -    | pF   | $I_D=\text{constant}$ , $V_{GS}=0V$ , $V_{DS}=0...400V$         |
| Turn-on delay time                                         | $t_{d(on)}$  | -      | 30   | -    | ns   | $V_{DD}=400V$ , $V_{GS}=13V$ , $I_D=58.3A$ ,<br>$R_G=1.8\Omega$ |
| Rise time                                                  | $t_r$        | -      | 27   | -    | ns   | $V_{DD}=400V$ , $V_{GS}=13V$ , $I_D=58.3A$ ,<br>$R_G=1.8\Omega$ |
| Turn-off delay time                                        | $t_{d(off)}$ | -      | 106  | -    | ns   | $V_{DD}=400V$ , $V_{GS}=13V$ , $I_D=58.3A$ ,<br>$R_G=1.8\Omega$ |
| Fall time                                                  | $t_f$        | -      | 5    | -    | ns   | $V_{DD}=400V$ , $V_{GS}=13V$ , $I_D=58.3A$ ,<br>$R_G=1.8\Omega$ |

**Table 6 Gate charge characteristics**

| Parameter             | Symbol        | Values |      |      | Unit | Note / Test Condition                             |
|-----------------------|---------------|--------|------|------|------|---------------------------------------------------|
|                       |               | Min.   | Typ. | Max. |      |                                                   |
| Gate to source charge | $Q_{gs}$      | -      | 53   | -    | nC   | $V_{DD}=400V$ , $I_D=58.3A$ , $V_{GS}=0$ to $10V$ |
| Gate to drain charge  | $Q_{gd}$      | -      | 71   | -    | nC   | $V_{DD}=400V$ , $I_D=58.3A$ , $V_{GS}=0$ to $10V$ |
| Gate charge total     | $Q_g$         | -      | 215  | -    | nC   | $V_{DD}=400V$ , $I_D=58.3A$ , $V_{GS}=0$ to $10V$ |
| Gate plateau voltage  | $V_{plateau}$ | -      | 5.4  | -    | V    | $V_{DD}=400V$ , $I_D=58.3A$ , $V_{GS}=0$ to $10V$ |

<sup>1)</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>2)</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         | $V_{SD}$  | -      | 0.9  | -    | V       | $V_{GS}=0V$ , $I_F=58.3A$ , $T_j=25^{\circ}C$ |
| Reverse recovery time         | $t_{rr}$  | -      | 760  | -    | ns      | $V_R=400V$ , $I_F=75A$ , $di_F/dt=70A/\mu s$  |
| Reverse recovery charge       | $Q_{rr}$  | -      | 20   | -    | $\mu C$ | $V_R=400V$ , $I_F=75A$ , $di_F/dt=70A/\mu s$  |
| Peak reverse recovery current | $I_{rrm}$ | -      | 50   | -    | A       | $V_R=400V$ , $I_F=75A$ , $di_F/dt=70A/\mu s$  |

