

# MOSFET

Metal Oxide Semiconductor Field Effect Transistor

## CoolMOS™ C6 650V

650V CoolMOS™ C6 Power Transistor  
IPx65R099C6

## Data Sheet

Rev. 2.0  
Final

Industrial & Multimarket

## 1 Description

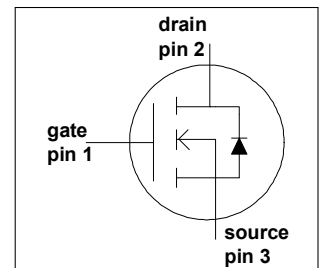
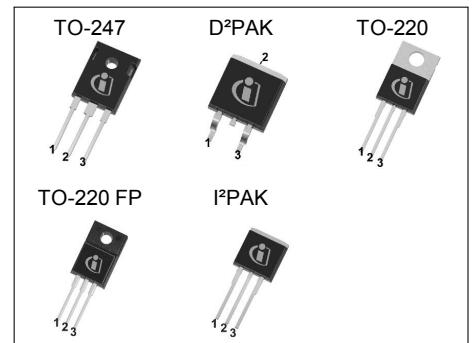
CoolMOS™ is a revolutionary technology for high voltage power MOSFETs, designed according to the superjunction (SJ) principle and pioneered by Infineon Technologies. CoolMOS™ C6 series combines the experience of the leading SJ MOSFET supplier with high class innovation. The resulting devices provide all benefits of a fast switching SJ MOSFET while not sacrificing ease of use. Extremely low switching and conduction losses make switching applications even more efficient, more compact, lighter and cooler.

## Features

- Extremely low losses due to very low FOM  $R_{ds(on)} \cdot Q_g$  and  $E_{oss}$
- Very high commutation ruggedness
- Easy to use/drive
- Pb-free plating, Halogen free mold compound
- Qualified for industrial grade applications according to JEDEC (J-STD20 and JESD22)

## Applications

PFC stages, hard switching PWM stages and resonant switching PWM stages for e.g. PC Silverbox, Adapter, LCD & PDP TV, Lighting, Server, Telecom, UPS and Solar.



**Table 1 Key Performance Parameters**

| Parameter             | Value | Unit       |
|-----------------------|-------|------------|
| $V_{DS} @ T_{j \max}$ | 700   | V          |
| $R_{DS(on),max}$      | 0.099 | $\Omega$   |
| $Q_g, typ$            | 127   | nC         |
| $I_D, pulse$          | 115   | A          |
| $E_{oss} @ 400V$      | 10    | $\mu J$    |
| Body diode $di/dt$    | 300   | A/ $\mu s$ |

| Type / Ordering Code | Package           | Marking | Related Links  |
|----------------------|-------------------|---------|----------------|
| IPW65R099C6          | PG-TO 247         | 65C6099 | see Appendix A |
| IPB65R099C6          | PG-TO 263         |         |                |
| IPP65R099C6          | PG-TO 220         |         |                |
| IPA65R099C6          | PG-TO 220 FullPAK |         |                |
| IPI65R099C6          | PG-TO 262         |         |                |

## Table of Contents

|                                           |    |
|-------------------------------------------|----|
| Description .....                         | 2  |
| Table of Contents .....                   | 3  |
| Maximum ratings .....                     | 4  |
| Thermal characteristics .....             | 5  |
| Electrical characteristics .....          | 6  |
| Electrical characteristics diagrams ..... | 8  |
| Test Circuits .....                       | 13 |
| Package Outlines .....                    | 14 |
| Appendix A .....                          | 19 |
| Revision History .....                    | 20 |
| Disclaimer .....                          | 20 |

## 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>                                | $I_D$               |        |      | 38.0  | A                | $T_C = 25^\circ\text{C}$                                                         |
|                                                                       |                     |        |      | 24.0  |                  | $T_C = 100^\circ\text{C}$                                                        |
| Pulsed drain current <sup>2)</sup>                                    | $I_{D,pulse}$       |        |      | 115   | A                | $T_C = 25^\circ\text{C}$                                                         |
| Avalanche energy, single pulse                                        | $E_{AS}$            |        |      | 845   | mJ               | $I_D = 6.6\text{A}$ , $V_{DS} = 50\text{V}$                                      |
| Avalanche energy, repetitive                                          | $E_{AR}$            |        |      | 1.28  | mJ               | $I_D = 6.6\text{A}$ , $V_{DS} = 50\text{V}$                                      |
| Avalanche current, repetitive                                         | $I_{AR}$            |        |      | 6.6   | A                |                                                                                  |
| MOSFET dv/dt ruggedness                                               | dv/dt               |        |      | 50    | V/ns             | $V_{DS} = 0 \dots 480\text{V}$                                                   |
| Gate source voltage                                                   | $V_{GS}$            | -20    |      | 20    | V                | static                                                                           |
|                                                                       |                     | -30    |      | 30    |                  | AC ( $f > 1\text{ Hz}$ )                                                         |
| Power dissipation (non FullPAK)<br>TO-247, TO-220, I <sup>2</sup> PAK | $P_{tot}$           |        |      | 278.0 | W                | $T_C = 25^\circ\text{C}$                                                         |
| Power dissipation (FullPAK)<br>TO-220 FP                              | $P_{tot}$           |        |      | 35.0  | W                | $T_C = 25^\circ\text{C}$                                                         |
| Operating and storage temperature                                     | $T_j, T_{stg}$      | -55    |      | 150   | $^\circ\text{C}$ |                                                                                  |
| Mounting torque (non FullPAK)<br>TO-247, TO-220, I <sup>2</sup> PAK   |                     |        |      | 60    | Ncm              | M3 and M3.5 screws                                                               |
| Mounting torque (FullPAK)<br>TO-220 FP                                |                     |        |      | 50    | Ncm              | M2.5 screws                                                                      |
| Continuous diode forward current                                      | $I_S$               |        |      | 33.0  | A                | $T_C = 25^\circ\text{C}$                                                         |
| Diode pulse current                                                   | $I_{S,pulse}$       |        |      | 115   | A                | $T_C = 25^\circ\text{C}$                                                         |
| Reverse diode dv/dt <sup>3)</sup>                                     | dv/dt               |        |      | 15    | V/ns             | $V_{DS} = 0 \dots 480\text{V}$ , $I_{SD} \leq I_D$ ,<br>$T_j = 25^\circ\text{C}$ |
| Maximum diode commutation speed                                       | di <sub>f</sub> /dt |        |      | 300   | A/ $\mu\text{s}$ |                                                                                  |

<sup>1)</sup> Limited by  $T_{j\text{ max}}$ . Maximum duty cycle  $D=0.75$

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

<sup>3)</sup> Identical low side and high side switch with identical  $R_G$

### 3 Thermal characteristics

**Table 3 Thermal characteristics TO-247, TO-220, I<sup>2</sup>PAK**

| Parameter                                                  | Symbol     | Values |      |      | Unit | Note / Test Condition                |
|------------------------------------------------------------|------------|--------|------|------|------|--------------------------------------|
|                                                            |            | Min.   | Typ. | Max. |      |                                      |
| Thermal resistance, junction - case                        | $R_{thJC}$ |        |      | 0.45 | °C/W |                                      |
| Thermal resistance, junction - ambient                     | $R_{thJA}$ |        |      | 62   | °C/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 TO-220 FP**

| Parameter                                                  | Symbol     | Values |      |      | Unit | Note / Test Condition                |
|------------------------------------------------------------|------------|--------|------|------|------|--------------------------------------|
|                                                            |            | Min.   | Typ. | Max. |      |                                      |
| Thermal resistance, junction - case                        | $R_{thJC}$ |        |      | 3.6  | °C/W |                                      |
| Thermal resistance, junction - ambient                     | $R_{thJA}$ |        |      | 80   | °C/W | leaded                               |
| Soldering temperature, wavesoldering only allowed at leads | $T_{sold}$ |        |      | 260  | °C   | 1.6 mm (0.063 in.) from case for 10s |

**Table 5 Thermal characteristics D<sup>2</sup>PAK**

| Parameter                                              | Symbol     | Values |      |      | Unit | Note / Test Condition                                     |
|--------------------------------------------------------|------------|--------|------|------|------|-----------------------------------------------------------|
|                                                        |            | Min.   | Typ. | Max. |      |                                                           |
| Thermal resistance, junction - case                    | $R_{thJC}$ |        |      | 0.45 | °C/W |                                                           |
| Thermal resistance, junction - ambient <sup>1)</sup>   | $R_{thJA}$ |        |      | 62   | °C/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.

