

# MOSFET

## 950V CoolMOS™ PFD7 SJ Power Device

The latest 950V CoolMOS™ PFD7 series sets a new benchmark in the super junction (SJ) technologies. This technology is designed to address Lighting and Industrial SMPS applications by combining best-in-class performance with state-of-the-art ease of use. Compared to the CoolMOS™ P7 families, the PFD7 offers an integrated ultra-fast body diode enabling usage in resonant topologies with markets lowest reverse recovery charge ( $Q_{rr}$ ).

### Features

- Integrated ultra-fast body diode
- Best-in-class reverse recovery charge  $Q_{rr}$
- Best-in-class FOM  $R_{DS(on)} * E_{oss}$ , reduced  $Q_g$ ,  $C_{iss}$ , and  $C_{oss}$
- Best-in-class  $V_{(GS)th}$  of 3V and smallest  $V_{(GS)th}$  variation of  $\pm 0.5V$
- Integrated fast body diode
- Best-in-class CoolMOS™ quality and reliability
- Fully optimized portfolio
- Best-in-class  $R_{DS(on)}$  in THD and SMD packages
- ESD protection min. Class 2 (HBM)

### Benefits

- Excellent hard commutation robustness enabling usage in resonant topologies
- Extra safety margin for designs with increased bus voltage
- Enabling increased power density solutions
- Improved full load efficiency in industrial SMPS applications
- Price competitiveness over previous CoolMOS™ families
- Improved production yield by reducing ESD related failures

### Potential applications

- Suitable for hard & soft switching topologies
- Optimized for usage in LLC and ZVS topologies
- PFC & LLC applications in Lighting and Industrial SMPS

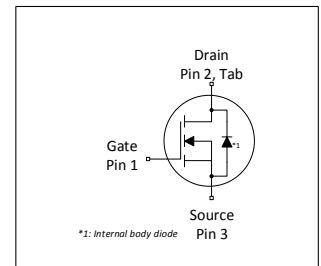
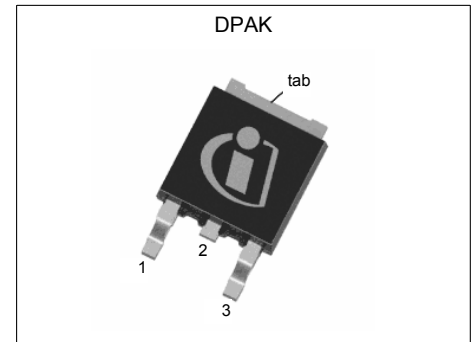
### Product validation

Fully qualified according to JEDEC for Industrial Applications

**Table 1 Key Performance Parameters**

| Parameter                   | Value | Unit |
|-----------------------------|-------|------|
| $V_{DS} @ T_J = 25^\circ C$ | 950   | V    |
| $R_{DS(on),max}$            | 450   | mΩ   |
| $Q_{g,typ}$                 | 43    | nC   |
| $I_D$                       | 13.3  | A    |
| $E_{oss} @ 500V$            | 3.0   | μJ   |
| Body diode $di_F/dt$        | 1300  | A/μs |
| $Q_{oss} @ 500V$            | 0.1   | μC   |

| Type / Ordering Code | Package    | Marking  | Related Links  |
|----------------------|------------|----------|----------------|
| IPD95R450PFD7        | PG-TO252-3 | 95R450D7 | see Appendix A |



RoHS

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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> | $I_D$         | -      | -    | 13.3<br>8.4 | A                | $T_C=25^\circ\text{C}$<br>$T_C=100^\circ\text{C}$                                           |
| Pulsed drain current <sup>2)</sup>     | $I_{D,pulse}$ | -      | -    | 43          | A                | $T_C=25^\circ\text{C}$                                                                      |
| Avalanche energy, single pulse         | $E_{AS}$      | -      | -    | 29          | mJ               | $I_D=1.8\text{A}$ ; $V_{DD}=50\text{V}$ ; see table 10                                      |
| Avalanche energy, repetitive           | $E_{AR}$      | -      | -    | 0.22        | mJ               | $I_D=1.8\text{A}$ ; $V_{DD}=50\text{V}$ ; see table 10                                      |
| Avalanche current, single pulse        | $I_{AS}$      | -      | -    | 1.8         | 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                      | $P_{tot}$     | -      | -    | 104         | 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                        | -             | -      | -    | -           | Ncm              | -                                                                                           |
| Continuous diode forward current       | $I_S$         | -      | -    | 9           | A                | $T_C=25^\circ\text{C}$                                                                      |
| Diode pulse current <sup>2)</sup>      | $I_{S,pulse}$ | -      | -    | 43          | A                | $T_C=25^\circ\text{C}$                                                                      |
| Reverse diode dv/dt <sup>3)</sup>      | dv/dt         | -      | -    | 70          | V/ns             | $V_{DS}=0\dots400\text{V}$ , $I_{SD}\leq 9\text{A}$ , $T_j=25^\circ\text{C}$<br>see table 8 |
| Maximum diode commutation speed        | di/dt         | -      | -    | 1300        | A/ $\mu\text{s}$ | $V_{DS}=0\dots400\text{V}$ , $I_{SD}\leq 9\text{A}$ , $T_j=25^\circ\text{C}$<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  $T_{j,max}$ . Maximum Duty Cycle  $D = 0.50$

<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                     | $R_{thJC}$ | -      | -    | 1.20 | °C/W | -                                                                                                                                                                                   |
| Thermal resistance, junction - ambient                  | $R_{thJA}$ | -      | -    | 62   | °C/W | device on PCB, minimal footprint                                                                                                                                                    |
| Thermal resistance, junction - ambient for SMD version  | $R_{thJA}$ | -      | 35   | 45   | °C/W | Device on 40mm*40mm*1.5mm epoxy PCB FR4 with 6cm <sup>2</sup> (one layer, 70μm thickness) copper area for drain connection and cooling. PCB is vertical without air stream cooling. |
| Soldering temperature, wave- & reflow soldering allowed | $T_{sold}$ | -      | -    | 260  | °C   | reflow MSL1                                                                                                                                                                         |