## 5 Electrical characteristics diagrams

Table 8

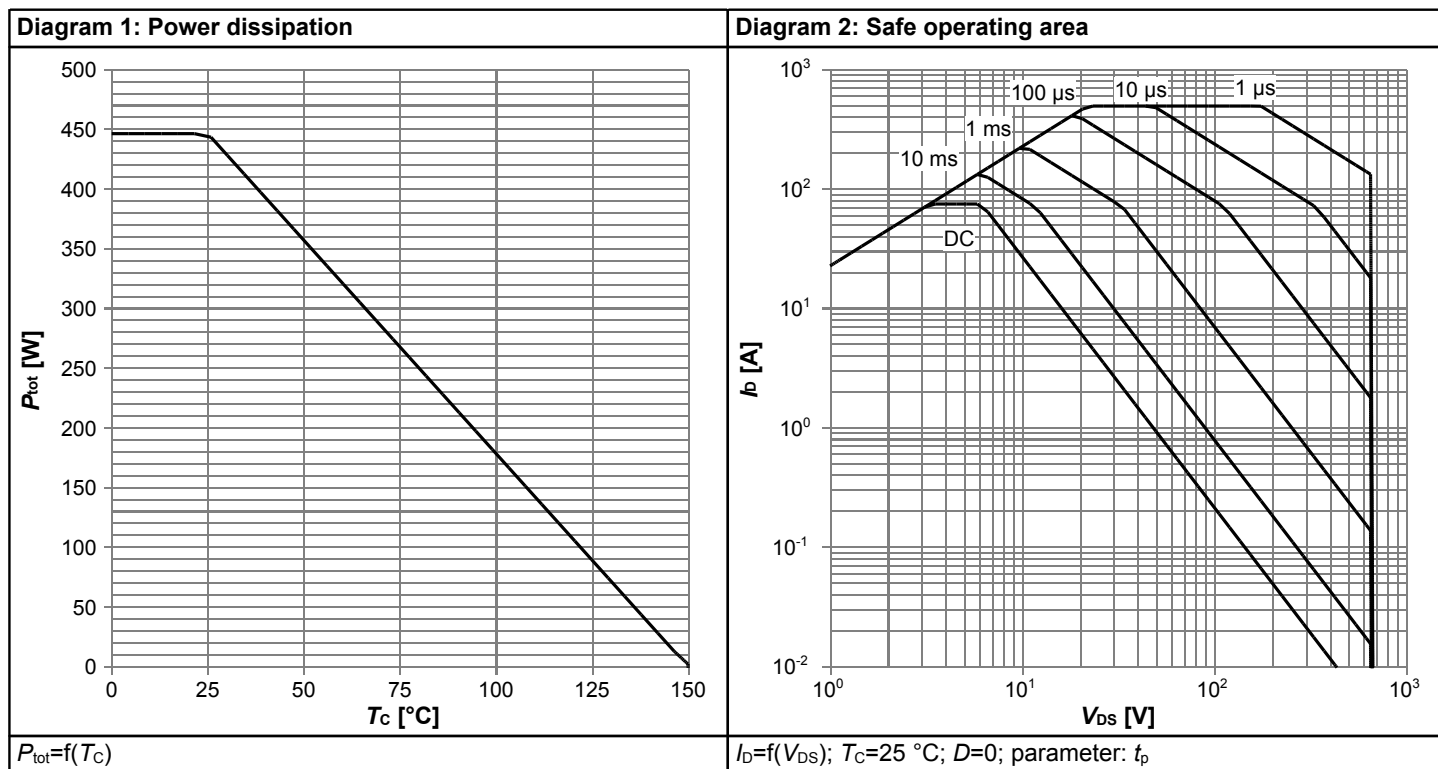


Table 9

