

## MOSFET

### 650V CoolMOS™ CFDA Power Transistor

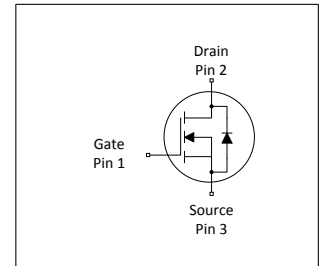
CoolMOS™ is a revolutionary technology for high voltage power MOSFETs, designed according to the superjunction (SJ) principle and pioneered by Infineon Technologies. 650V CoolMOS™ CFDA series combines the experience of the leading SJ MOSFET supplier with high class innovation. The resulting devices provide all benefits of a fast switching SJ MOSFET while offering an extremely fast and robust body diode. This combination of extremely low switching, commutation and conduction losses together with highest robustness make especially resonant switching applications more reliable, more efficient, lighter, and cooler.

#### Features

- Ultra-fast body diode
- Very high commutation ruggedness
- Extremely low losses due to very low FOM  $R_{ds(on)} \cdot Q_g$  and  $E_{oss}$
- Easy to use/drive
- Qualified according to AEC Q101
- Green package (RoHS compliant), Pb-free plating, halogen free for mold compound

#### Potential applications

650V CoolMOS™ CFDA is designed for switching applications.



**Table 1 Key Performance Parameters**

| Parameter          | Value | Unit       |
|--------------------|-------|------------|
| $V_{DS}$           | 650   | V          |
| $R_{DS(on),max}$   | 0.66  | $\Omega$   |
| $Q_g,typ$          | 20    | nC         |
| $I_D,pulse$        | 17    | A          |
| $E_{oss} @ 400V$   | 1.8   | $\mu J$    |
| Body diode $di/dt$ | 900   | A/ $\mu s$ |
| $Q_{rr}$           | 0.2   | $\mu C$    |
| $t_{rr}$           | 65    | ns         |
| $I_{rrm}$          | 4.5   | A          |

| Type / Ordering Code | Package     | Marking  | Related Links |
|----------------------|-------------|----------|---------------|
| IPB65R660CFDA        | PG-TO 263-3 | 65F6660A | -             |
| IPP65R660CFDA        | PG-TO 220-3 |          |               |

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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>                                | $I_D$          |        |      | 6    | A                | $T_C = 25^\circ\text{C}$                                                         |
|                                                                       |                |        |      | 3.8  |                  | $T_C = 100^\circ\text{C}$                                                        |
| Pulsed drain current <sup>2)</sup>                                    | $I_{D,pulse}$  |        |      | 17   | A                | $T_C = 25^\circ\text{C}$                                                         |
| Avalanche energy, single pulse                                        | $E_{AS}$       |        |      | 115  | mJ               | $I_D = 1.2\text{A}$ , $V_{DD} = 50\text{V}$<br>(see table 11)                    |
| Avalanche energy, repetitive                                          | $E_{AR}$       |        |      | 0.21 | mJ               | $I_D = 1.2\text{A}$ , $V_{DD} = 50\text{V}$                                      |
| Avalanche current, repetitive                                         | $I_{AR}$       |        |      | 1.2  | A                |                                                                                  |
| MOSFET dv/dt ruggedness                                               | dv/dt          |        |      | 50   | V/ns             | $V_{DS} = 0 \dots 400\text{V}$                                                   |
| Gate source voltage                                                   | $V_{GS}$       | -20    |      | 20   | V                | static                                                                           |
|                                                                       |                | -30    |      | 30   |                  | AC ( $f > 1\text{ Hz}$ )                                                         |
| Power dissipation (non FullPAK, SMD)<br>PG-TO 220, D <sup>2</sup> PAK | $P_{tot}$      |        |      | 62.5 | W                | $T_C = 25^\circ\text{C}$                                                         |
| Operating and storage temperature                                     | $T_j, T_{stg}$ | -40    |      | 150  | $^\circ\text{C}$ |                                                                                  |
| Mounting torque (non FullPAK)<br>PG-TO 220                            |                |        |      | 70   | Ncm              | M3 and M3.5 screws                                                               |
| Continuous diode forward current                                      | $I_S$          |        |      | 6    | A                | $T_C = 25^\circ\text{C}$                                                         |
| Diode pulse current                                                   | $I_{S,pulse}$  |        |      | 17   | A                | $T_C = 25^\circ\text{C}$                                                         |
| Reverse diode dv/dt <sup>3)</sup>                                     | dv/dt          |        |      | 50   | V/ns             | $V_{DS} = 0 \dots 400\text{V}$ , $I_{SD} \leq I_D$ ,<br>$T_j = 25^\circ\text{C}$ |
| Maximum diode commutation speed                                       | di/dt          |        |      | 900  | A/ $\mu\text{s}$ | (see table 9)                                                                    |

<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  $R_G$

## 2 Thermal characteristics

**Table 3 Thermal characteristics PG-TO 220**

| Parameter                                                  | Symbol     | Values |      |      | Unit | Note / Test Condition                |
|------------------------------------------------------------|------------|--------|------|------|------|--------------------------------------|
|                                                            |            | Min.   | Typ. | Max. |      |                                      |
| Thermal resistance, junction - case                        | $R_{thJC}$ |        |      | 2    | K/W  |                                      |
| Thermal resistance, junction - ambient                     | $R_{thJA}$ |        |      | 62   | K/W  | leaded                               |
| Soldering temperature, wavesoldering only allowed at leads | $T_{sold}$ |        |      | 260  | °C   | 1.6 mm (0.063 in.) from case for 10s |

**Table 4 Thermal characteristics D<sup>2</sup>PAK**

| Parameter                                              | Symbol     | Values |      |      | Unit | Note / Test Condition                                     |
|--------------------------------------------------------|------------|--------|------|------|------|-----------------------------------------------------------|
|                                                        |            | Min.   | Typ. | Max. |      |                                                           |
| Thermal resistance, junction - case                    | $R_{thJC}$ |        |      | 2    | K/W  |                                                           |
| Thermal resistance, junction - ambient <sup>1)</sup>   | $R_{thJA}$ |        |      | 62   | K/W  | SMD version, device on PCB, minimal footprint             |
|                                                        |            |        | 35   |      |      | SMD version, device on PCB, 6cm <sup>2</sup> cooling area |
| Soldering temperature, wave- & reflowsoldering allowed | $T_{sold}$ |        |      | 260  | °C   | reflow MSL                                                |

<sup>1)</sup> Device on 40mm\*40mm\*1.5mm one layer epoxy PCB FR4 with 6cm<sup>2</sup> copper area (thickness 70µm) for drain connection. PCB is vertical without air stream cooling.