## 4 Electrical characteristics

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

**Table 6 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           | $V_{GS(th)}$  | 2.5    | 3     | 3.5   | V        | $V_{DS} = V_{GS}, I_D = 1.2mA$                  |
| Zero gate voltage drain current  | $I_{DSS}$     |        |       | 1     | $\mu A$  | $V_{DS} = 650V, V_{GS} = 0V, T_j = 25^\circ C$  |
|                                  |               |        | 10    |       |          | $V_{DS} = 650V, V_{GS} = 0V, T_j = 150^\circ C$ |
| Gate-source leakage current      | $I_{GSS}$     |        |       | 100   | nA       | $V_{GS} = 20V, V_{DS} = 0V$                     |
| Drain-source on-state resistance | $R_{DS(on)}$  |        | 0.089 | 0.099 | $\Omega$ | $V_{GS} = 10V, I_D = 12.8A, T_j = 25^\circ C$   |
|                                  |               |        | 0.231 |       |          | $V_{GS} = 10V, I_D = 12.8A, T_j = 150^\circ C$  |
| Gate resistance                  | $R_G$         |        | 1.7   |       | $\Omega$ | $f = 1MHz, \text{open drain}$                   |

**Table 7 Dynamic characteristics**

| Parameter                                                  | Symbol       | Values |      |      | Unit | Note / Test Condition                                                         |
|------------------------------------------------------------|--------------|--------|------|------|------|-------------------------------------------------------------------------------|
|                                                            |              | Min.   | Typ. | Max. |      |                                                                               |
| Input capacitance                                          | $C_{iss}$    |        | 2780 |      | pF   | $V_{GS} = 0V, V_{DS} = 100V, f = 1MHz$                                        |
| Output capacitance                                         | $C_{oss}$    |        | 142  |      | pF   |                                                                               |
| Effective output capacitance, energy related <sup>1)</sup> | $C_{o(er)}$  |        | 110  |      | pF   | $V_{GS} = 0V, V_{DS} = 0 \dots 480V$                                          |
| Effective output capacitance, time related <sup>2)</sup>   | $C_{o(tr)}$  |        | 525  |      | pF   | $I_D = \text{constant}, V_{GS} = 0V, V_{DS} = 0 \dots 480V$                   |
| Turn-on delay time                                         | $t_{d(on)}$  |        | 10.6 |      | ns   | $V_{DD} = 480V, V_{GS} = 13V, I_D = 19.2A, R_G = 1.7\Omega$<br>(see table 21) |
| Rise time                                                  | $t_r$        |        | 9    |      | ns   |                                                                               |
| Turn-off delay time                                        | $t_{d(off)}$ |        | 77   |      | ns   |                                                                               |
| Fall time                                                  | $t_f$        |        | 6    |      | ns   |                                                                               |

**Table 8 Gate charge characteristics**

| Parameter             | Symbol        | Values |      |      | Unit | Note / Test Condition                                    |
|-----------------------|---------------|--------|------|------|------|----------------------------------------------------------|
|                       |               | Min.   | Typ. | Max. |      |                                                          |
| Gate to source charge | $Q_{gs}$      |        | 15   |      | nC   | $V_{DD} = 480V, I_D = 19.2A, V_{GS} = 0 \text{ to } 10V$ |
| Gate to drain charge  | $Q_{gd}$      |        | 65   |      | nC   |                                                          |
| Gate charge total     | $Q_g$         |        | 127  |      | nC   |                                                          |
| Gate plateau voltage  | $V_{plateau}$ |        | 5.5  |      | V    |                                                          |

<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 80%  $V_{(BR)DSS}$

<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 80%  $V_{(BR)DSS}$

**Table 9 Reverse diode characteristics**

| Parameter                     | Symbol    | Values |      |      | Unit    | Note / Test Condition                                                  |
|-------------------------------|-----------|--------|------|------|---------|------------------------------------------------------------------------|
|                               |           | Min.   | Typ. | Max. |         |                                                                        |
| Diode forward voltage         | $V_{SD}$  |        | 0.9  |      | V       | $V_{GS} = 0V, I_F = 19.2A, T_j = 25^\circ C$                           |
| Reverse recovery time         | $t_{rr}$  |        | 615  |      | ns      | $V_R = 400V, I_F = 19.2A,$<br>$di_F/dt = 100A/\mu s$<br>(see table 20) |
| Reverse recovery charge       | $Q_{rr}$  |        | 14.8 |      | $\mu C$ |                                                                        |
| Peak reverse recovery current | $I_{rrm}$ |        | 46   |      | A       |                                                                        |