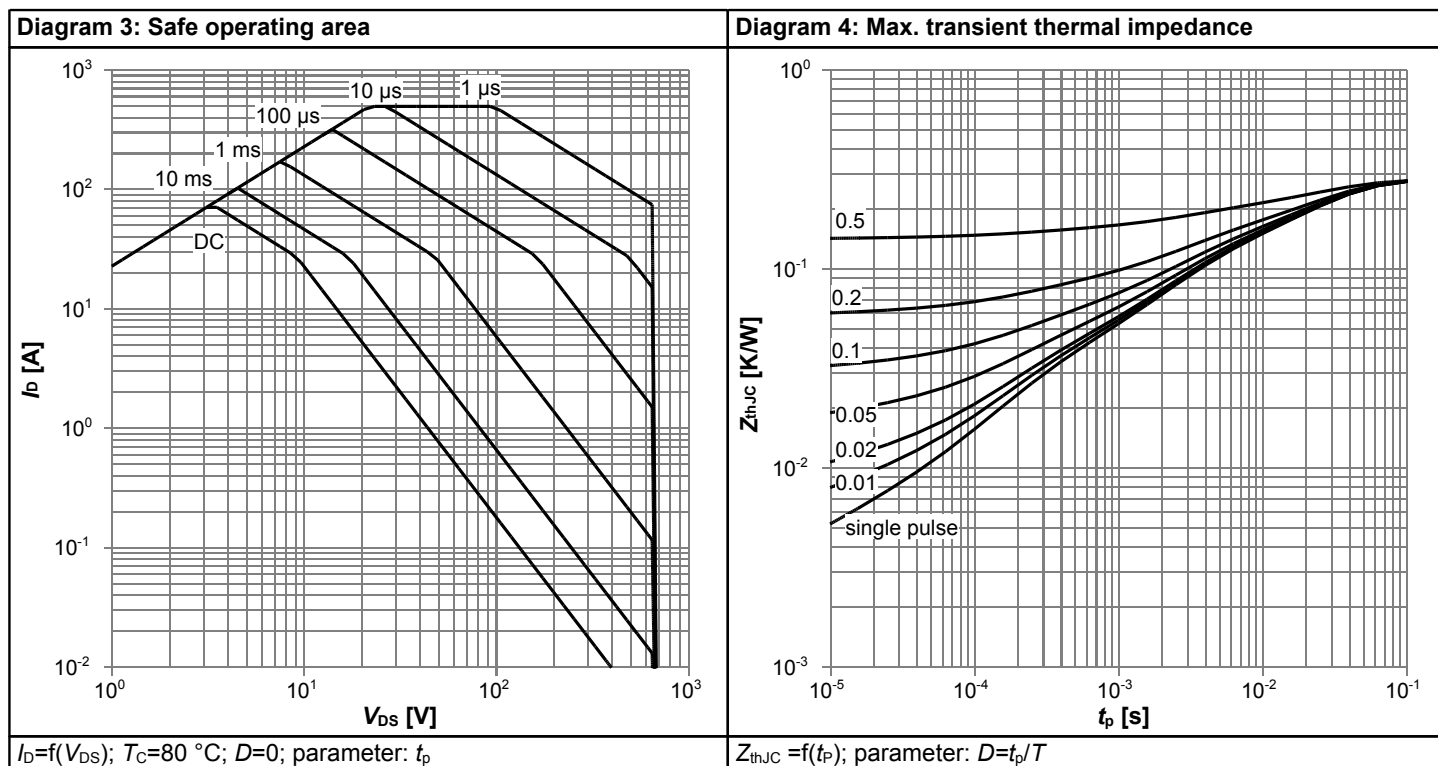


Table 10

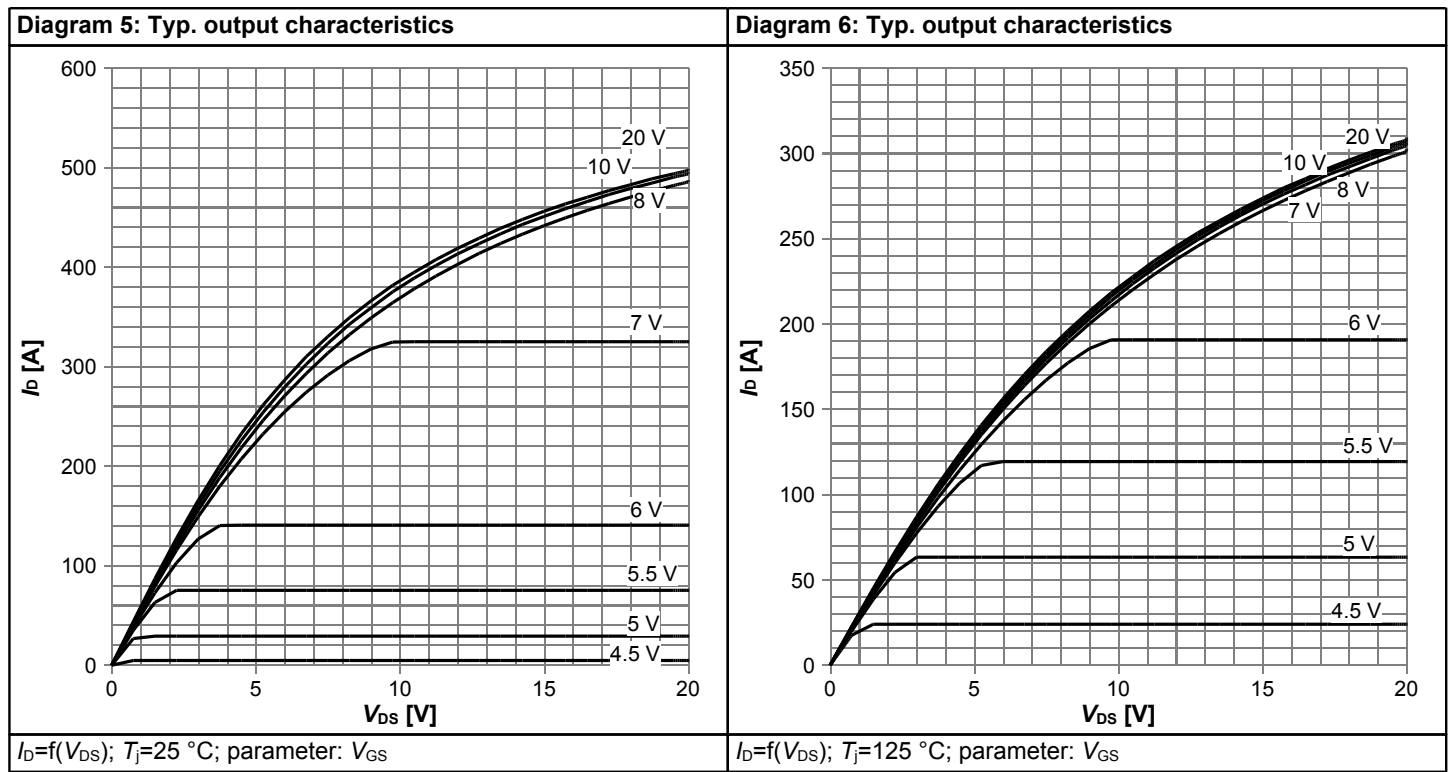


Table 11