### 3 Electrical characteristics

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

**Table 5 Static characteristics**

| Parameter                                    | Symbol        | Values |       |      | Unit     | Note / Test Condition                           |
|----------------------------------------------|---------------|--------|-------|------|----------|-------------------------------------------------|
|                                              |               | Min.   | Typ.  | Max. |          |                                                 |
| Drain-source breakdown voltage <sup>1)</sup> | $V_{(BR)DSS}$ | 650    |       |      | V        | $V_{GS} = 0V, I_D = 1mA$                        |
| Gate threshold voltage                       | $V_{GS(th)}$  | 3.5    | 4     | 4.5  | V        | $V_{DS} = V_{GS}, I_D = 0.2mA$                  |
| Zero gate voltage drain current              | $I_{DSS}$     |        |       | 1    | $\mu A$  | $V_{DS} = 650V, V_{GS} = 0V, T_j = 25^\circ C$  |
|                                              |               |        | 100   |      |          | $V_{DS} = 650V, V_{GS} = 0V, T_j = 150^\circ C$ |
| Gate-source leakage current                  | $I_{GSS}$     |        |       | 100  | nA       | $V_{GS} = 20V, V_{DS} = 0V$                     |
| Drain-source on-state resistance             | $R_{DS(on)}$  |        | 0.594 | 0.66 | $\Omega$ | $V_{GS} = 10V, I_D = 3.2A, T_j = 25^\circ C$    |
|                                              |               |        | 1.544 |      |          | $V_{GS} = 10V, I_D = 3.2A, T_j = 150^\circ C$   |
| Gate resistance                              | $R_G$         |        | 6.5   |      | $\Omega$ | $f = 1MHz$ , open drain                         |

**Table 6 Dynamic characteristics**

| Parameter                                                  | Symbol       | Values |      |      | Unit | Note / Test Condition                                                        |
|------------------------------------------------------------|--------------|--------|------|------|------|------------------------------------------------------------------------------|
|                                                            |              | Min.   | Typ. | Max. |      |                                                                              |
| Input capacitance                                          | $C_{iss}$    |        | 543  |      | pF   | $V_{GS} = 0V, V_{DS} = 100V, f = 1MHz$                                       |
| Output capacitance                                         | $C_{oss}$    |        | 32   |      | pF   |                                                                              |
| Effective output capacitance, energy related <sup>2)</sup> | $C_{o(er)}$  |        | 24   |      | pF   | $V_{GS} = 0V, V_{DS} = 0 \dots 400V$                                         |
| Effective output capacitance, time related <sup>3)</sup>   | $C_{o(tr)}$  |        | 97   |      | pF   | $I_D = \text{constant}, V_{GS} = 0V, V_{DS} = 0 \dots 400V$                  |
| Turn-on delay time                                         | $t_{d(on)}$  |        | 9    |      | ns   | $V_{DD} = 400V, V_{GS} = 13V, I_D = 3.2A, R_G = 6.8\Omega$<br>(see table 10) |
| Rise time                                                  | $t_r$        |        | 8    |      | ns   |                                                                              |
| Turn-off delay time                                        | $t_{d(off)}$ |        | 40   |      | ns   |                                                                              |
| Fall time                                                  | $t_f$        |        | 10   |      | ns   |                                                                              |

**Table 7 Gate charge characteristics**

| Parameter             | Symbol        | Values |      |      | Unit | Note / Test Condition                                   |
|-----------------------|---------------|--------|------|------|------|---------------------------------------------------------|
|                       |               | Min.   | Typ. | Max. |      |                                                         |
| Gate to source charge | $Q_{gs}$      |        | 3.5  |      | nC   | $V_{DD} = 480V, I_D = 3.2A, V_{GS} = 0 \text{ to } 10V$ |
| Gate to drain charge  | $Q_{gd}$      |        | 11   |      | nC   |                                                         |
| Gate charge total     | $Q_g$         |        | 20   |      | nC   |                                                         |
| Gate plateau voltage  | $V_{plateau}$ |        | 6.4  |      | V    |                                                         |

<sup>1)</sup> For applications with applied blocking voltage > 65% of the specified blocking voltage, we recommend to evaluate the impact of the cosmic radiation effect in early design phase. For assessment please contact local Infineon sales office.