### 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   | $V_{(BR)DSS}$ | 950    | -            | -         | V        | $V_{GS}=0V$ , $I_D=1mA$                                                                                       |
| Gate threshold voltage           | $V_{(GS)th}$  | 2.5    | 3            | 3.5       | V        | $V_{DS}=V_{GS}$ , $I_D=0.36mA$                                                                                |
| Zero gate voltage drain current  | $I_{DSS}$     | -      | -            | 1         | $\mu A$  | $V_{DS}=950V$ , $V_{GS}=0V$ , $T_j=25^\circ\text{C}$<br>$V_{DS}=950V$ , $V_{GS}=0V$ , $T_j=150^\circ\text{C}$ |
| Gate-source leakage current      | $I_{GSS}$     | -      | -            | 100       | nA       | $V_{GS}=20V$ , $V_{DS}=0V$                                                                                    |
| Drain-source on-state resistance | $R_{DS(on)}$  | -      | 0.35<br>0.93 | 0.45<br>- | $\Omega$ | $V_{GS}=10V$ , $I_D=7.2A$ , $T_j=25^\circ\text{C}$<br>$V_{GS}=10V$ , $I_D=7.2A$ , $T_j=150^\circ\text{C}$     |
| Gate resistance                  | $R_G$         | -      | 1            | -         | $\Omega$ | $f=250kHz$ , open drain                                                                                       |

**Table 5 Dynamic characteristics**

| Parameter                                                  | Symbol       | Values |      |      | Unit | Note / Test Condition                                                        |
|------------------------------------------------------------|--------------|--------|------|------|------|------------------------------------------------------------------------------|
|                                                            |              | Min.   | Typ. | Max. |      |                                                                              |
| Input capacitance                                          | $C_{iss}$    | -      | 1230 | -    | pF   | $V_{GS}=0V$ , $V_{DS}=400V$ , $f=250kHz$                                     |
| Output capacitance                                         | $C_{oss}$    | -      | 17   | -    | pF   | $V_{GS}=0V$ , $V_{DS}=400V$ , $f=250kHz$                                     |
| Effective output capacitance, energy related <sup>1)</sup> | $C_{o(er)}$  | -      | 28   | -    | pF   | $V_{GS}=0V$ , $V_{DS}=0...400V$                                              |
| Effective output capacitance, time related <sup>2)</sup>   | $C_{o(tr)}$  | -      | 277  | -    | pF   | $I_D=\text{constant}$ , $V_{GS}=0V$ , $V_{DS}=0...400V$                      |
| Turn-on delay time                                         | $t_{d(on)}$  | -      | 9    | -    | ns   | $V_{DD}=400V$ , $V_{GS}=13V$ , $I_D=7.2A$ ,<br>$R_G=5.3\Omega$ ; see table 9 |
| Rise time                                                  | $t_r$        | -      | 8.7  | -    | ns   | $V_{DD}=400V$ , $V_{GS}=13V$ , $I_D=7.2A$ ,<br>$R_G=5.3\Omega$ ; see table 9 |
| Turn-off delay time                                        | $t_{d(off)}$ | -      | 45   | -    | ns   | $V_{DD}=400V$ , $V_{GS}=13V$ , $I_D=7.2A$ ,<br>$R_G=5.3\Omega$ ; see table 9 |
| Fall time                                                  | $t_f$        | -      | 4.7  | -    | ns   | $V_{DD}=400V$ , $V_{GS}=13V$ , $I_D=7.2A$ ,<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 | $Q_{gs}$      | -      | 6    | -    | nC   | $V_{DD}=760V$ , $I_D=7.2A$ , $V_{GS}=0$ to $10V$ |
| Gate to drain charge  | $Q_{gd}$      | -      | 13   | -    | nC   | $V_{DD}=760V$ , $I_D=7.2A$ , $V_{GS}=0$ to $10V$ |
| Gate charge total     | $Q_g$         | -      | 43   | -    | nC   | $V_{DD}=760V$ , $I_D=7.2A$ , $V_{GS}=0$ to $10V$ |
| Gate plateau voltage  | $V_{plateau}$ | -      | 4.5  | -    | V    | $V_{DD}=760V$ , $I_D=7.2A$ , $V_{GS}=0$ 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         | $V_{SD}$  | -      | 1.1  | -    | V       | $V_{GS}=0V$ , $I_F=7.2A$ , $T_J=25^{\circ}C$                 |
| Reverse recovery time         | $t_{rr}$  | -      | 149  | -    | ns      | $V_R=400V$ , $I_F=7.2A$ , $di_F/dt=100A/\mu s$ ; see table 8 |
| Reverse recovery charge       | $Q_{rr}$  | -      | 0.72 | -    | $\mu C$ | $V_R=400V$ , $I_F=7.2A$ , $di_F/dt=100A/\mu s$ ; see table 8 |
| Peak reverse recovery current | $I_{rrm}$ | -      | 9.3  | -    | A       | $V_R=400V$ , $I_F=7.2A$ , $di_F/dt=100A/\mu s$ ; see table 8 |