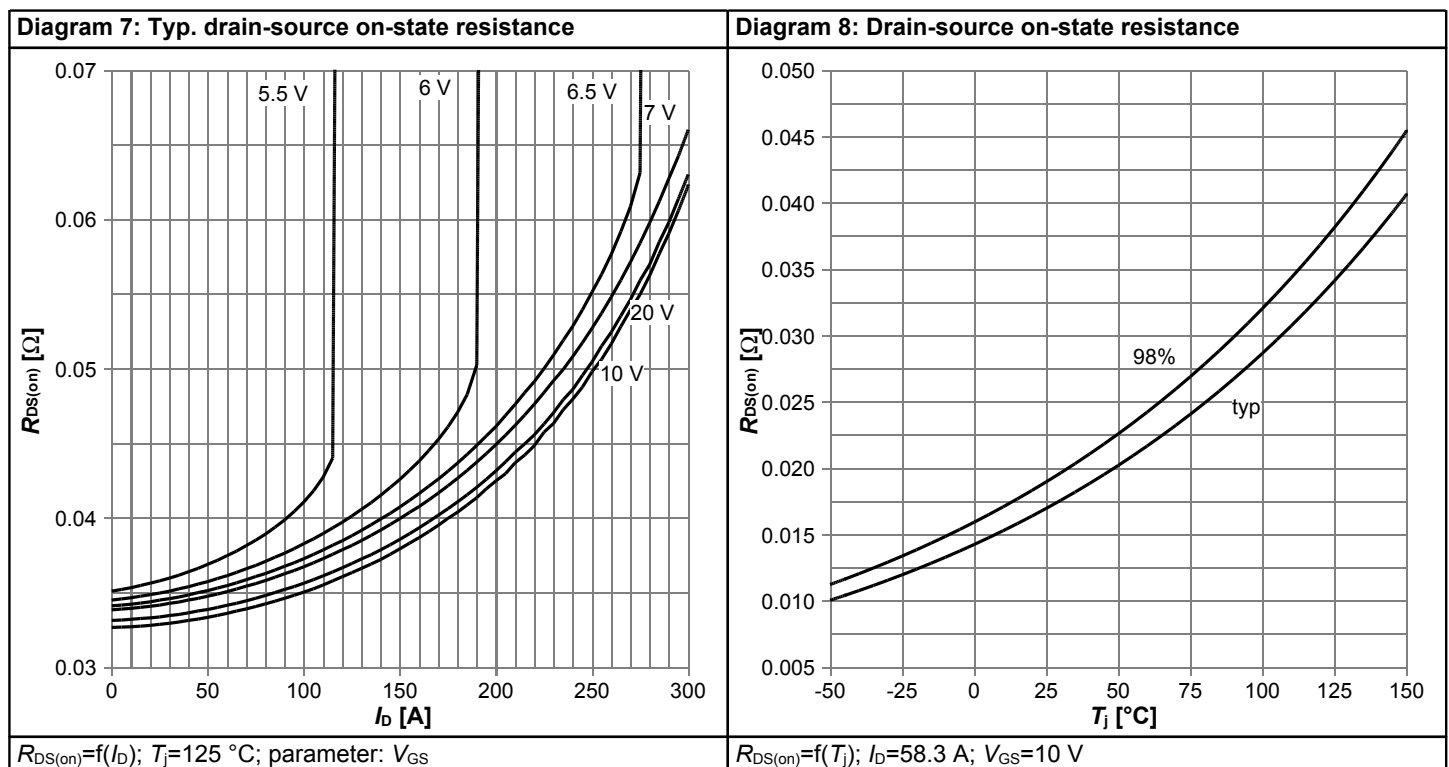


Table 12

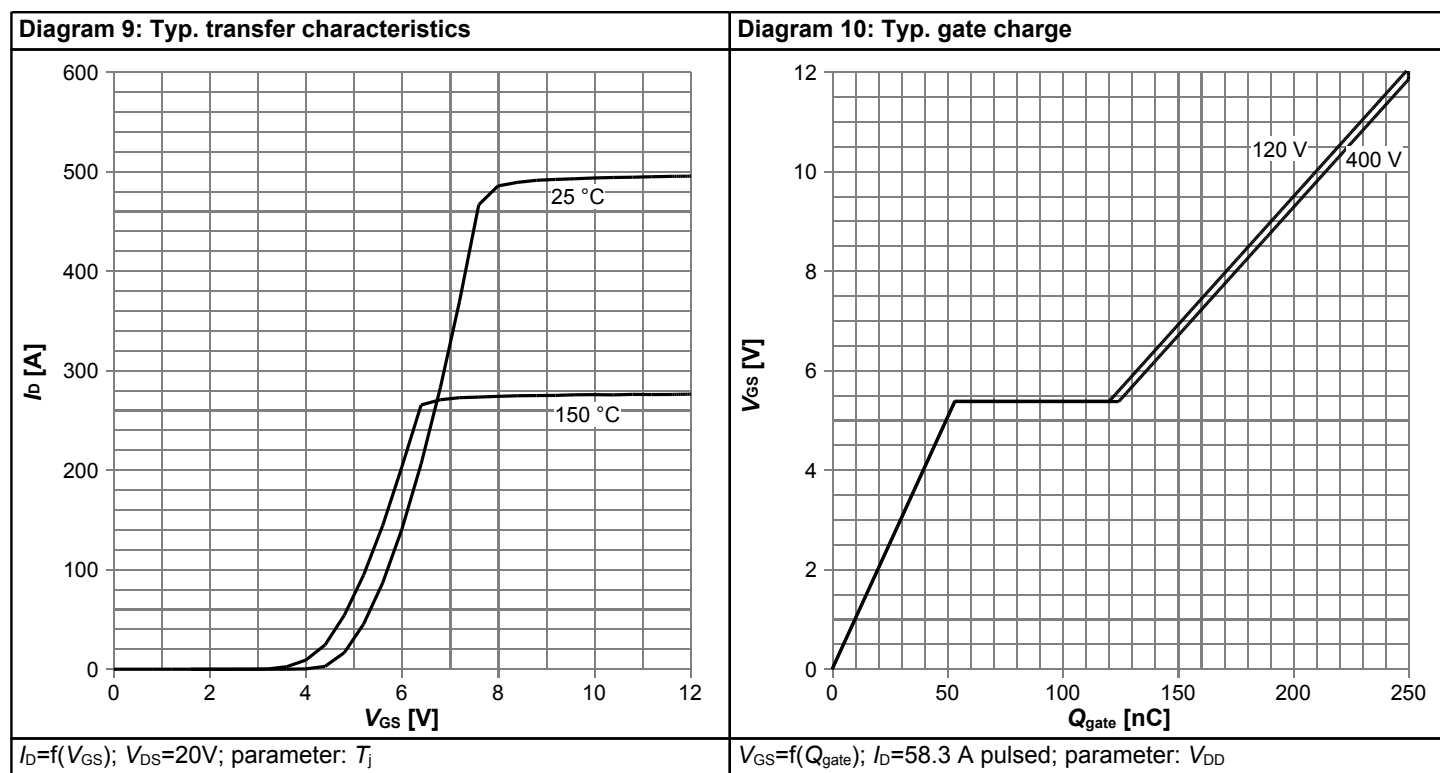


Table 13