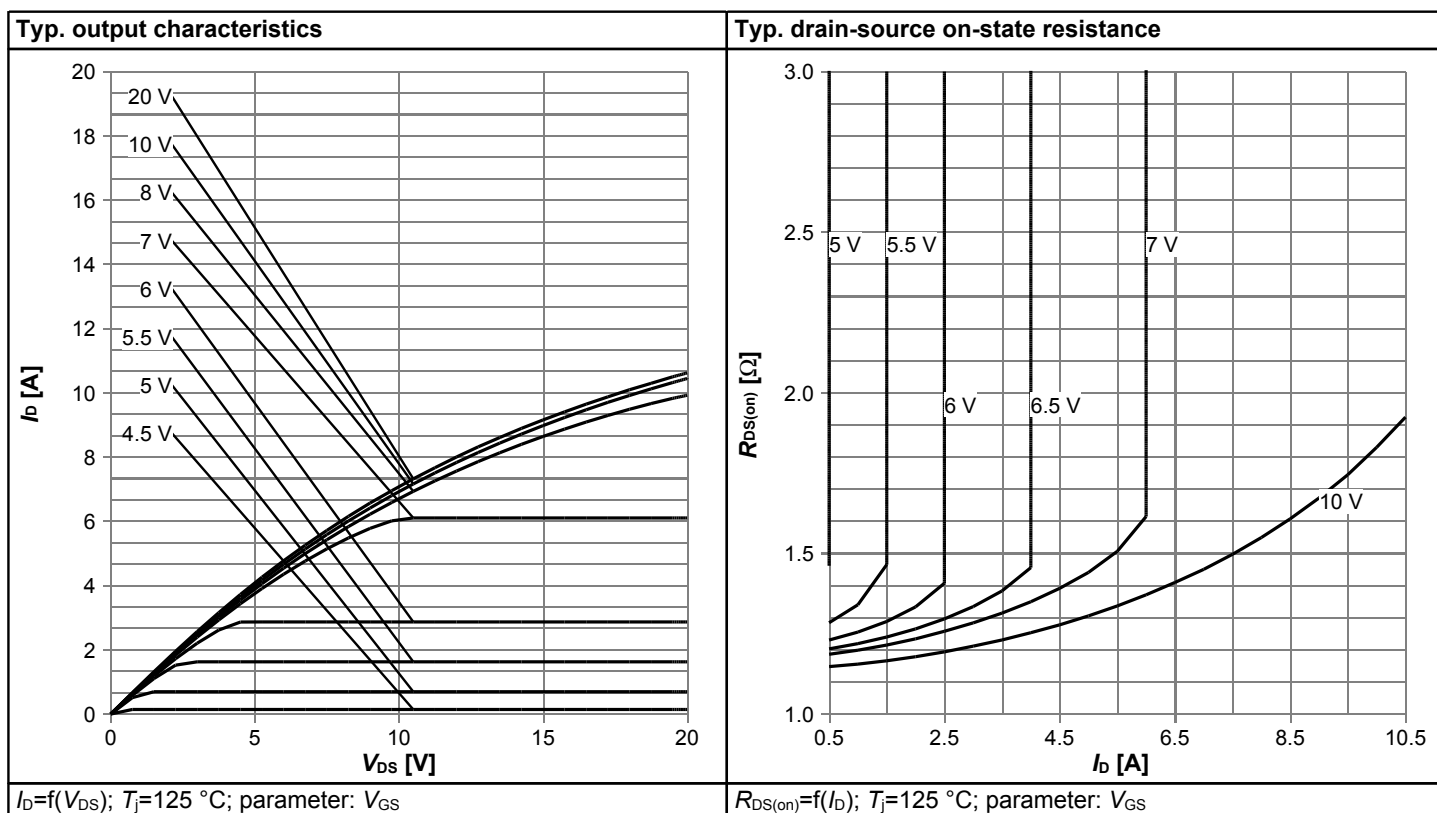
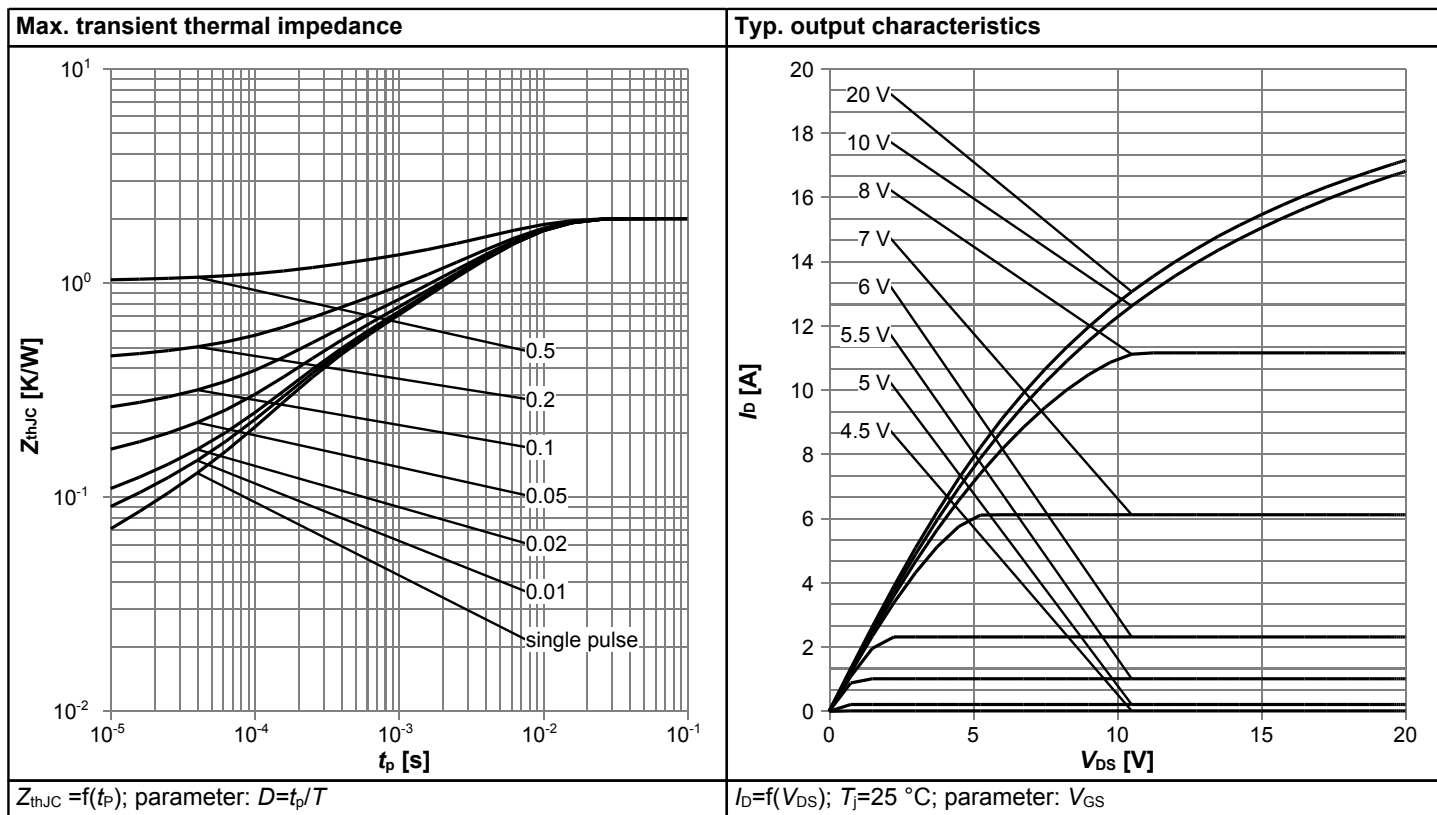
<sup>2)</sup>  $C_{o(er)}$  is a fixed capacitance that gives the same stored energy as  $C_{oss}$  while  $V_{DS}$  is rising from 0 to 400V