## 4 Electrical characteristics diagrams

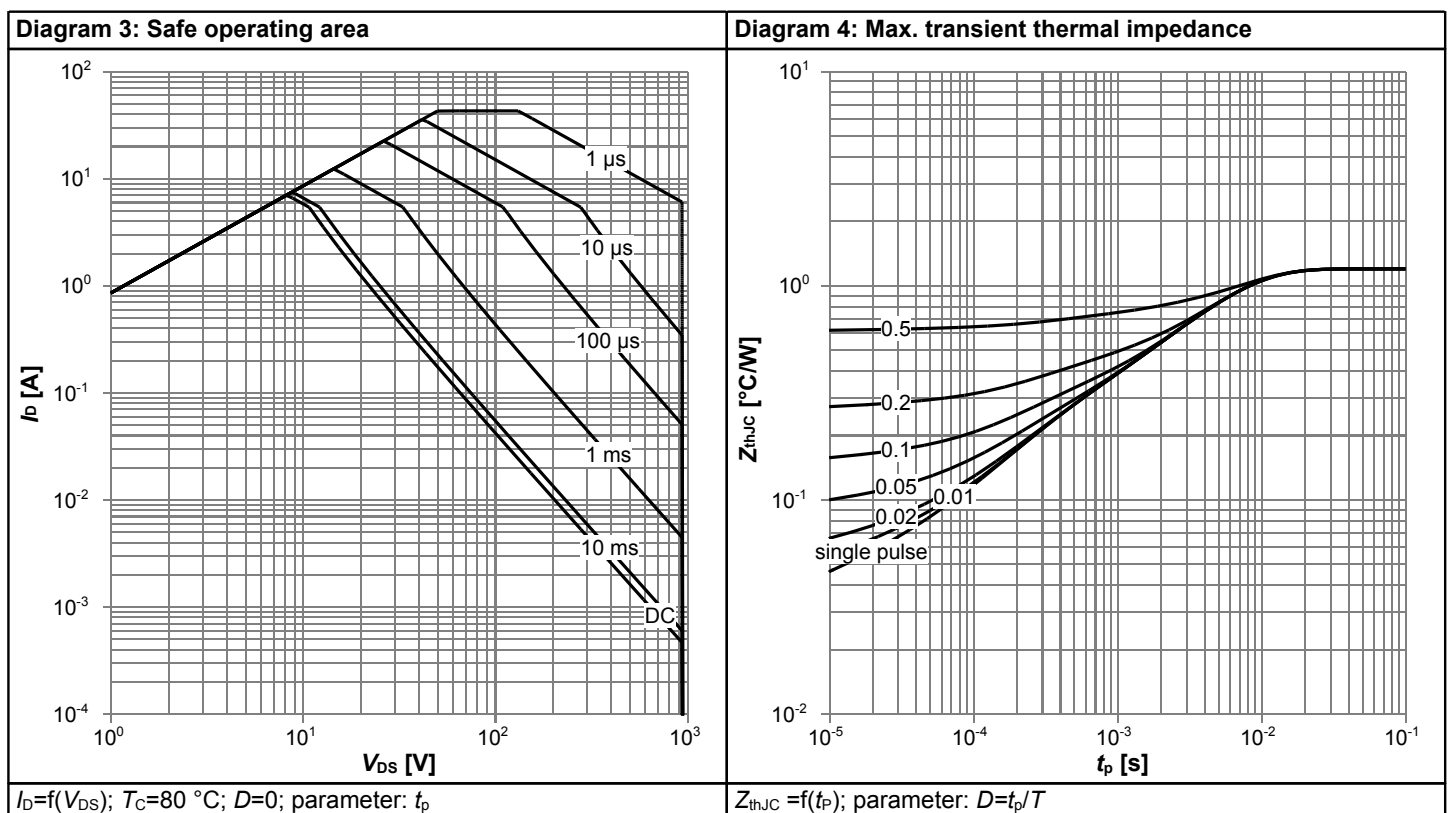
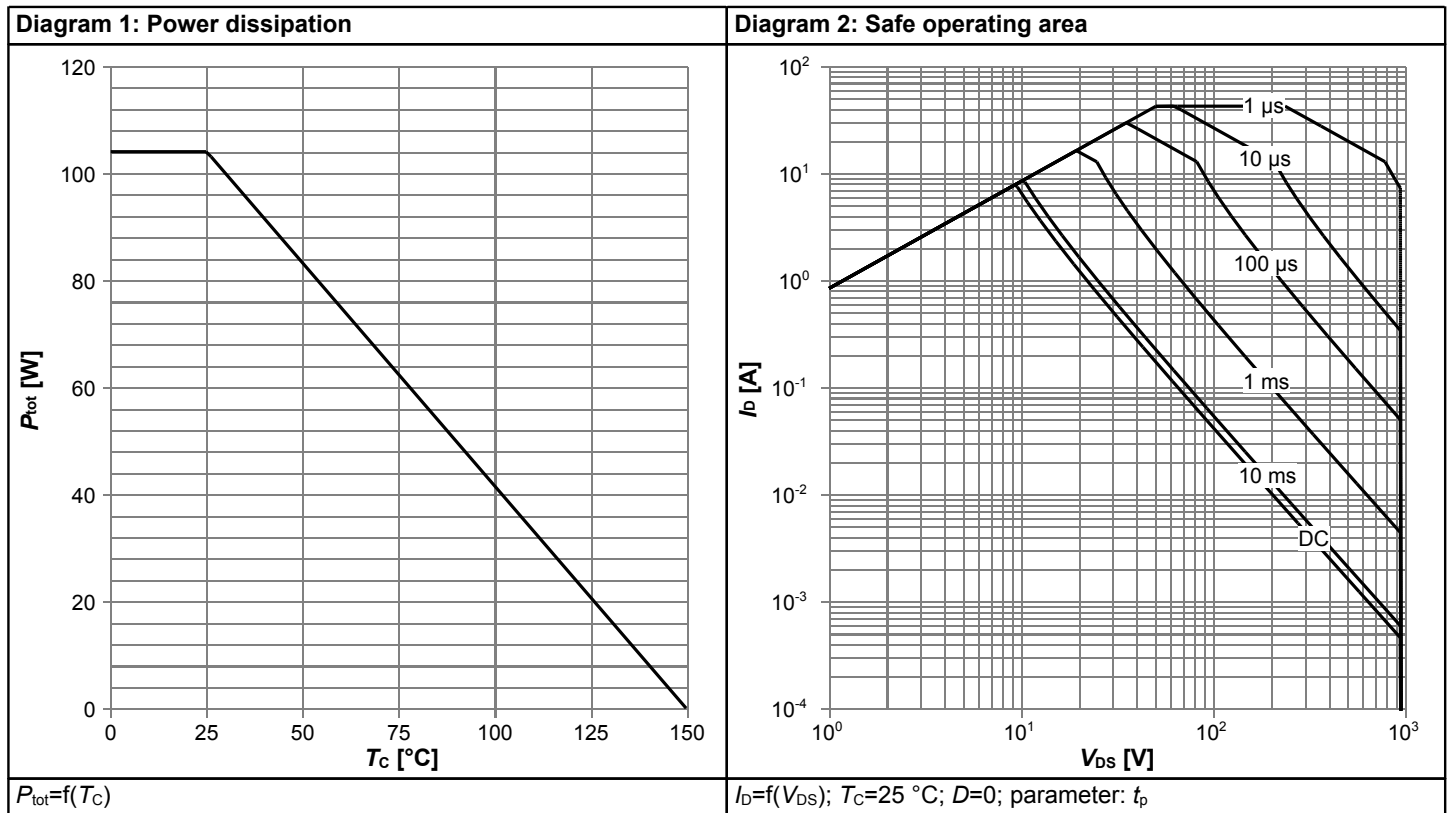
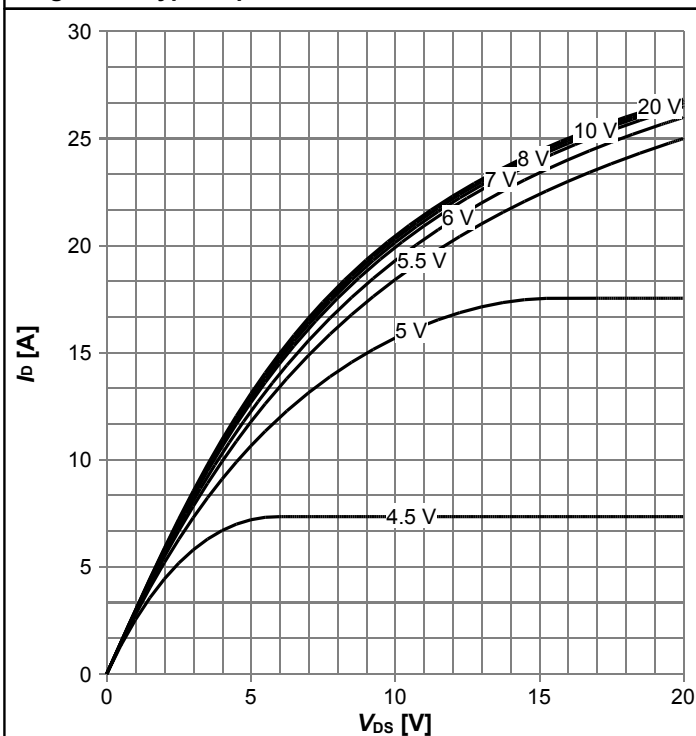
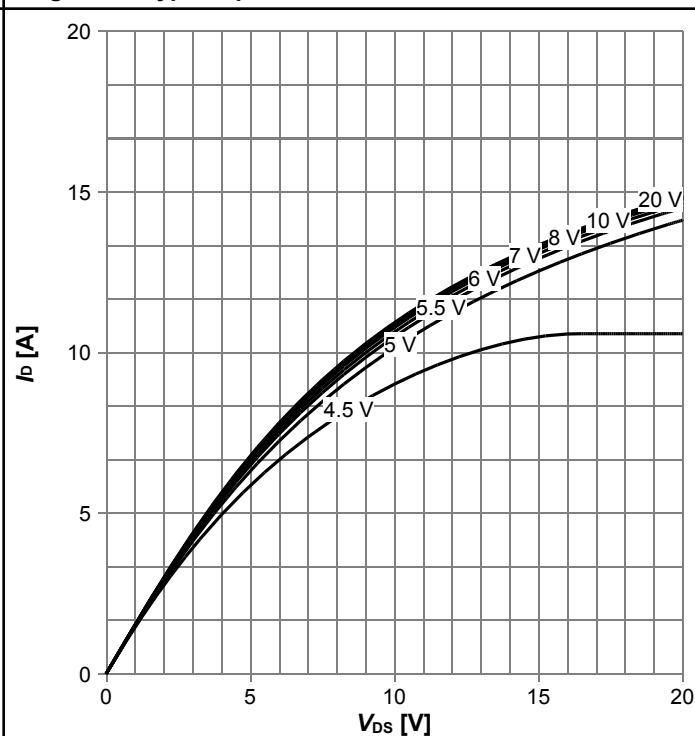