## 5 Electrical characteristics diagrams

Table 10

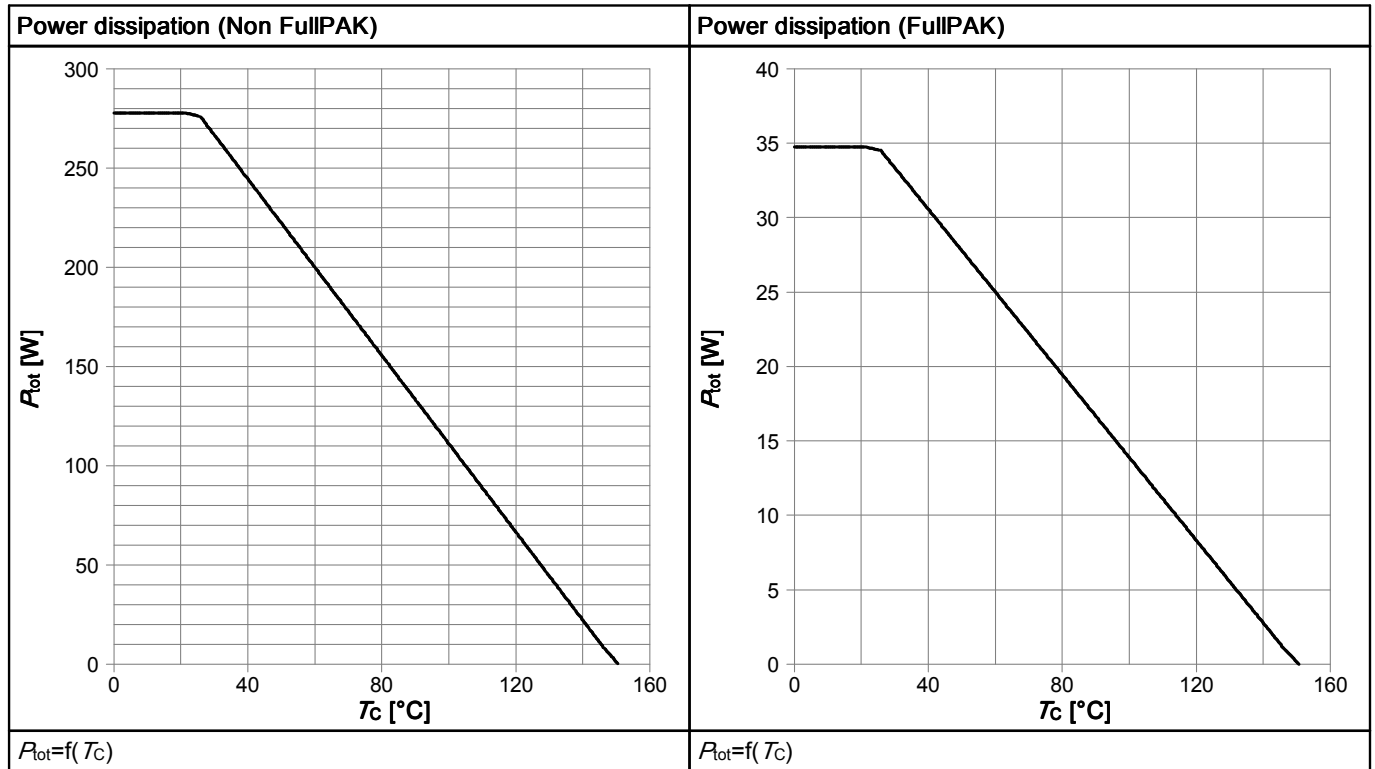


Table 11

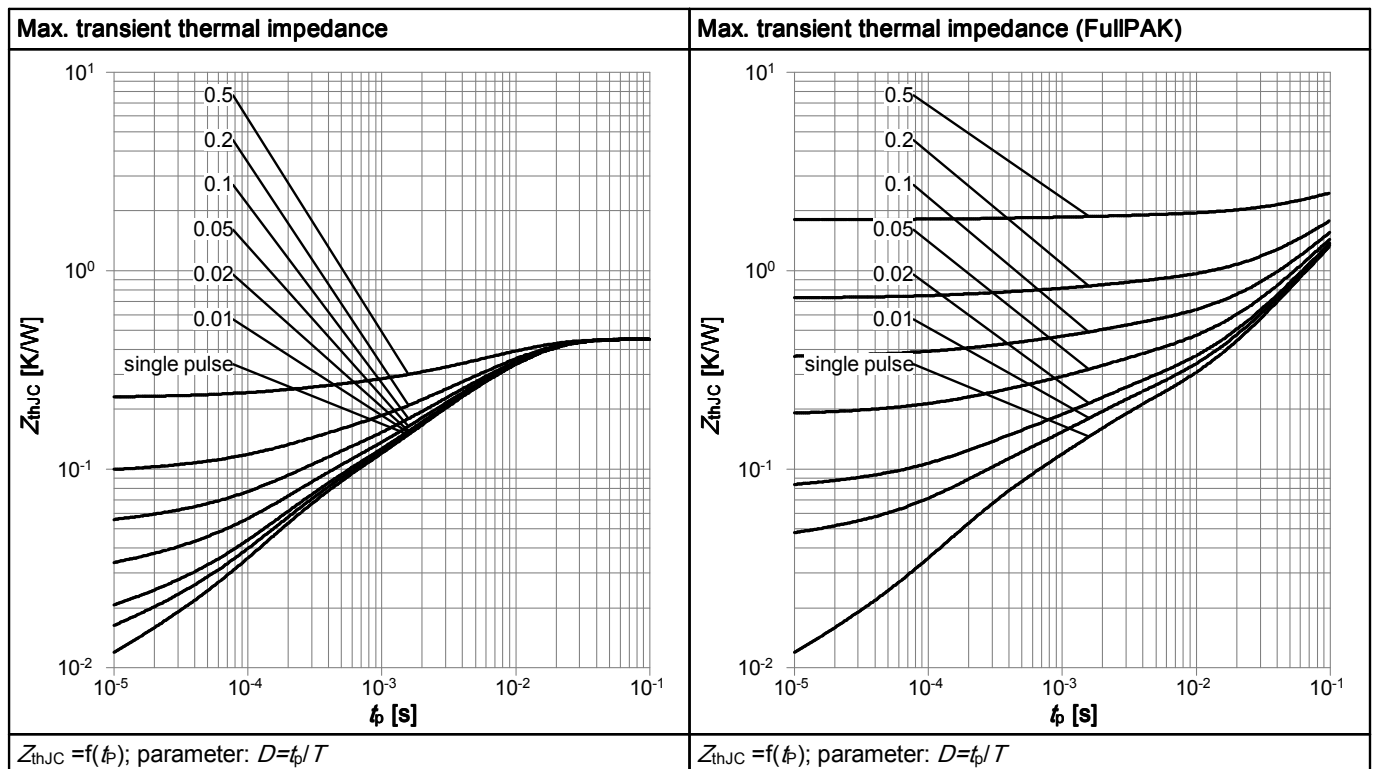




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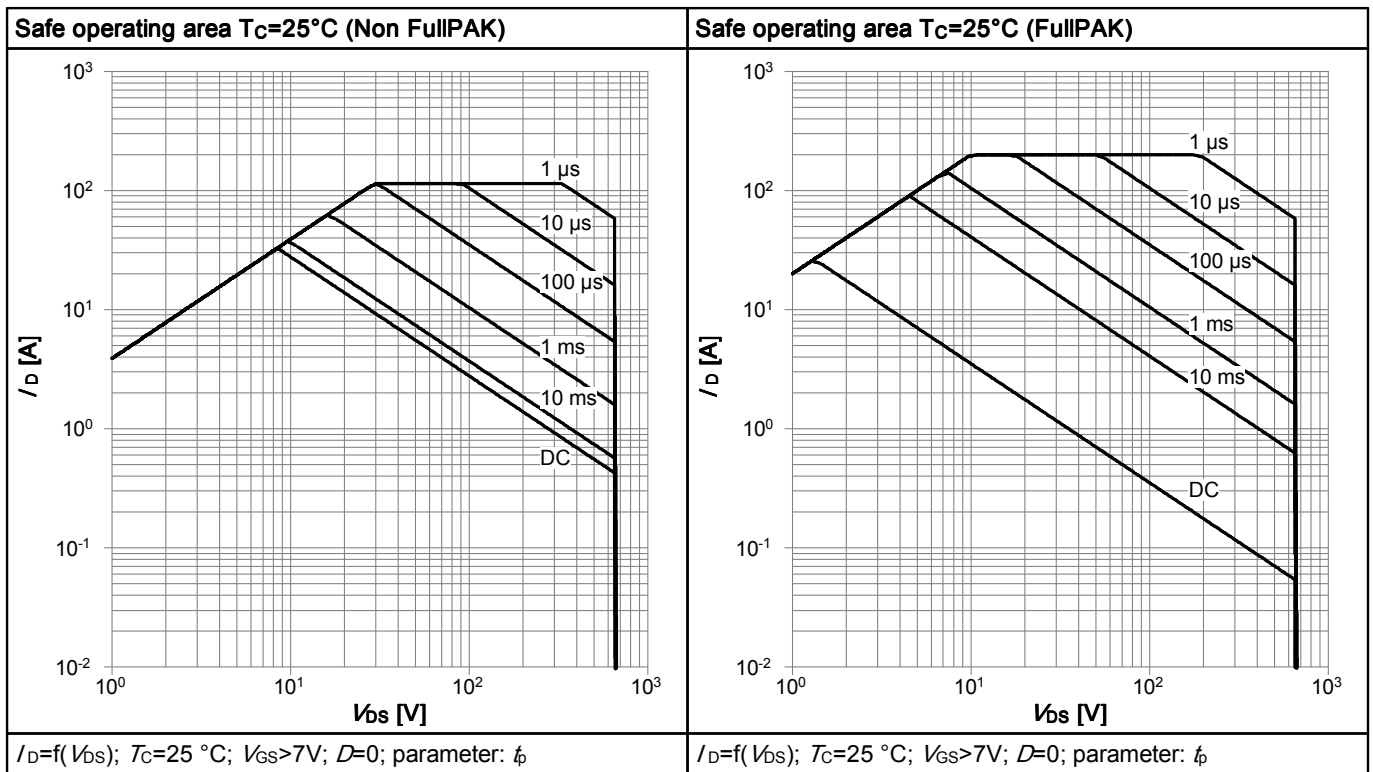


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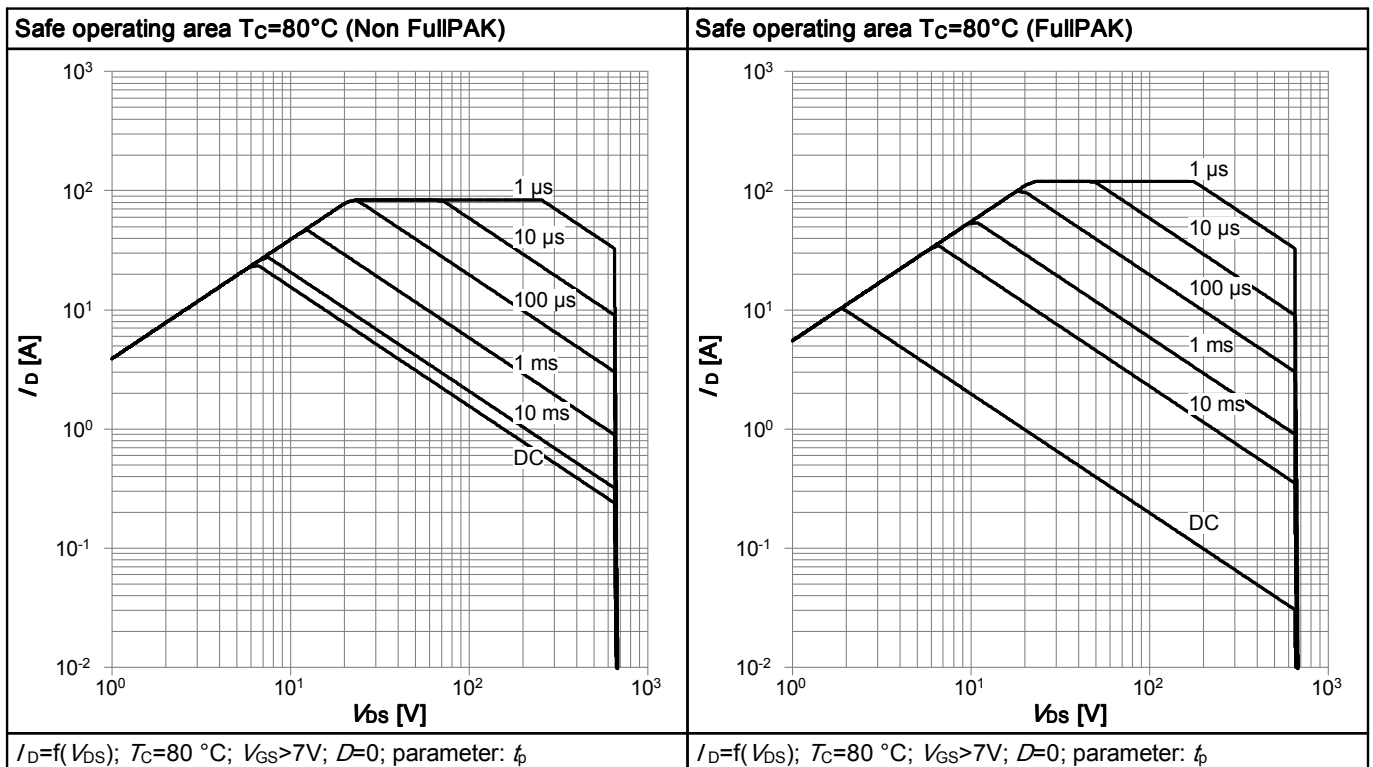