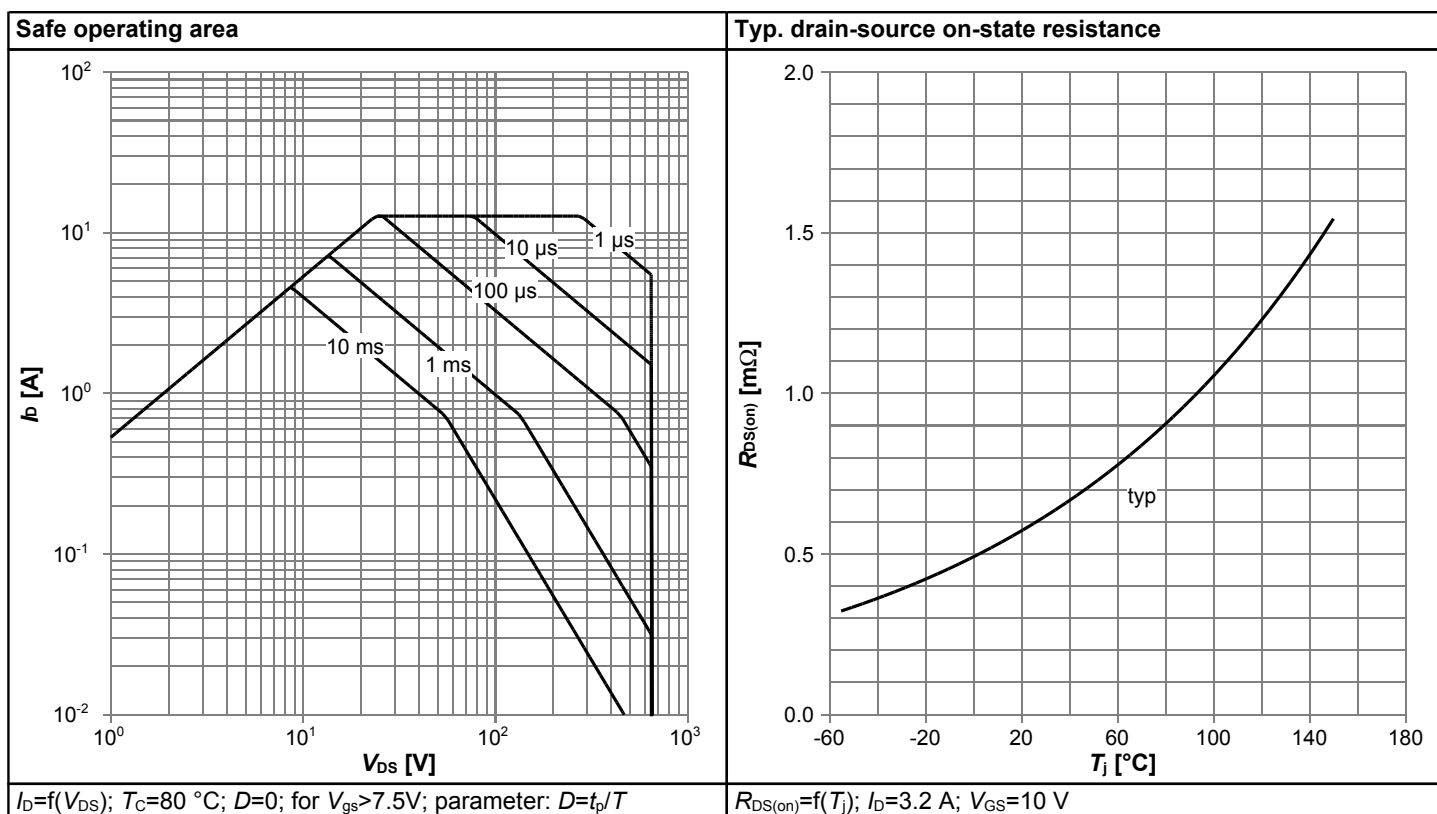
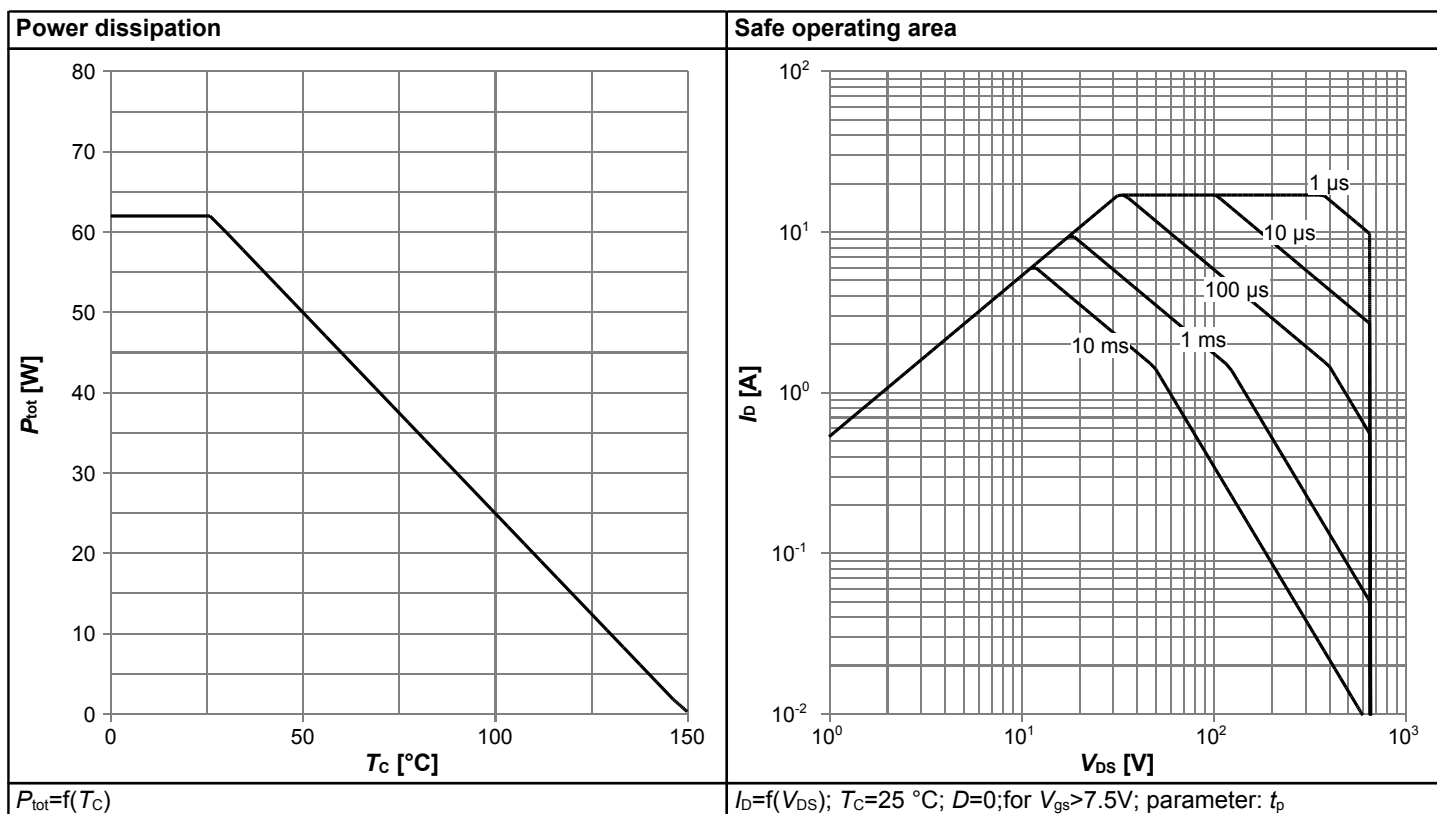
<sup>3)</sup>  $C_{o(tr)}$  is a fixed capacitance that gives the same charging time as  $C_{oss}$  while  $V_{DS}$  is rising from 0 to 400V