Diagram 5: Typ. output characteristics



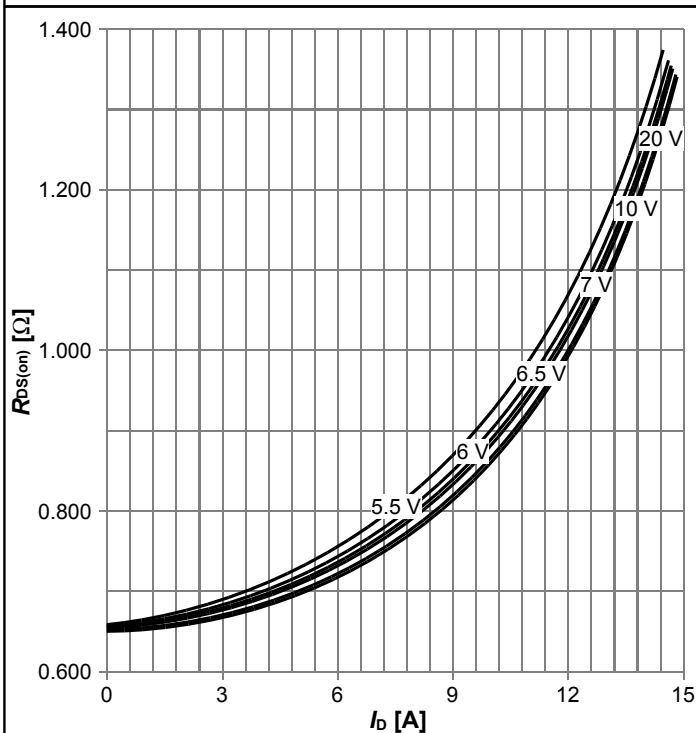
$I_D = f(V_{DS})$ ;  $T_j = 25\text{ °C}$ ; parameter:  $V_{GS}$