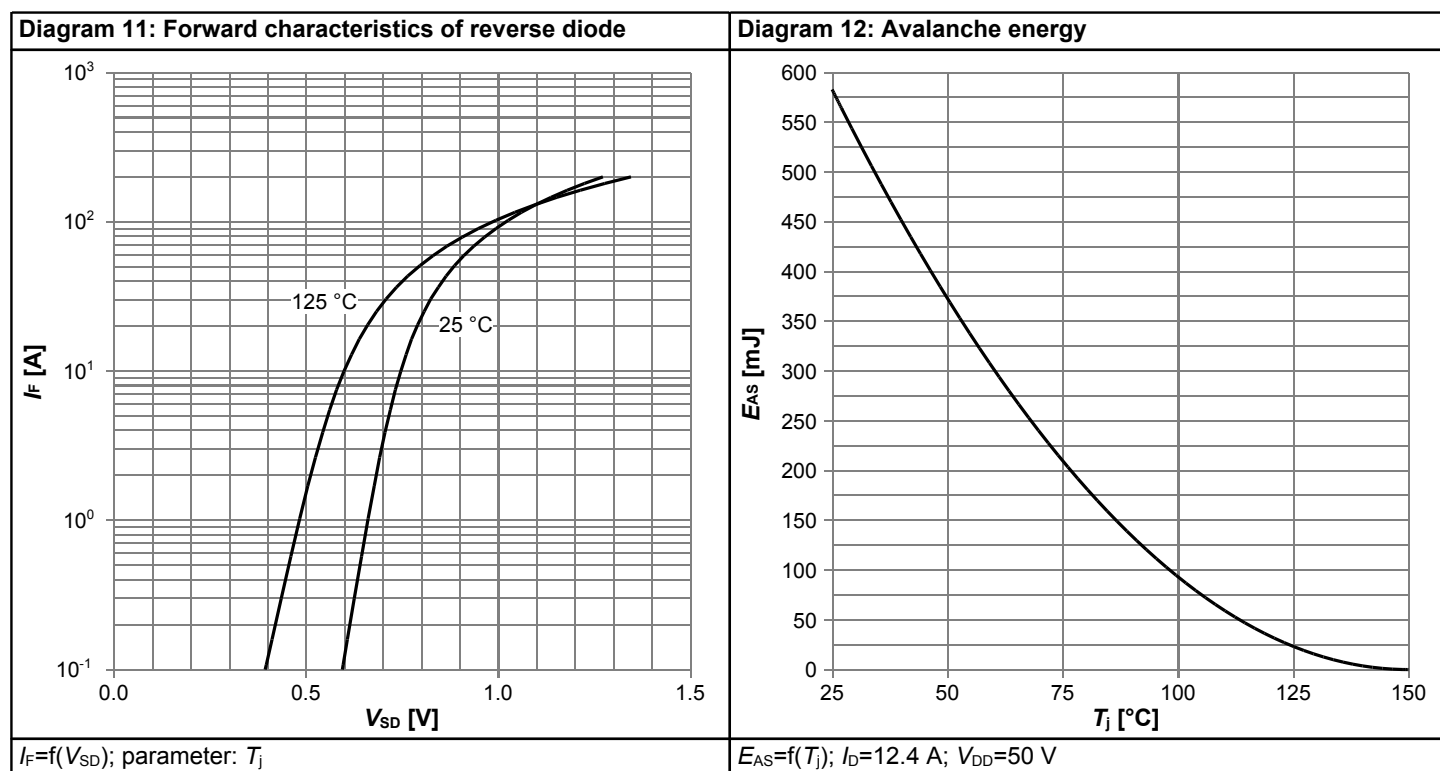


Table 14

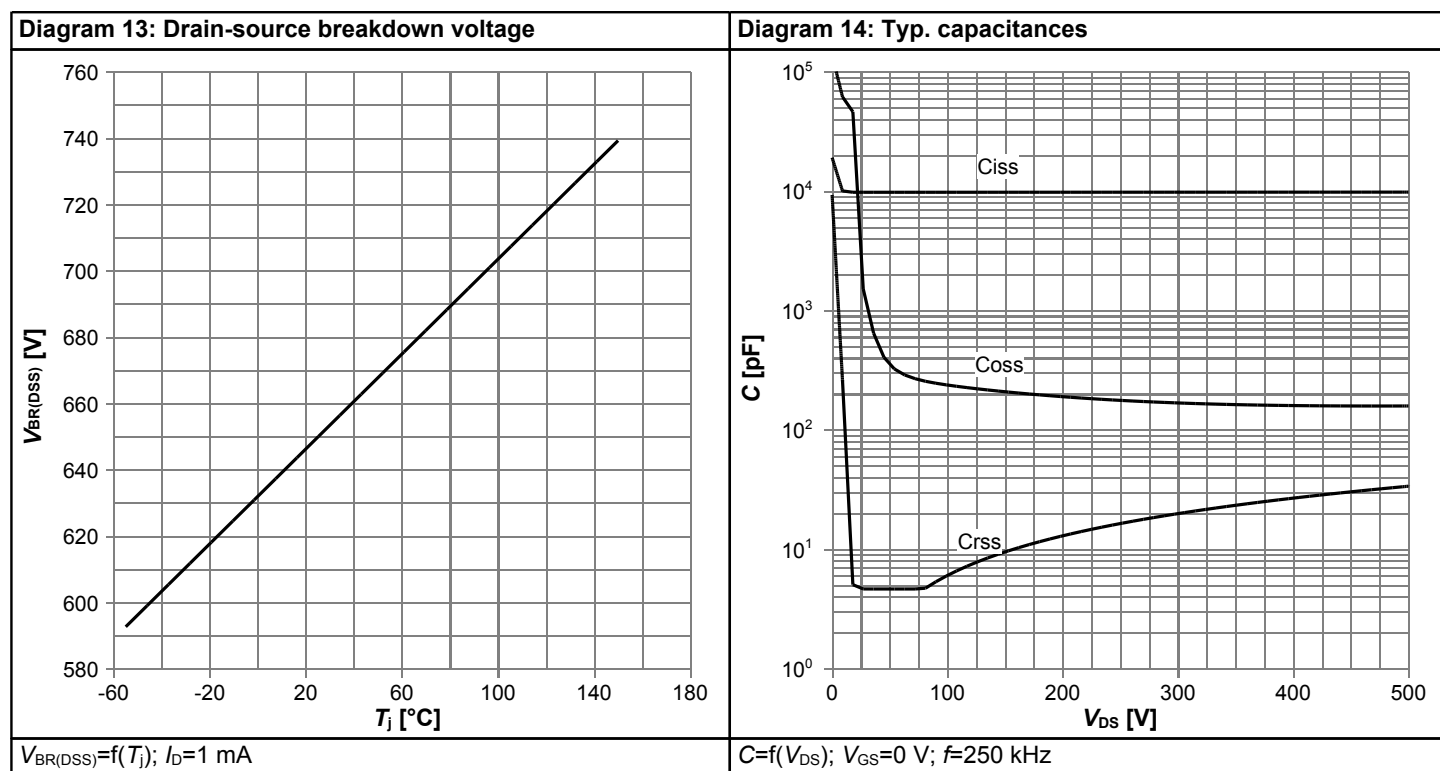