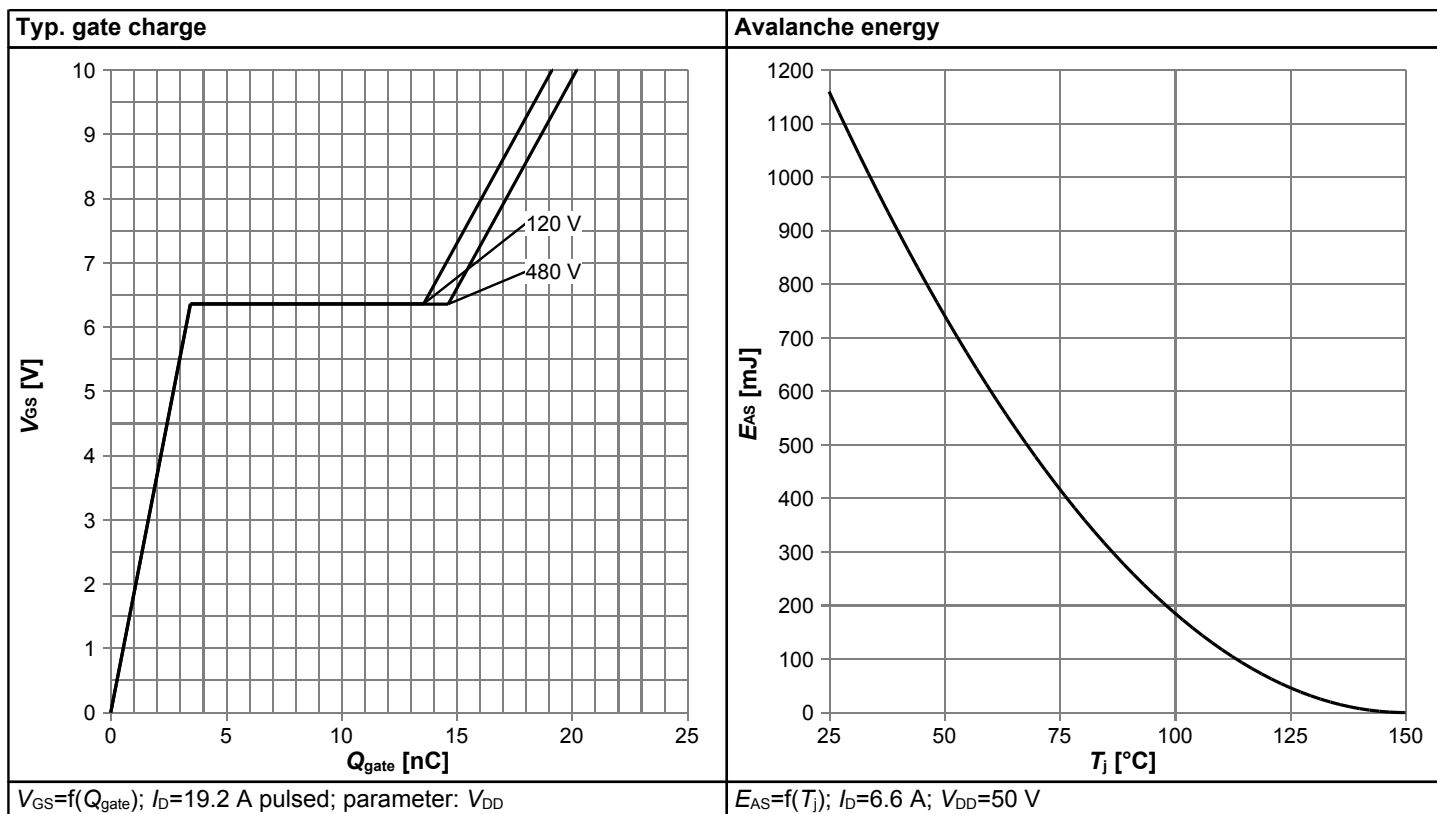
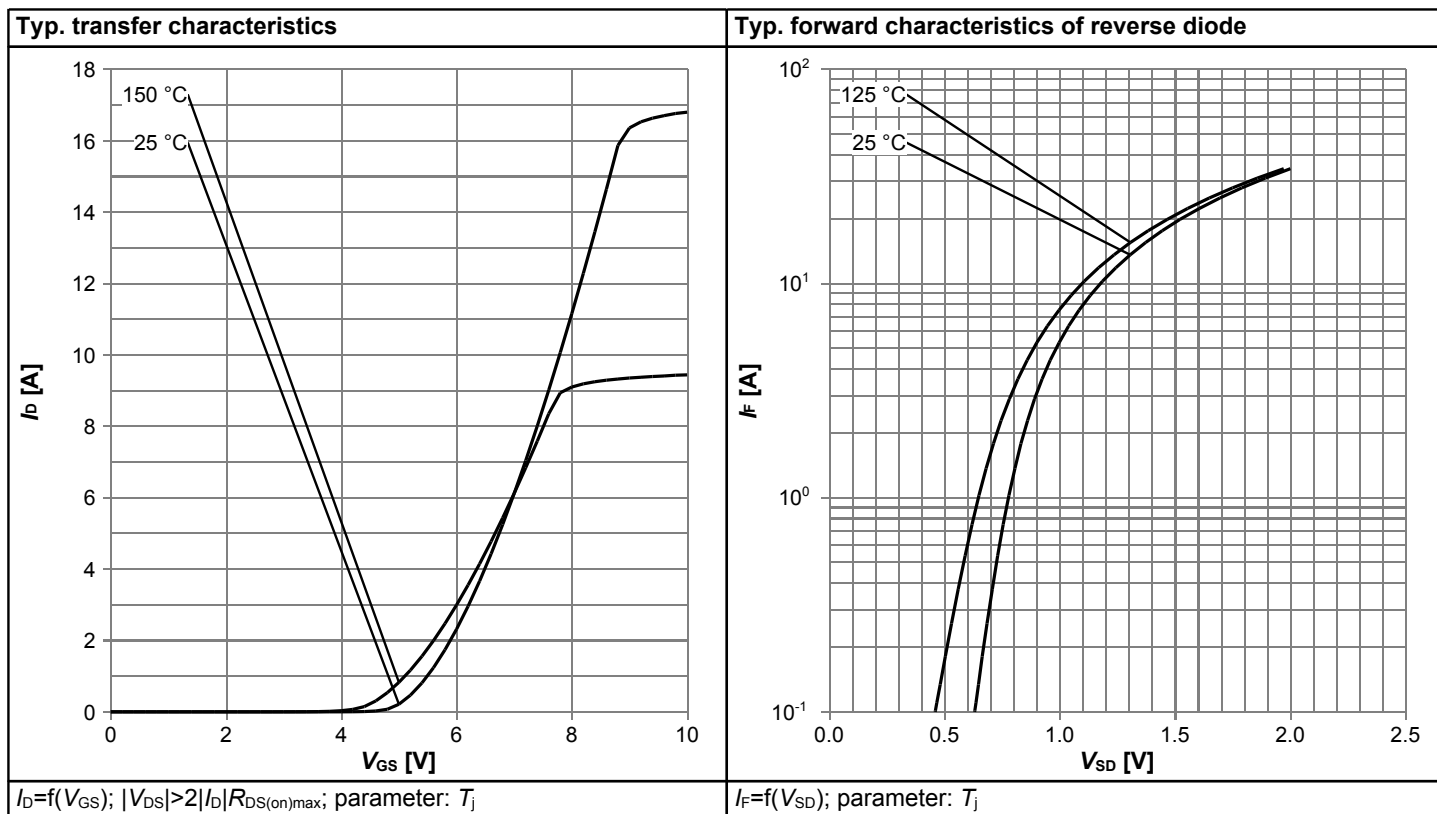
**Table 8 Reverse diode characteristics**