Table 14

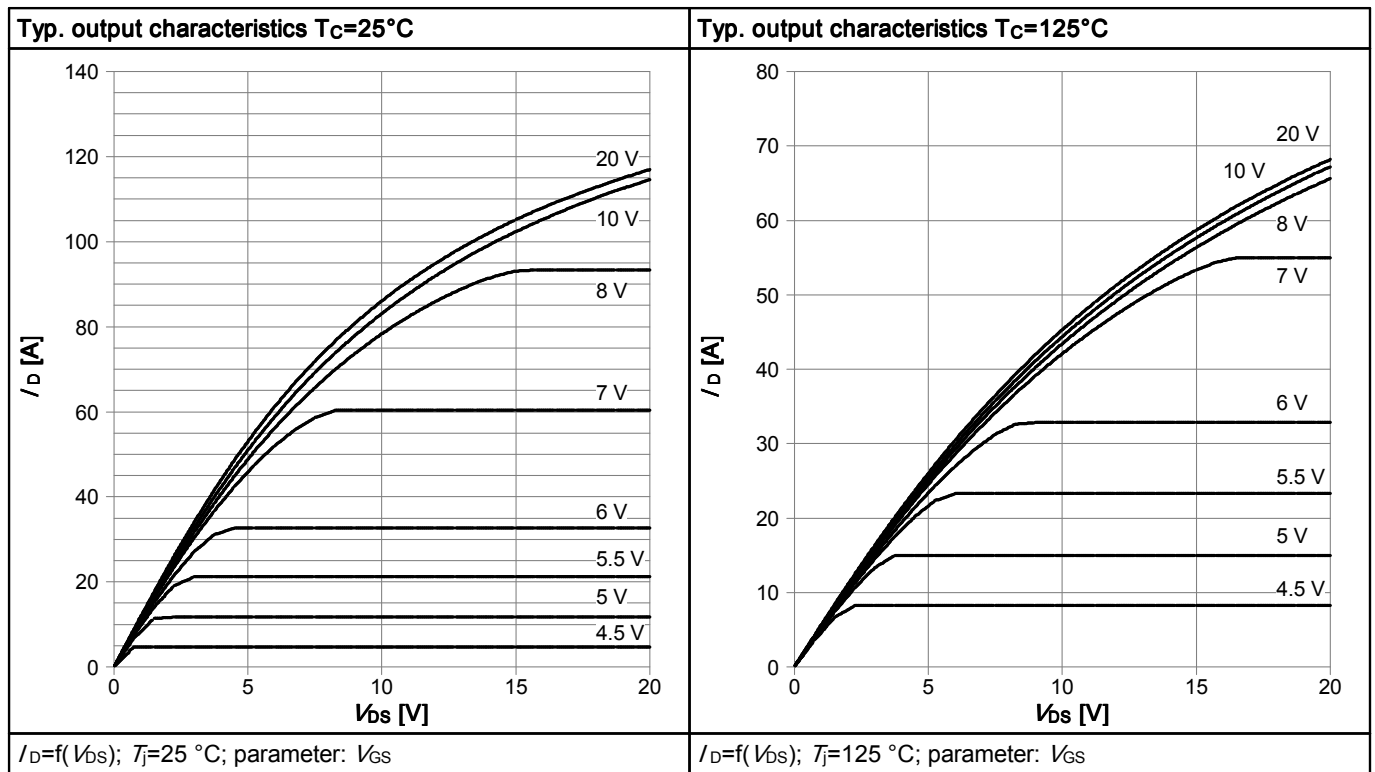


Table 15

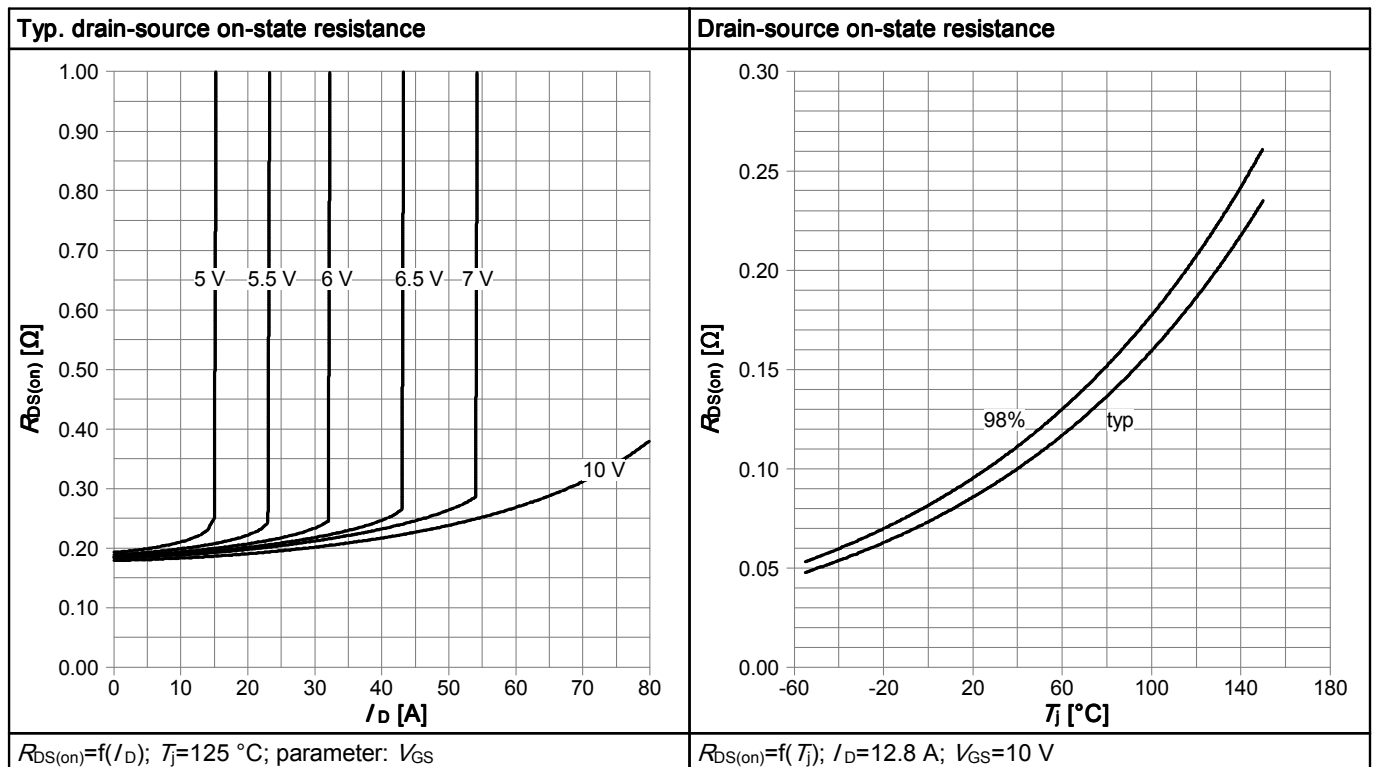


Table 16

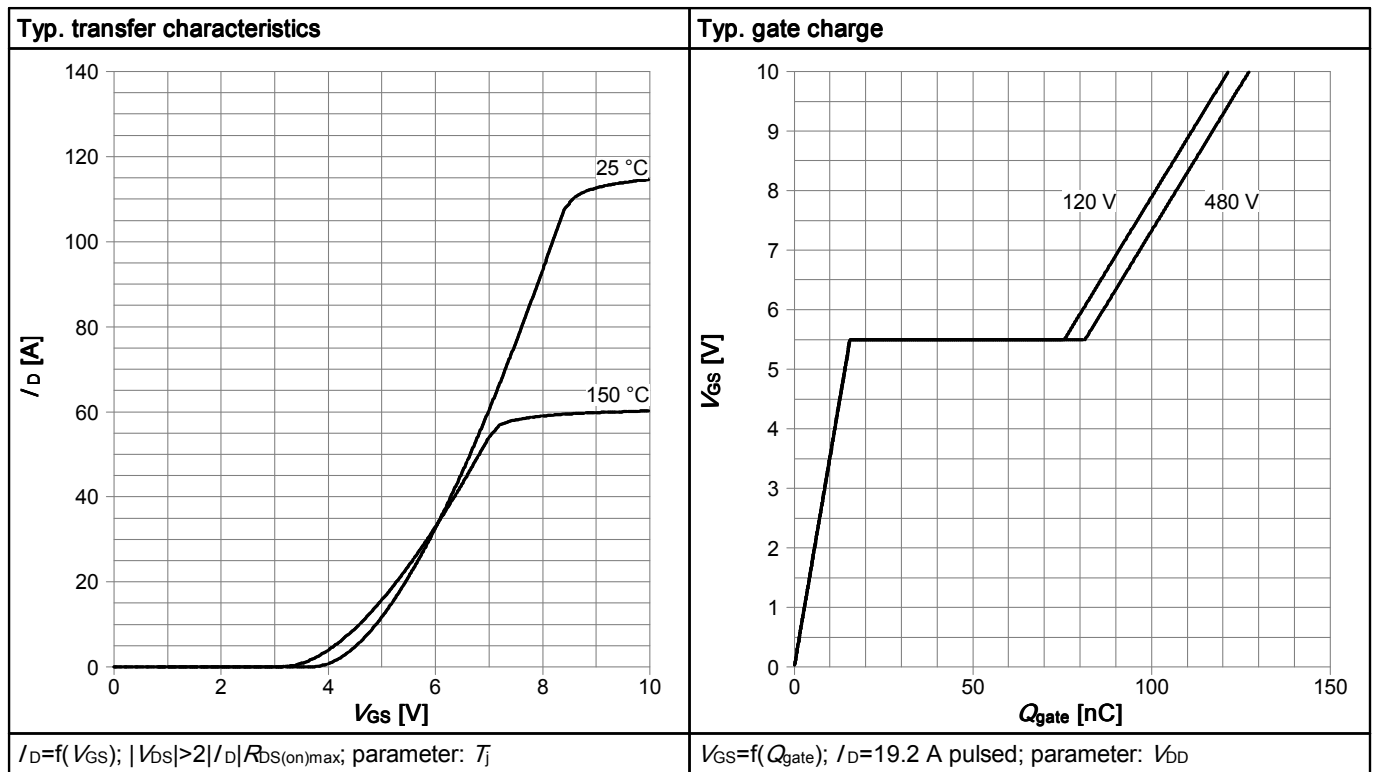


Table 17

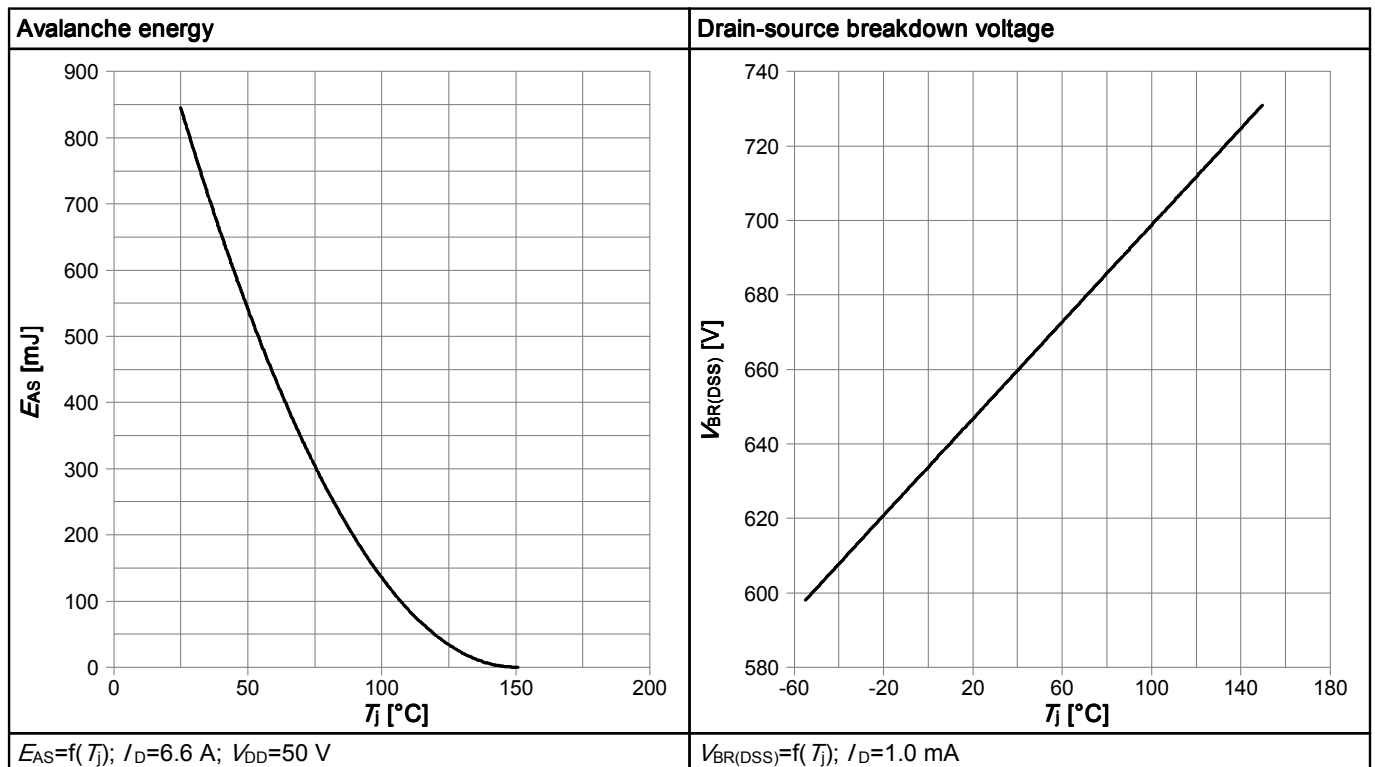