Diagram 6: Typ. output characteristics



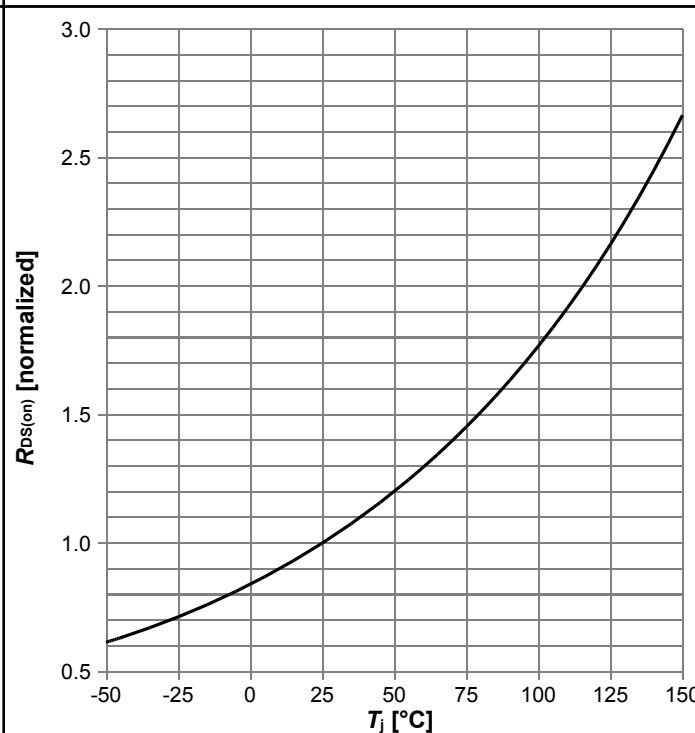
$I_D = f(V_{DS})$ ;  $T_j = 125\text{ °C}$ ; parameter:  $V_{GS}$

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



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

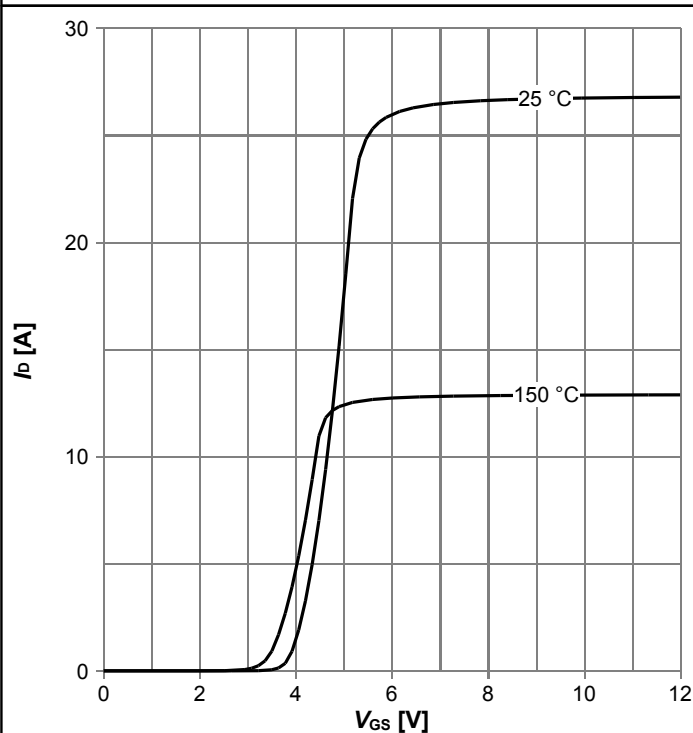
Diagram 8: Drain-source on-state resistance