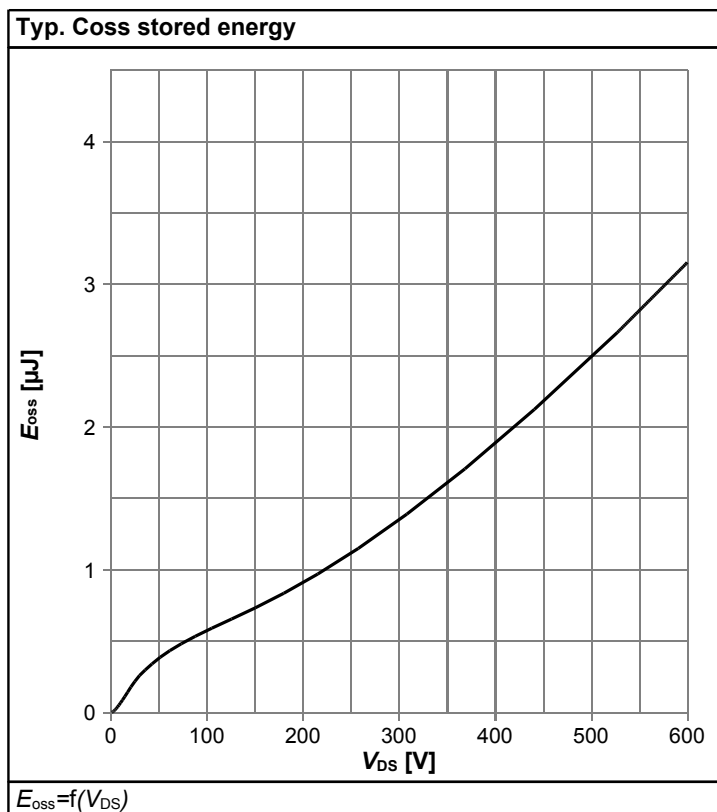
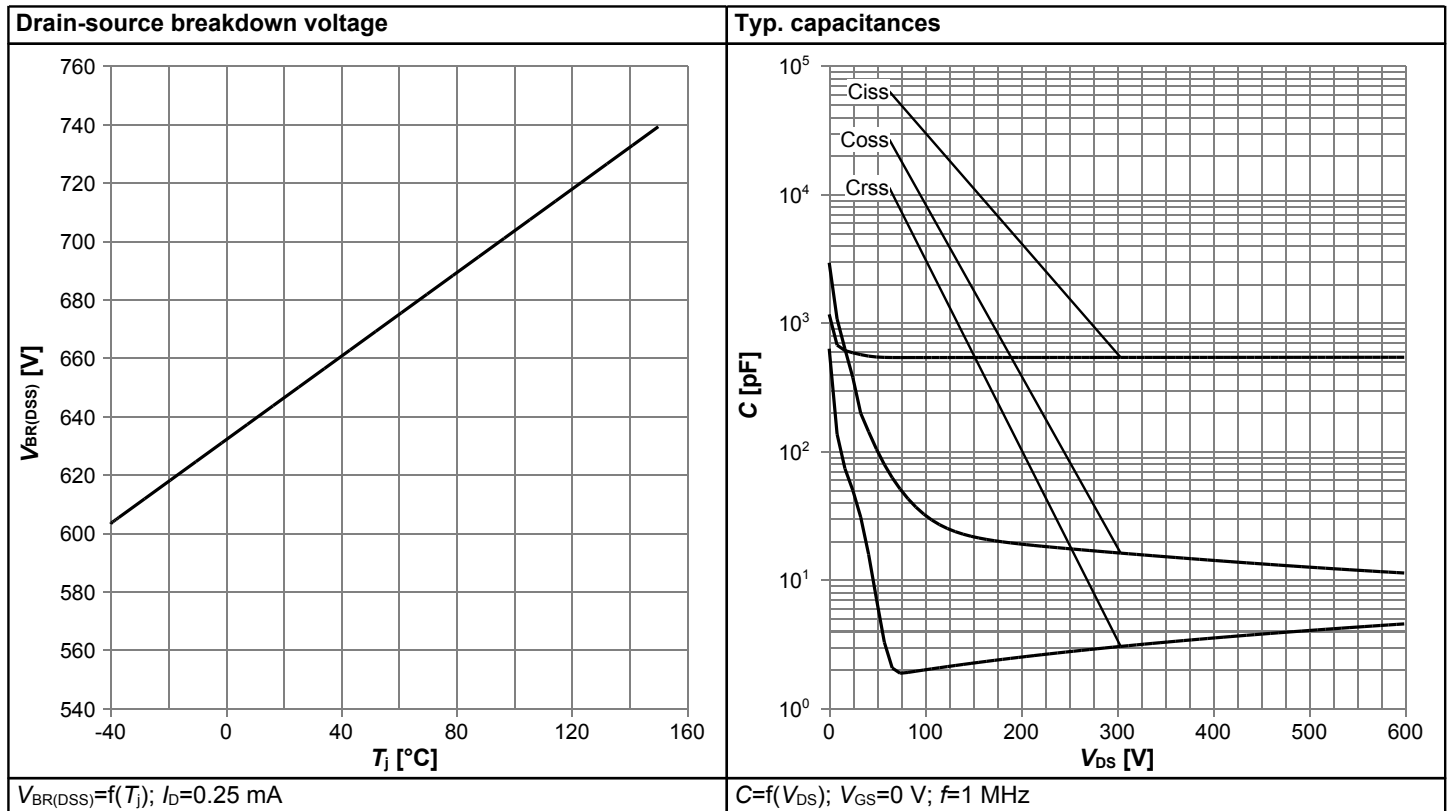
| Parameter                     | Symbol    | Values |      |      | Unit    | Note / Test Condition                                                |
|-------------------------------|-----------|--------|------|------|---------|----------------------------------------------------------------------|
|                               |           | Min.   | Typ. | Max. |         |                                                                      |
| Diode forward voltage         | $V_{SD}$  |        | 0.9  |      | V       | $V_{GS} = 0V, I_F = 3.2A, T_j = 25^\circ C$                          |
| Reverse recovery time         | $t_{rr}$  |        | 65   |      | ns      | $V_R = 400V, I_F = 3.2A,$<br>$di_F/dt = 100A/\mu s$<br>(see table 9) |
| Reverse recovery charge       | $Q_{rr}$  |        | 0.2  |      | $\mu C$ |                                                                      |
| Peak reverse recovery current | $I_{rrm}$ |        | 4.5  |      | A       |                                                                      |