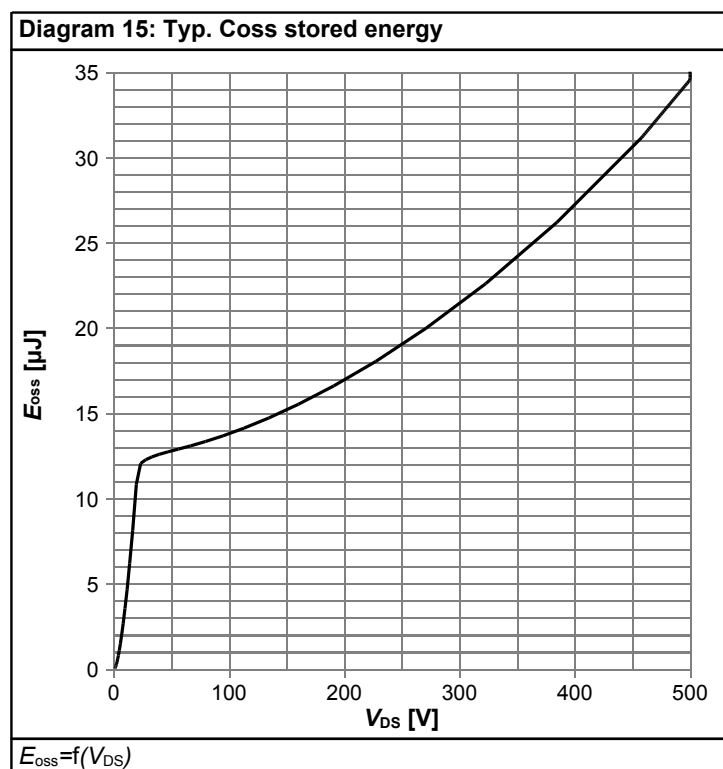
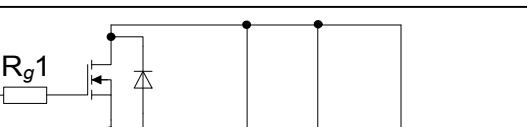
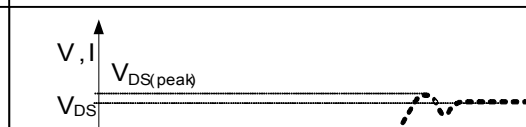