$R_{DS(on)} = f(T_j)$ ;  $I_D = 7.2\text{ A}$ ;  $V_{GS} = 10\text{ V}$

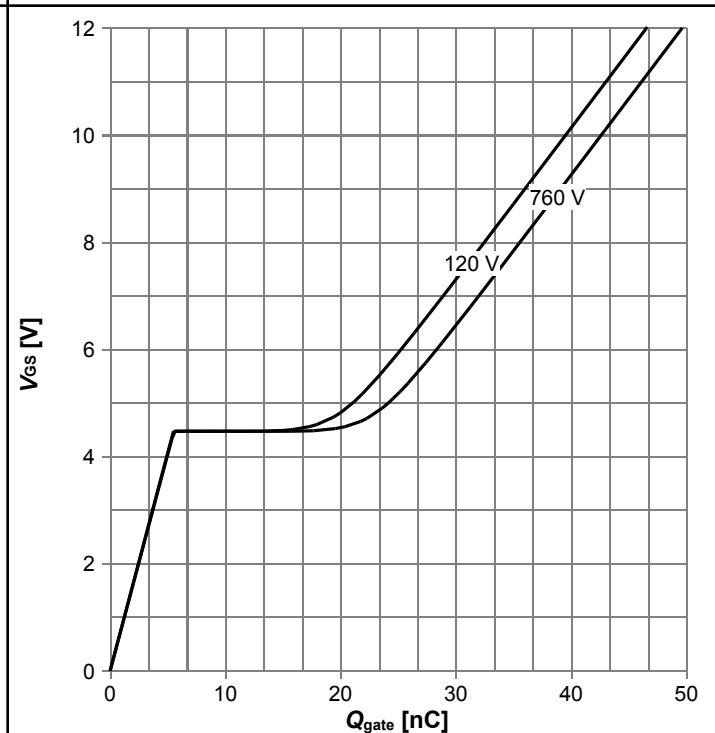


**Diagram 9: Typ. transfer characteristics**



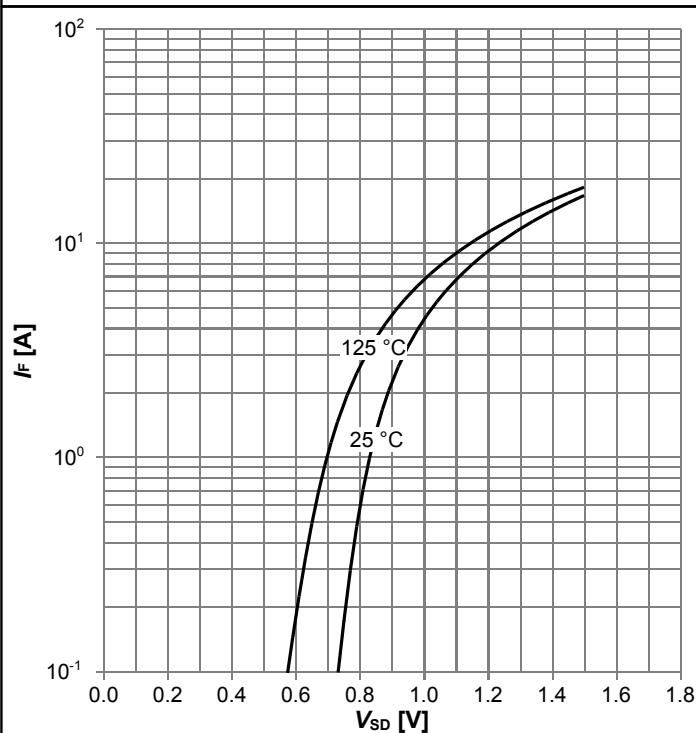
$I_D = f(V_{GS})$ ;  $V_{DS} = 20$  V; parameter:  $T_j$

**Diagram 10: Typ. gate charge**



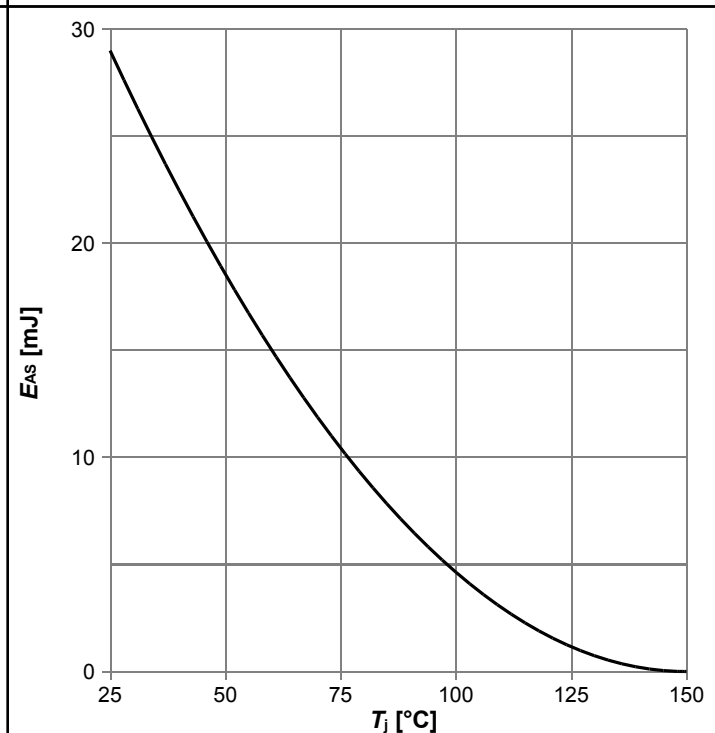
$V_{GS} = f(Q_{gate})$ ;  $I_D = 7.2$  A pulsed; parameter:  $V_{DD}$