## 4 Electrical characteristics diagrams









## 5 Test Circuits

**Table 9 Diode characteristics**

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

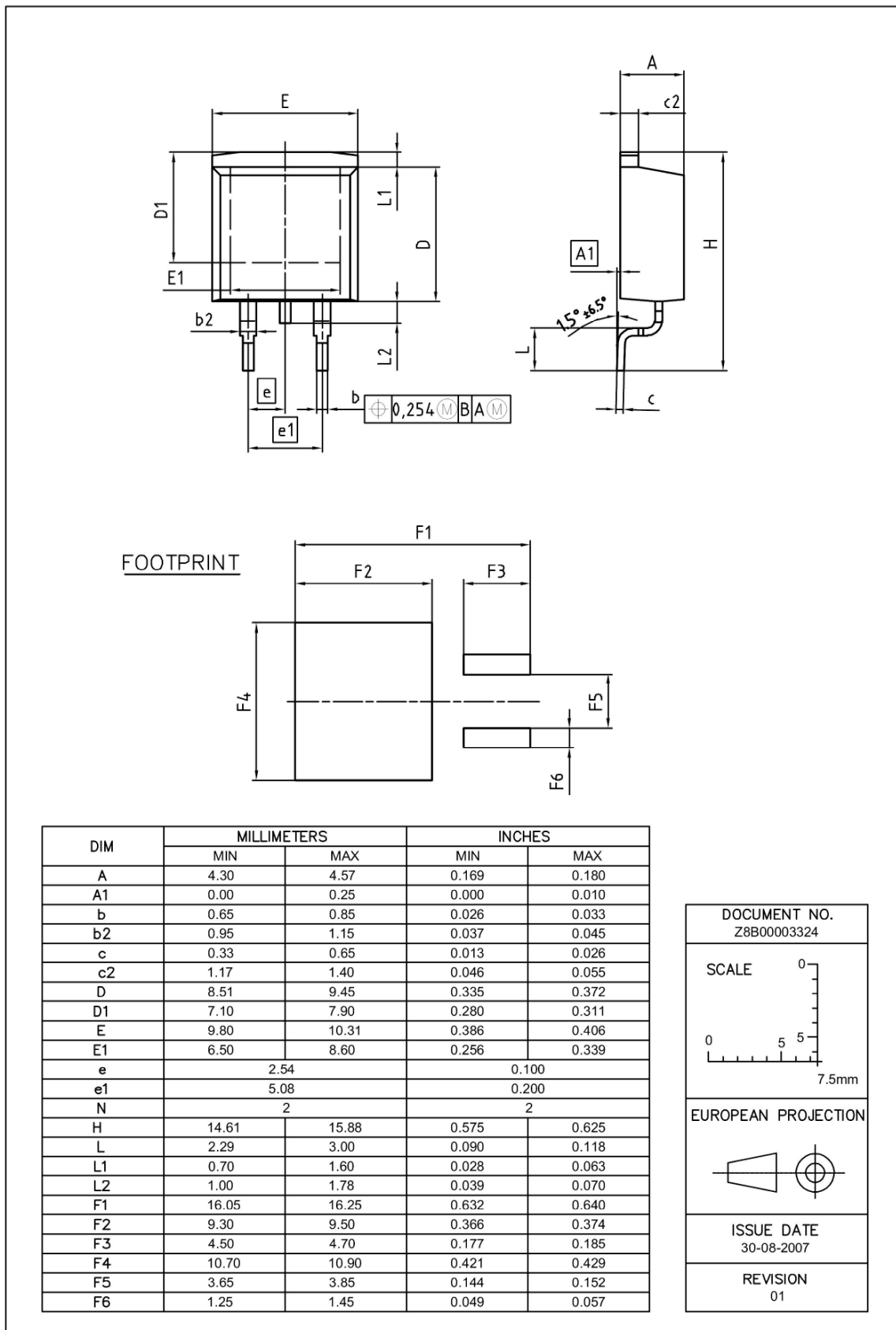
**Table 10 Switching times**

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

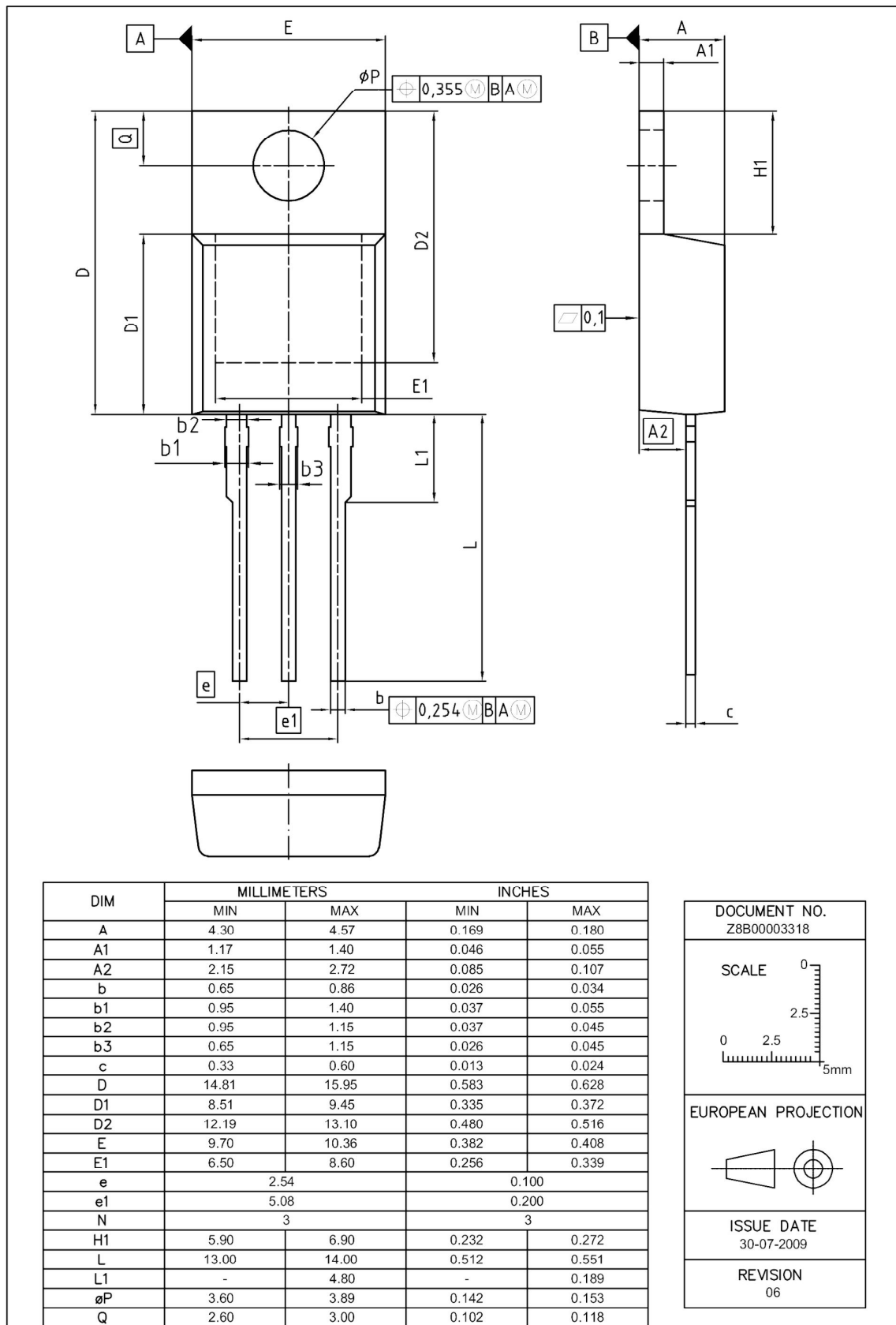
**Table 11 Unclamped inductive load**

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

## 6 Package Outlines



**Figure 1 Outline PG-TO 263-3, dimensions in mm/inches**



**Figure 2 Outline PG-TO 220-3, dimensions in mm/inches**

## Revision History

IPB65R660CFDA, IPP65R660CFDA

**Revision: 2017-11-27, Rev. 2.3**

Previous Revision

| Revision | Date       | Subjects (major changes since last revision)                                                        |
|----------|------------|-----------------------------------------------------------------------------------------------------|
| 2.0      | 2012-03-28 | Final datasheet                                                                                     |
| 2.1      | 2014-11-19 | Correction of Markingcode                                                                           |
| 2.2      | 2016-12-19 | Updated: SOA diagrams, Mounting torque, Correction Diagram R <sub>ds(on)</sub> vs. T <sub>j</sub> . |
| 2.3      | 2017-11-27 | Correction of Marking Code                                                                          |

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