Table 18

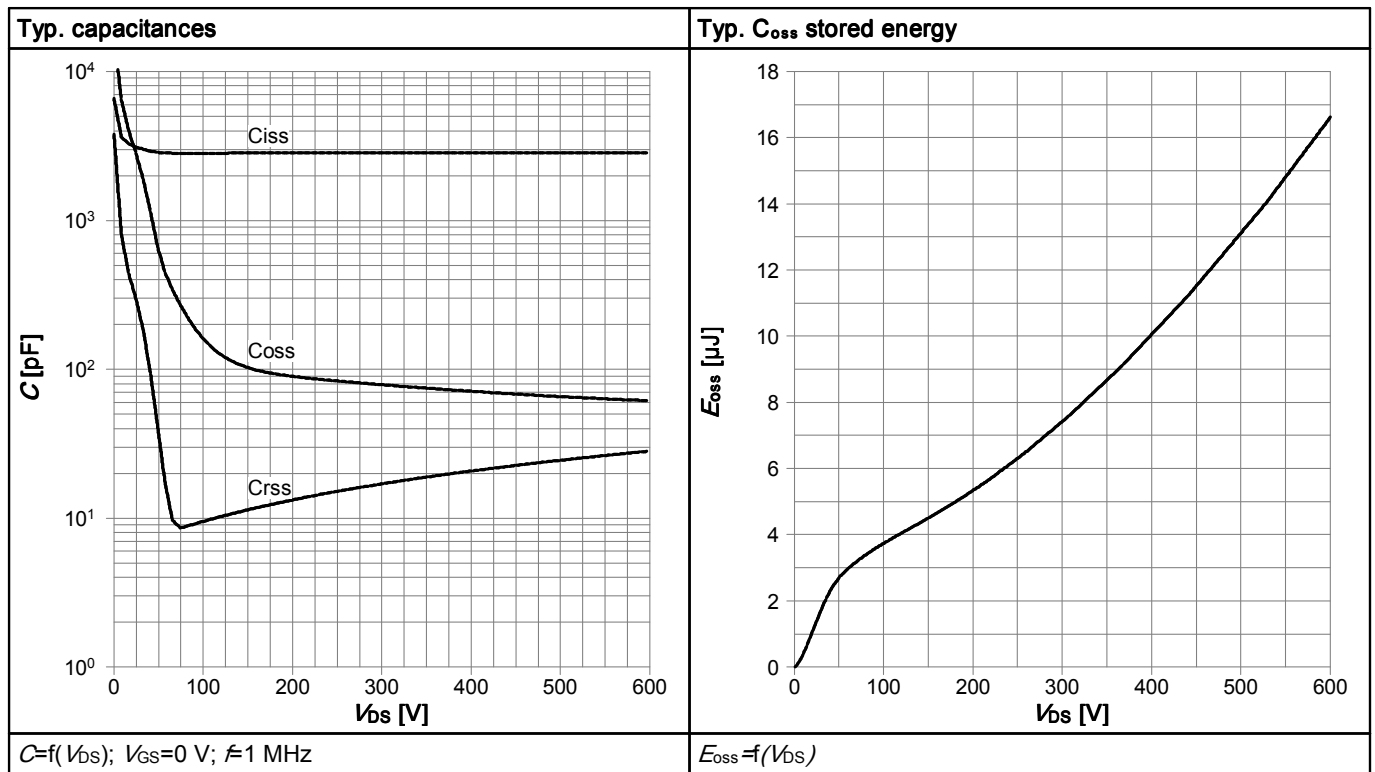
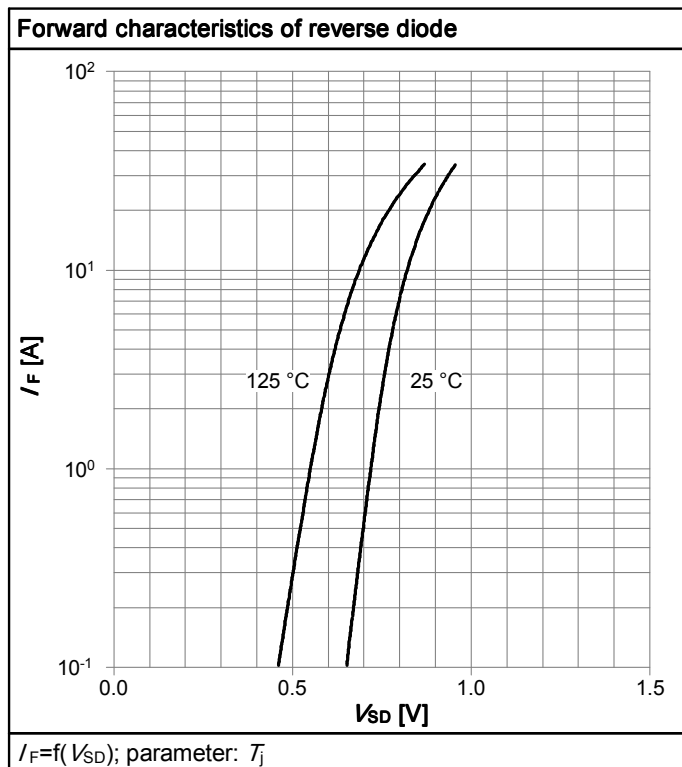
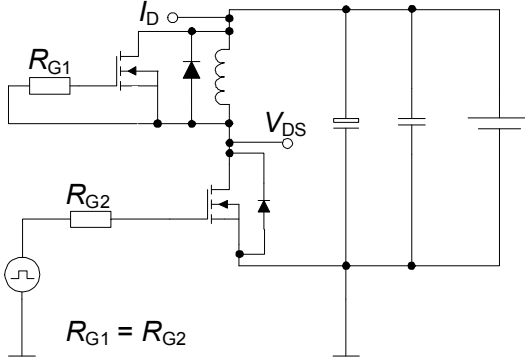
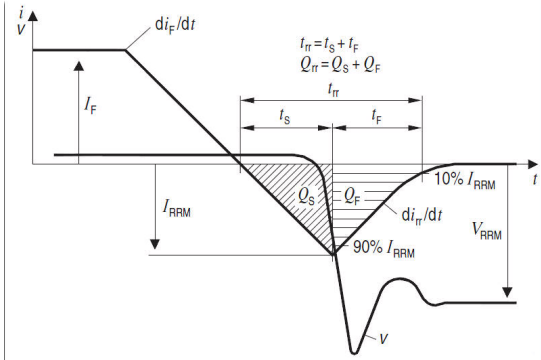