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



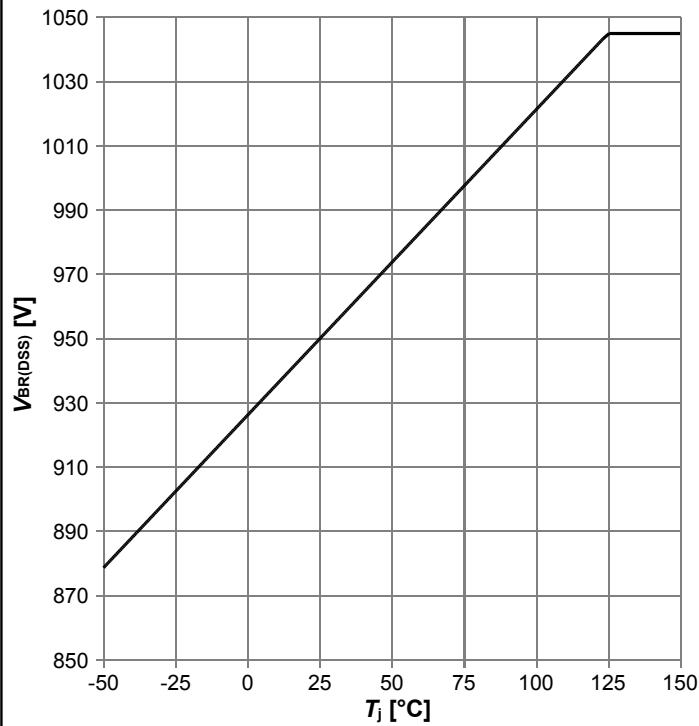
$I_F = f(V_{SD})$ ; parameter:  $T_j$

**Diagram 12: Avalanche energy**



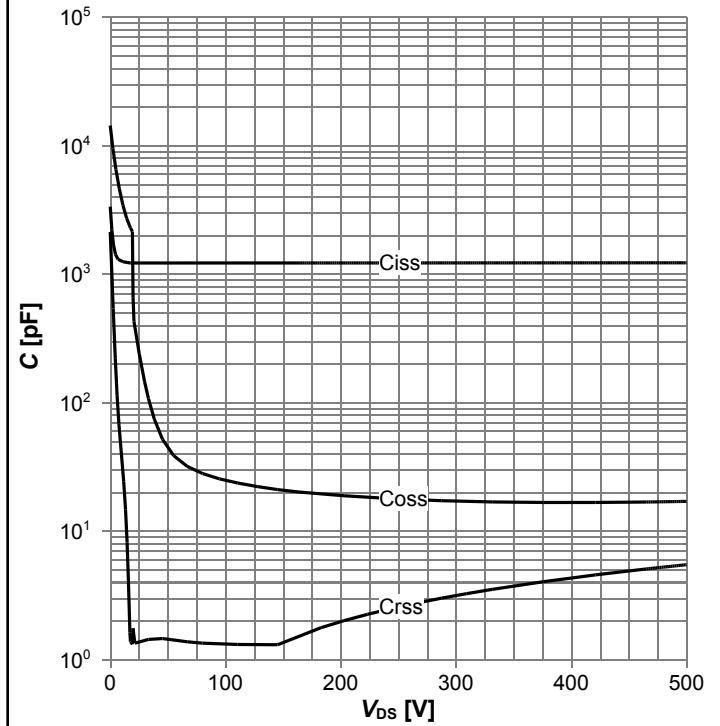
$E_{AS} = f(T_j)$ ;  $I_D = 1.8$  A;  $V_{DD} = 50$  V

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



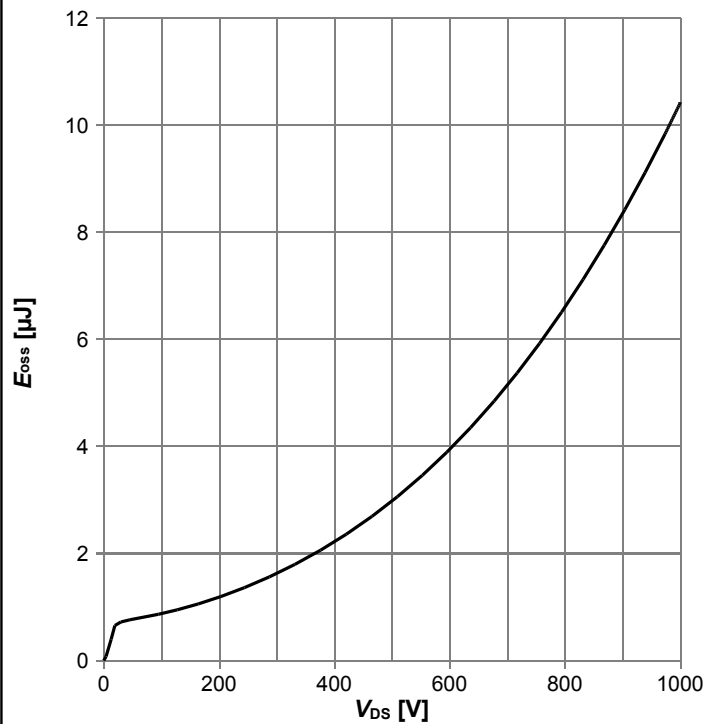
$V_{BR(DSS)} = f(T_j); I_D = 1 \text{ mA}$

**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

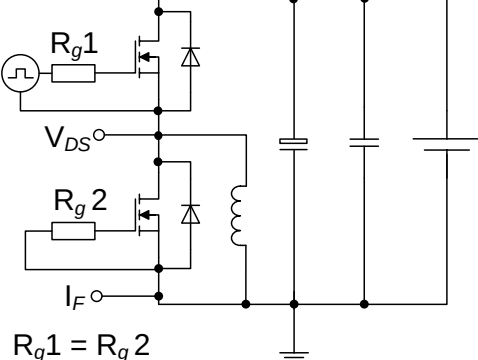
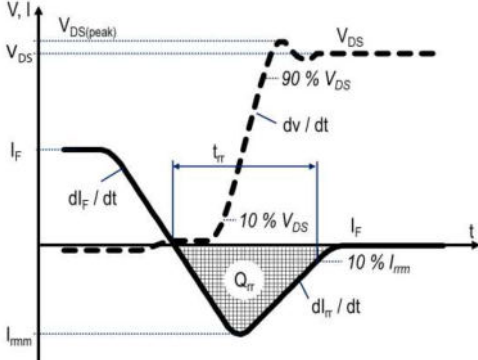
| Test circuit for diode characteristics                                                                                | Diode recovery waveform                                                            |
|-----------------------------------------------------------------------------------------------------------------------|------------------------------------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