Table 15

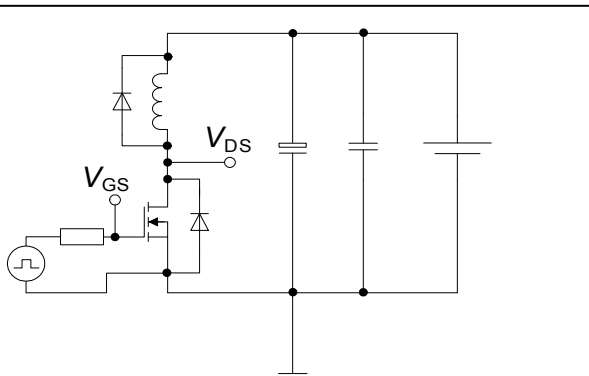
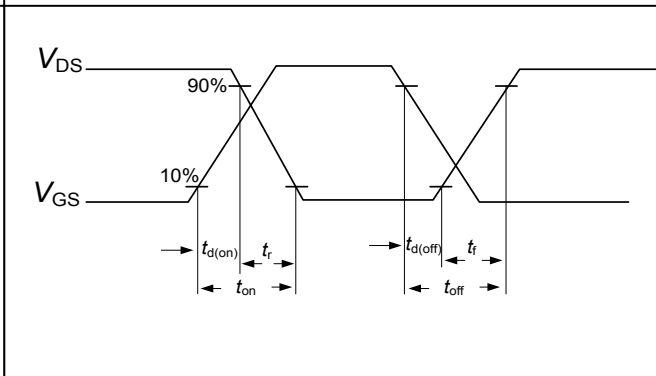


## 6 Test Circuits

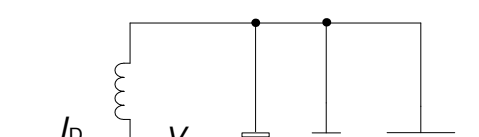
### Table 16 Diode characteristics

|                                                                                                                                                                     |                                                                                                                                                                                               |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>Test circuit for diode characteristics</p>  <p><math>R_{g1} = R_{g2}</math></p> | <p>Diode recovery waveform</p>  <p><math>t_{rr} = t_F + t_S</math><br/> <math>Q_{rr} = Q_F + Q_S</math></p> |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