Table 19

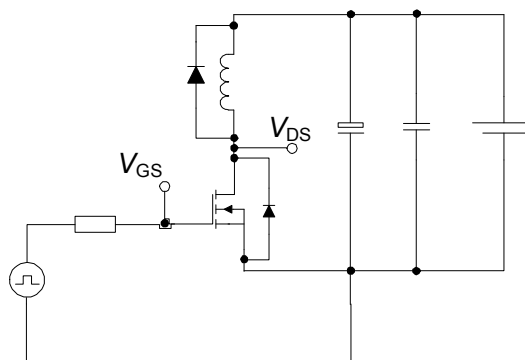
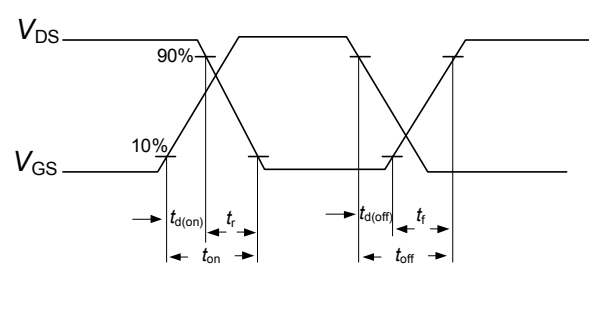


## 6 Test Circuits

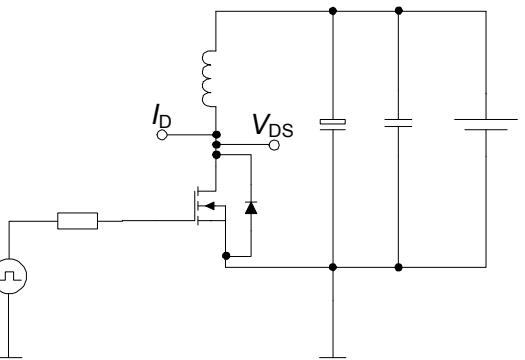
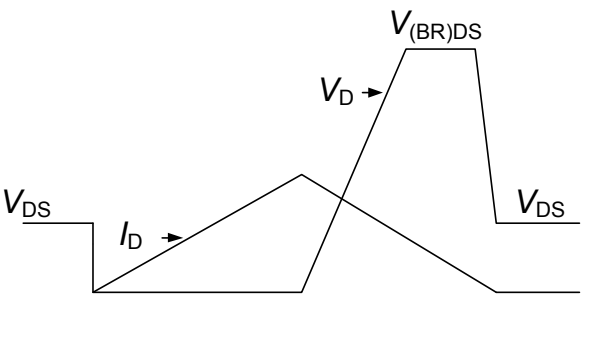
**Table 20 Diode characteristics**

| Test circuit for diode characteristics                                                                                | Diode recovery waveform                                                            |
|-----------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------|
|  <p><math>R_{G1} = R_{G2}</math></p> |  |