Table 9 Switching times

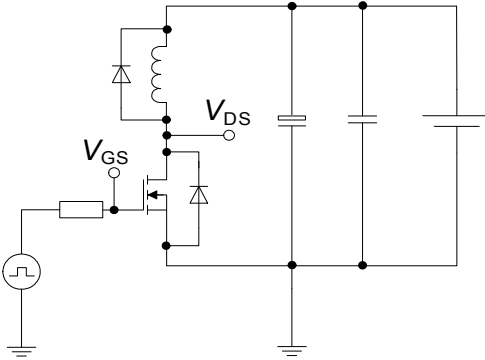
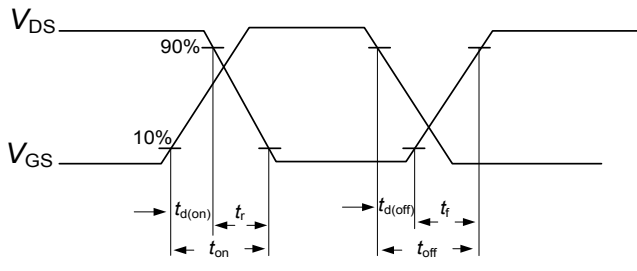
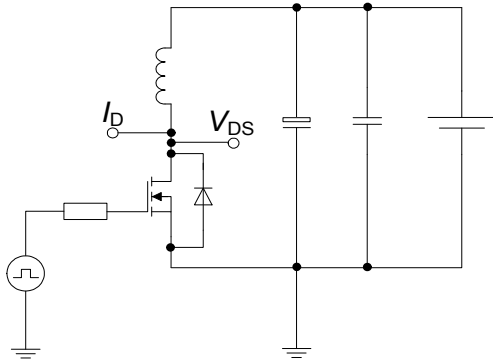
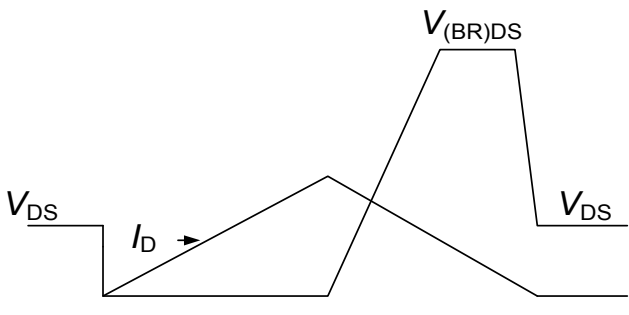
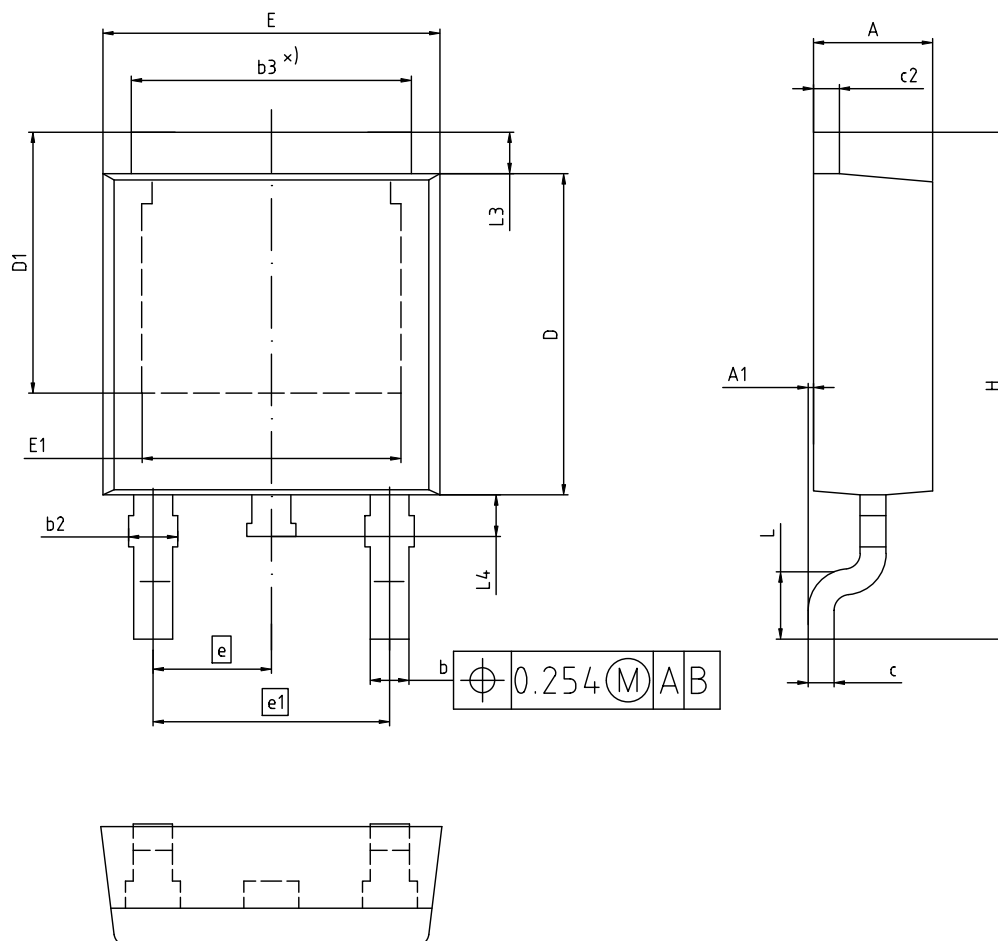
| Switching times test circuit for inductive load                                    | Switching times waveform                                                            |
|------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|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

Table 10 Unclamped inductive load

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

## 6 Package Outlines

### PG-TO252-3 (DPAK)



ALL DIMENSIONS REFER TO JEDEC STANDARD TO-252 AND DO NOT INCLUDE MOLD FLASH OR PROTRUSIONS.

| DIMENSION | MILLIMETERS |       |
|-----------|-------------|-------|
|           | MIN.        | MAX.  |
| A         | 2.16        | 2.41  |
| A1        | 0.00        | 0.15  |
| b         | 0.64        | 0.89  |
| b2        | 0.65        | 1.15  |
| b3        | 4.95        | 5.50  |
| c         | 0.46        | 0.61  |
| c2        | 0.40        | 0.98  |
| D         | 5.97        | 6.22  |
| D1        | 5.02        | 5.84  |
| E         | 6.35        | 6.73  |
| E1        | 4.32        | 5.50  |
| e         | 2.29        |       |
| e1        | 4.57        |       |
| N         | 3           |       |
| H         | 9.40        | 10.48 |
| L         | 1.18        | 1.78  |
| L3        | 0.89        | 1.27  |
| L4        | 0.51        | 1.02  |

|                               |
|-------------------------------|
| DOCUMENT NO.<br>Z8B00003328   |
| REVISION<br>07                |
| SCALE:<br>10:1<br>0 1 2mm<br> |
| EUROPEAN PROJECTION<br>       |
| ISSUE DATE<br>01.04.2020      |

Figure 1 Outline PG-TO252-3, dimensions in mm/inches

## **7 Appendix A**

### **Table 11 Related Links**

- IFX CoolMOS PFD7 950V Webpage: [www.infineon.com](http://www.infineon.com)
- IFX CoolMOS PFD7 950V application note: [www.infineon.com](http://www.infineon.com)
- IFX CoolMOS PFD7 950V simulation model: [www.infineon.com](http://www.infineon.com)
- IFX Design tools: [www.infineon.com](http://www.infineon.com)

## Revision History

IPD95R450PFD7

**Revision: 2022-04-22, Rev. 2.1**

Previous Revision

| Revision | Date       | Subjects (major changes since last revision) |
|----------|------------|----------------------------------------------|
| 2.0      | 2022-03-18 | Release of final version                     |
| 2.1      | 2022-04-22 | Modified features                            |

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