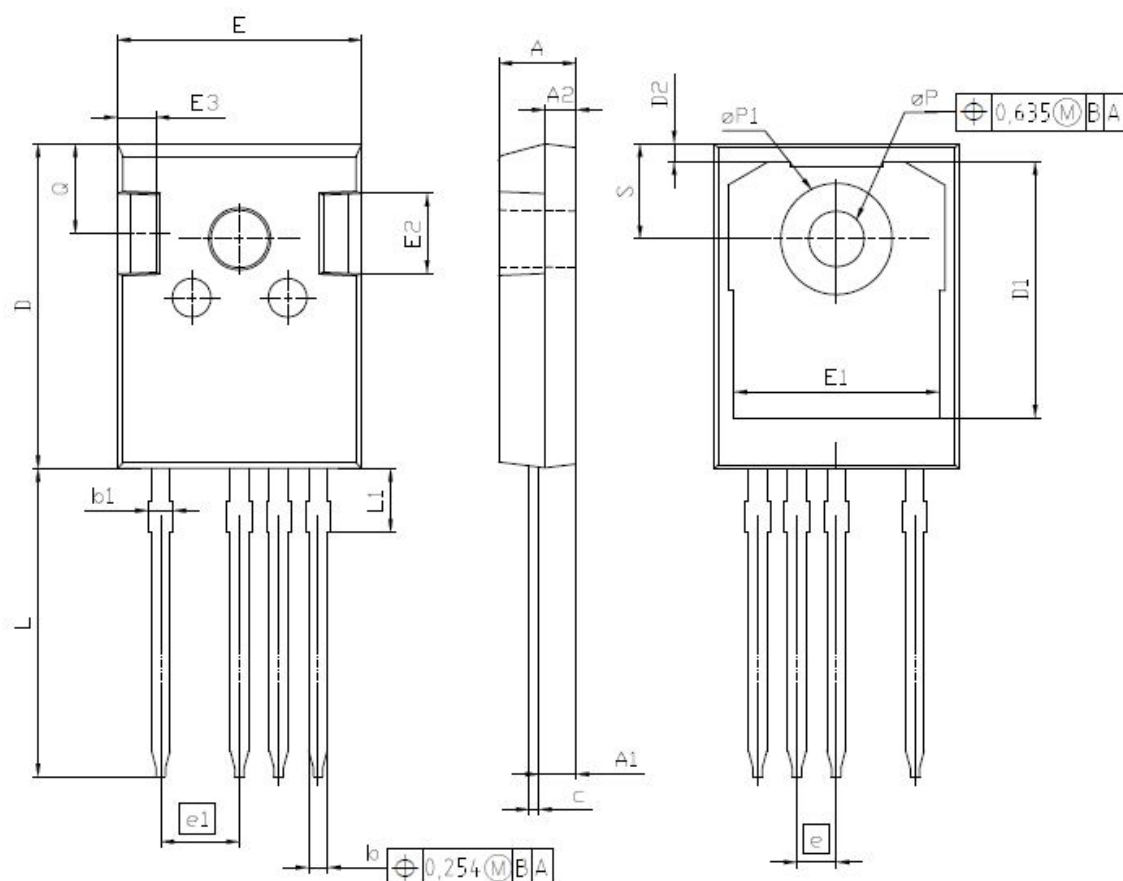
**Table 17    switching times (ss)**

| Switching times test circuit for inductive load                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Switching times waveform                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|  <p>The circuit diagram illustrates a MOSFET switching an inductive load. A pulse generator provides a gate voltage <math>V_{GS}</math> through a resistor. The MOSFET's drain is connected to a DC source <math>V_{DS}</math> and an inductive load (inductor and diode). The source is grounded. The inductor is in series with the MOSFET's drain, and a diode is in parallel with the load. The MOSFET's gate is driven by a pulse generator. The drain voltage <math>V_{DS}</math> and gate voltage <math>V_{GS}</math> are indicated for measurement.</p> |  <p>The timing diagram shows the switching waveforms for <math>V_{DS}</math> and <math>V_{GS}</math>. The gate voltage <math>V_{GS}</math> transitions from 10% to 90% and back. The drain voltage <math>V_{DS}</math> transitions from high to low and back. The switching times are defined as follows:</p> <ul style="list-style-type: none"> <li><math>t_{d(on)}</math>: Delay time from 10% <math>V_{GS}</math> to 90% <math>V_{DS}</math>.</li> <li><math>t_r</math>: Rise time from 90% <math>V_{DS}</math> to 10% <math>V_{DS}</math>.</li> <li><math>t_{on}</math>: Total on-time from 10% <math>V_{GS}</math> to 10% <math>V_{DS}</math>.</li> <li><math>t_{d(off)}</math>: Delay time from 90% <math>V_{GS}</math> to 90% <math>V_{DS}</math>.</li> <li><math>t_f</math>: Fall time from 90% <math>V_{DS}</math> to 10% <math>V_{DS}</math>.</li> <li><math>t_{off}</math>: Total off-time from 90% <math>V_{GS}</math> to 10% <math>V_{DS}</math>.</li> </ul> |

**Table 18    Unclamped inductive load (ss)**

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

## 7 Package Outlines



| DIM | MILLIMETERS |       | INCHES      |       |
|-----|-------------|-------|-------------|-------|
|     | MIN         | MAX   | MIN         | MAX   |
| A   | 4.83        | 5.21  | 0.190       | 0.205 |
| A1  | 2.29        | 2.54  | 0.090       | 0.100 |
| A2  | 1.90        | 2.16  | 0.075       | 0.085 |
| b   | 1.07        | 1.33  | 0.042       | 0.052 |
| b1  | 1.10        | 1.70  | 0.043       | 0.067 |
| c   | 0.50        | 0.70  | 0.020       | 0.028 |
| D   | 20.80       | 21.10 | 0.819       | 0.831 |
| D1  | 16.25       | 17.65 | 0.640       | 0.695 |
| D2  | 0.95        | 1.35  | 0.037       | 0.053 |
| E   | 15.70       | 16.13 | 0.618       | 0.635 |
| E1  | 13.10       | 14.15 | 0.516       | 0.557 |
| E2  | 3.68        | 5.10  | 0.145       | 0.201 |
| E3  | 1.00        | 2.60  | 0.039       | 0.102 |
| e   | 2.54 (BSC)  |       | 0.100 (BSC) |       |
| e1  | 5.08        |       | 0.200       |       |
| N   | 4           |       | 4           |       |
| L   | 19.72       | 20.32 | 0.776       | 0.800 |
| L1  | 4.02        | 4.40  | 0.158       | 0.173 |
| øP  | 3.50        | 3.70  | 0.138       | 0.146 |
| øP1 | 7.00        | 7.40  | 0.276       | 0.291 |
| Q   | 5.49        | 6.00  | 0.216       | 0.236 |
| S   | 6.04        | 6.30  | 0.238       | 0.248 |

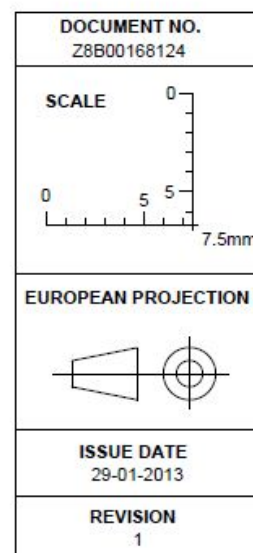


Figure 1 Outline PG-TO 247-4, dimensions in mm/inches

## 8 Appendix A

### Table 19 Related Links

- IFX CoolMOS™ C7 Webpage: [www.infineon.com](http://www.infineon.com)
- IFX CoolMOS™ C7 application note: [www.infineon.com](http://www.infineon.com)
- IFX CoolMOS™ C7 simulation model: [www.infineon.com](http://www.infineon.com)
- IFX Design tools: [www.infineon.com](http://www.infineon.com)

## Revision History

IPZ65R019C7

**Revision: 2013-04-30, Rev. 2.0**

Previous Revision

| Revision | Date       | Subjects (major changes since last revision) |
|----------|------------|----------------------------------------------|
| 2.0      | 2013-04-30 | Release of final version                     |

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Any information within this document that you feel is wrong, unclear or missing at all? Your feedback will help us to continuously improve the quality of this document. Please send your proposal (including a reference to this document) to:

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