**Table 21 Switching times**

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

**Table 22 Unclamped inductive**

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

## 7 Package Outlines

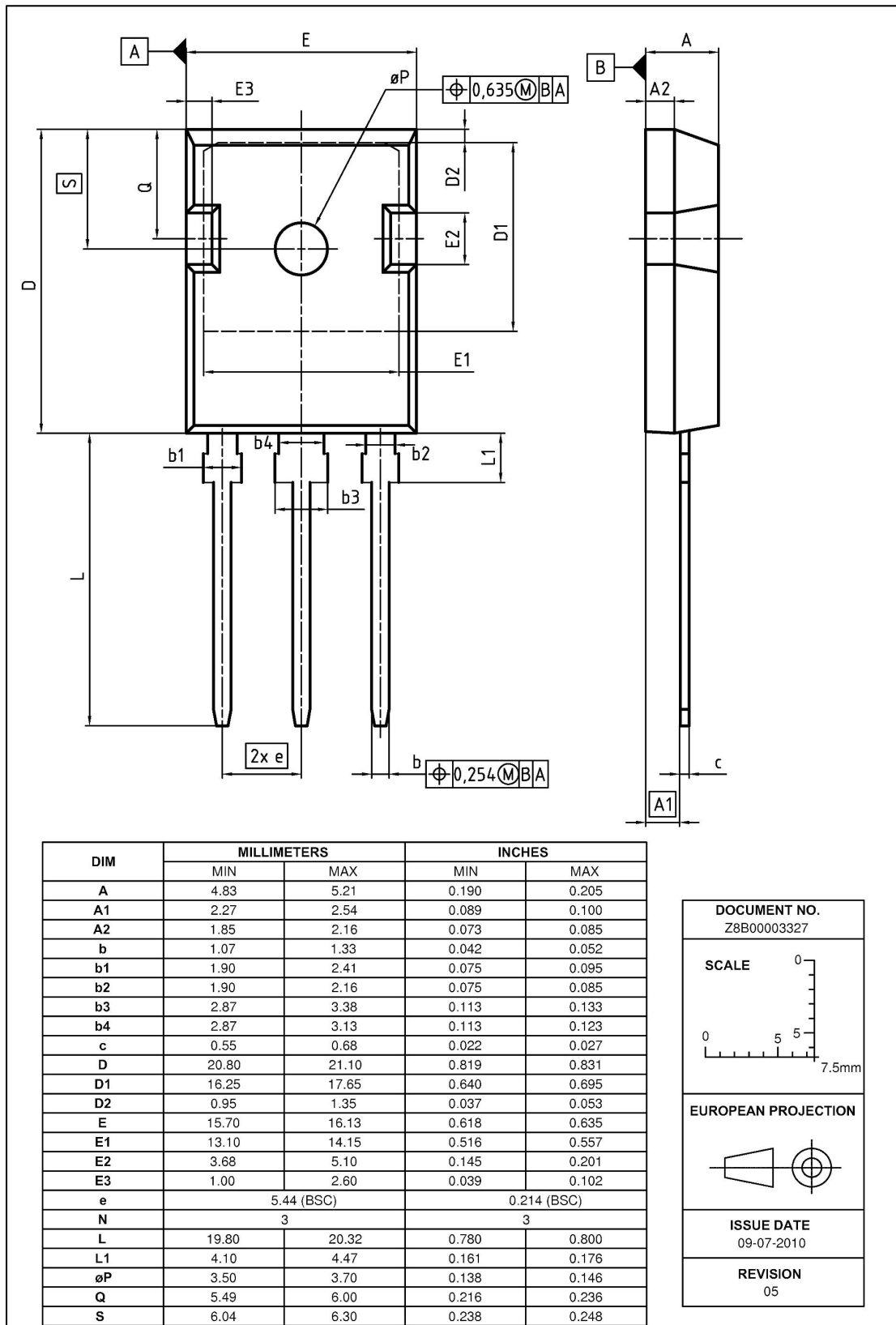
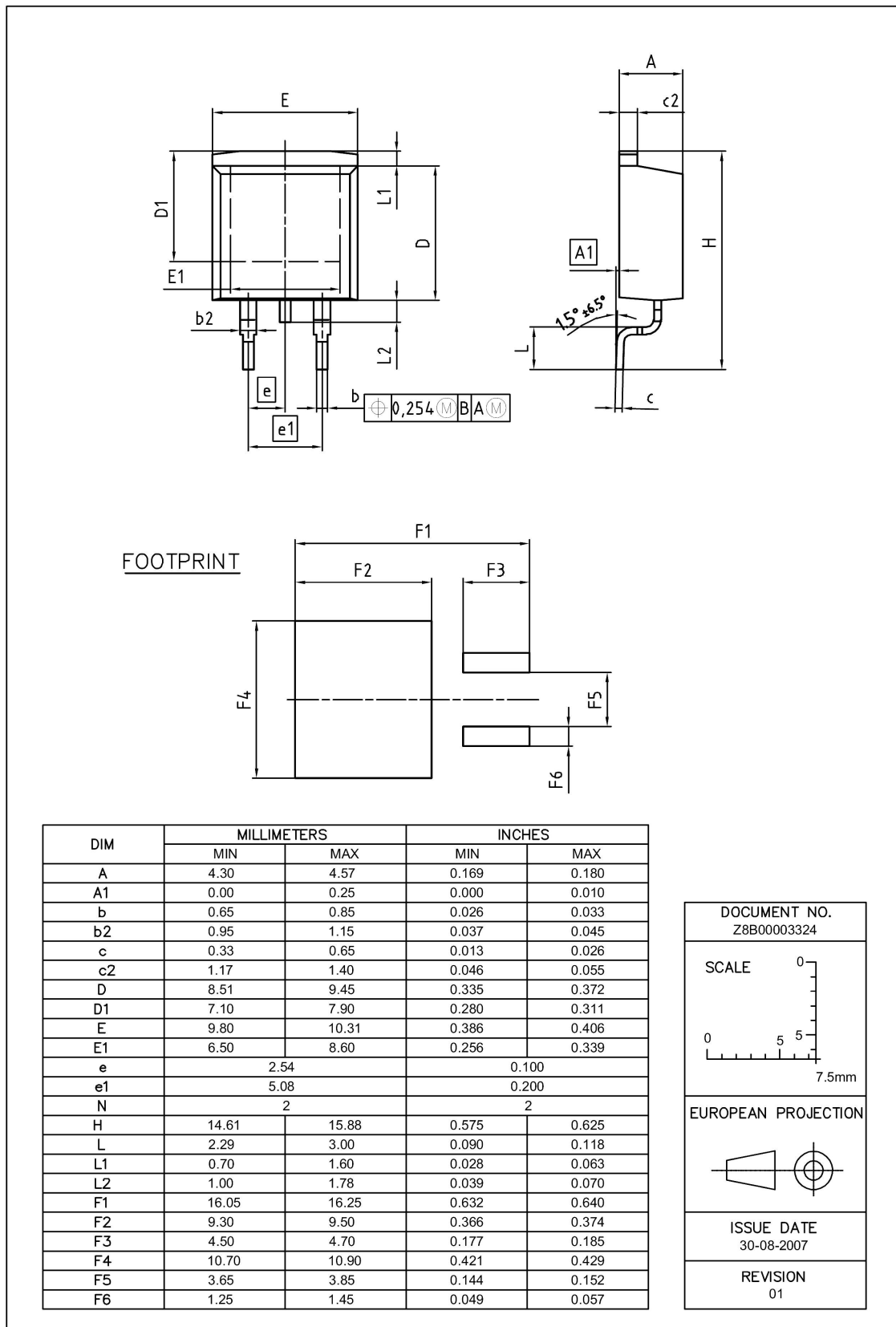


Figure 1 Outline PG-TO 247, dimensions in mm/inches



**Figure 2 Outline PG-TO 263, dimensions in mm/inches**

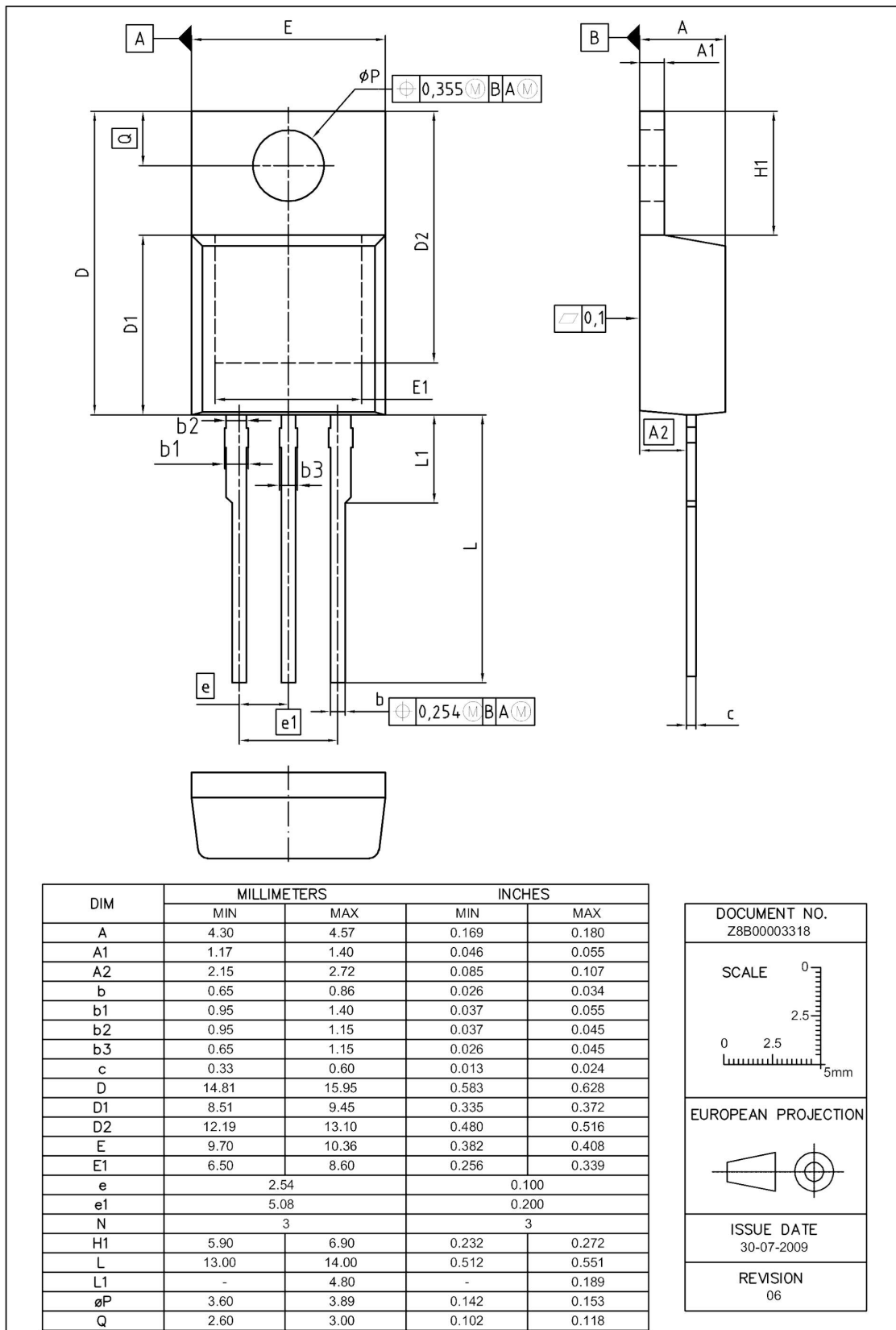


Figure 3 Outline PG-TO 220, dimensions in mm/inches



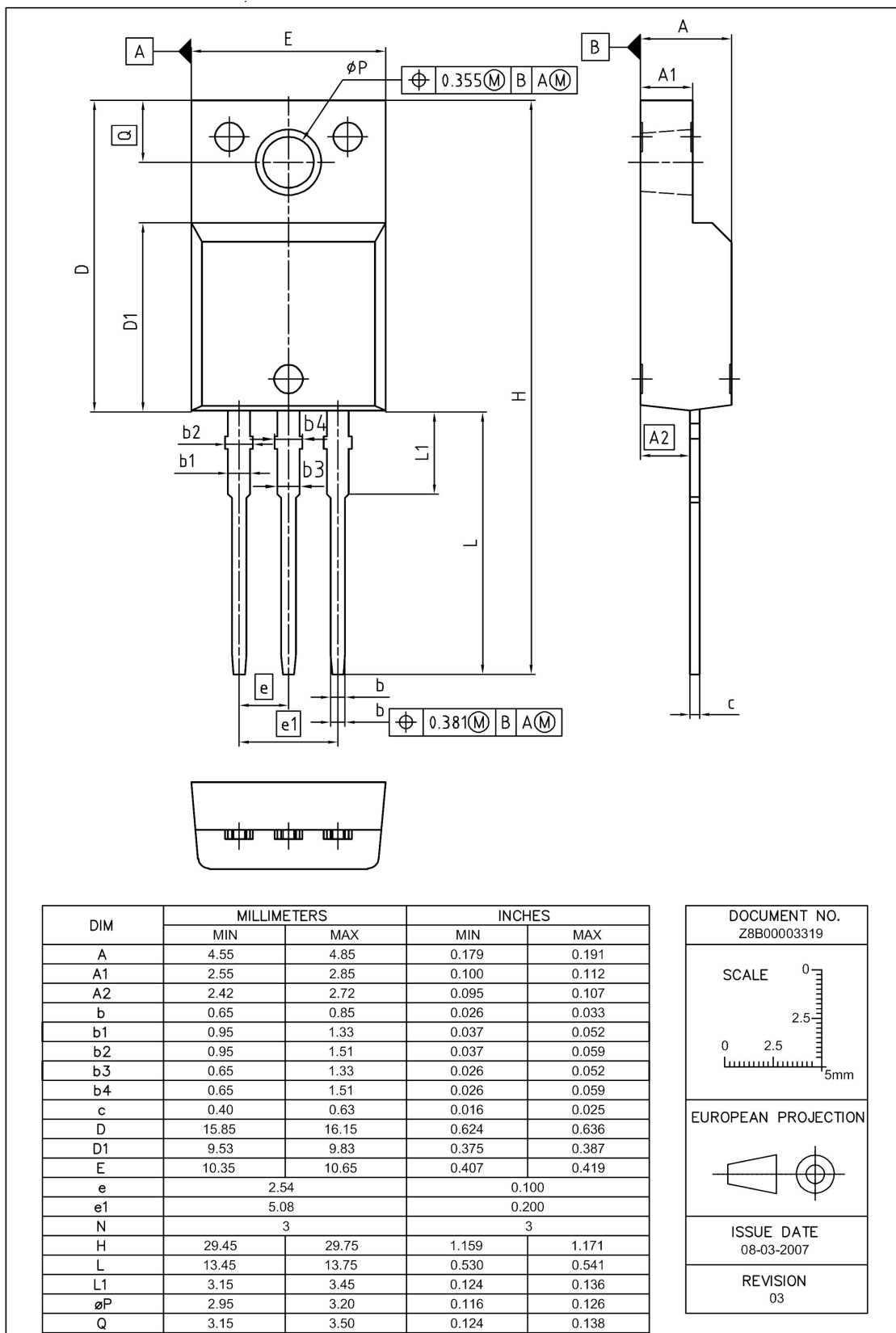


Figure 4 Outline PG-TO 220 FullPAK, dimensions in mm/inches

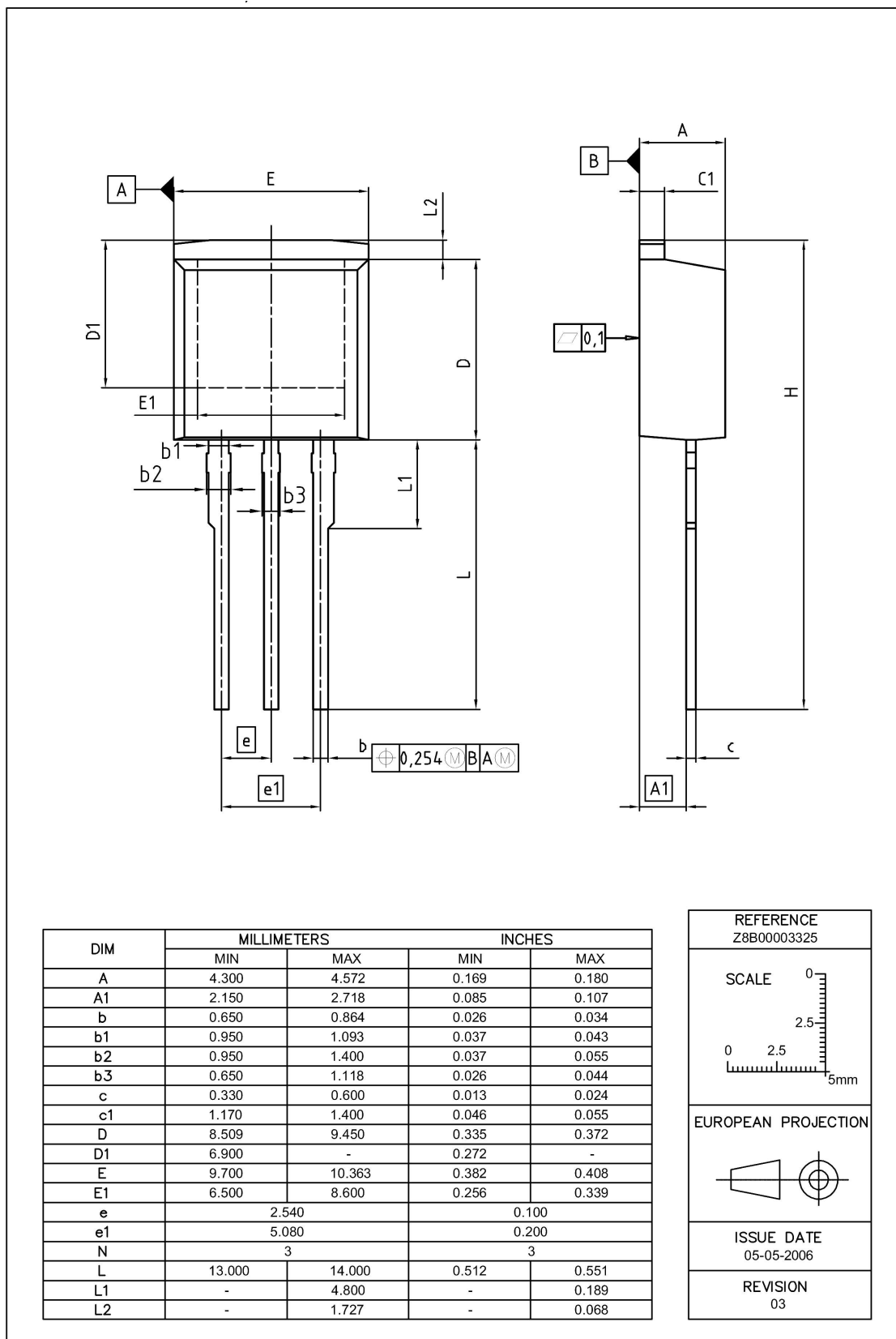


Figure 5 Outline PG-TO 262, dimensions in mm/inches

## 8 Appendix A

### Table 23 Related Links

- **IFX C6 Product Brief:**

<http://www.infineon.com/dgdl/Product+Brief+600V+CoolMOS+C6+.pdf?folderId=db3a3043156fd5730115939eb6b506db>

- **IFX C6 Portfolio:**

[http://www.infineon.com/cms/en/product/findProductTypeByName.html?q=ip\\*c6](http://www.infineon.com/cms/en/product/findProductTypeByName.html?q=ip*c6)

- **IFX CoolMOS Webpage:**

<http://www.infineon.com/cms/en/product/channel.html?channel=ff80808112ab681d0112ab6a628704d8>

- **IFX Design Tools:**

<http://www.infineon.com/cms/en/product/promopages/designtools/index.html>

## Revision History

IPW65R099C6, IPB65R099C6, IPP65R099C6, IPA65R099C6, IPI65R099C6

**Revision: 2011-12-14, Rev. 2.0**

Previous Revision

| Revision | Date       | Subjects (major changes since last revision) |
|----------|------------|----------------------------------------------|
| 1.0      | 2011-12-14 | Release of final datasheet                   |
| 2.0      | 2011-12-14 | Release of final datasheet                   |

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