



**THE DATASHEET OF
IPA60R380E6XKSA1**



MOSFET

Metal Oxide Semiconductor Field Effect Transistor

CoolMOS™ E6 600V

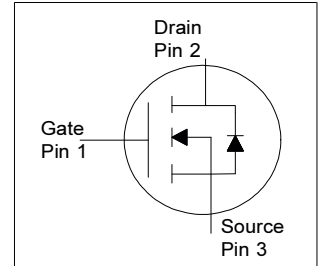
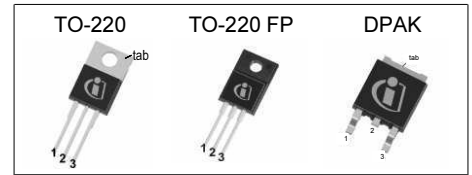
600V CoolMOS™ E6 Power Transistor
IPx60R380E6

Data Sheet

Rev. 2.6
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™ E6 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 (except PG-TO252)
- 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 and UPS.



Table 1 Key Performance Parameters

| Parameter | Value | Unit |
|----------------------|-------|------------|
| $V_{DS} @ T_{j,max}$ | 650 | V |
| $R_{DS(on),max}$ | 0.38 | Ω |
| Q_g,typ | 32 | nC |
| $I_D,pulse$ | 30 | A |
| $E_{oss} @ 400V$ | 2.8 | μJ |
| Body diode di/dt | 500 | A/ μs |

| Type / Ordering Code | Package | Marking | Related Links |
|----------------------|-------------------|---------|----------------|
| IPP60R380E6 | PG-TO 220 | 6R380E6 | see Appendix A |
| IPA60R380E6 | PG-TO 220 FullPAK | | |
| IPD60R380E6 | PG-TO 252 | | |



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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 ¹⁾ | I_D | | | 10.6 | A | $T_C = 25^\circ\text{C}$ |
| | | | | 6.7 | | $T_C = 100^\circ\text{C}$ |
| Pulsed drain current ²⁾ | $I_{D,pulse}$ | | | 30 | A | $T_C = 25^\circ\text{C}$ |
| Avalanche energy, single pulse | E_{AS} | | | 210 | mJ | $I_D = 1.8\text{A}$, $V_{DD} = 50\text{V}$ (see table 22) |
| Avalanche energy, repetitive | E_{AR} | | | 0.32 | mJ | $I_D = 1.8\text{A}$, $V_{DD} = 50\text{V}$ |
| Avalanche current, repetitive | I_{AR} | | | 1.8 | 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) TO-220 | P_{tot} | | | 83 | W | $T_C = 25^\circ\text{C}$ |
| Power dissipation (FullPAK) TO-220 FP | P_{tot} | | | 31 | W | $T_C = 25^\circ\text{C}$ |
| Operating and storage temperature | T_j, T_{stg} | -55 | | 150 | $^\circ\text{C}$ | |
| Mounting torque (non FullPAK) TO-220 | | | | 60 | Ncm | M3 and M3.5 screws |
| Mounting torque (FullPAK) TO-220 FP | | | | 50 | Ncm | M2.5 screws |
| Continuous diode forward current | I_S | | | 9.2 | A | $T_C = 25^\circ\text{C}$ |
| Diode pulse current | $I_{S,pulse}$ | | | 30 | A | $T_C = 25^\circ\text{C}$ |
| Reverse diode dv/dt ³⁾ | dv/dt | | | 15 | V/ns | $V_{DS} = 0 \dots 480\text{V}$, $I_{SD} \leq I_D$, $T_j = 25^\circ\text{C}$ (see table 20) |
| Maximum diode commutation speed | di/dt | | | 500 | A/ μs | |

¹⁾ Limited by $T_{j,max}$. Maximum duty cycle $D=0.75$

²⁾ Pulse width t_p limited by $T_{j,max}$

³⁾ Identical low side and high side switch with identical R_G

3 Thermal characteristics

Table 3 Thermal characteristics TO-220

| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|--|------------|--------|------|------|------|--------------------------------------|
| | | Min. | Typ. | Max. | | |
| Thermal resistance, junction - case | R_{thJC} | | | 1.5 | °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} | | | 4.0 | °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 DPAK

| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|--|------------|--------|------|------|------|---|
| | | Min. | Typ. | Max. | | |
| Thermal resistance, junction - case | R_{thJC} | | | 1.5 | °C/W | |
| Thermal resistance, junction - ambient ¹⁾ | R_{thJA} | | | 62 | °C/W | SMD version, device on PCB, minimal footprint |
| | | | 35 | | | SMD version, device on PCB, 6cm ² cooling area |
| Soldering temperature, wave- & reflowsoldering allowed | T_{sold} | | | 260 | °C | reflow MSL |

¹⁾ Device on 40mm*40mm*1.5mm one layer epoxy PCB FR4 with 6cm² 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 | $V_{(BR)DSS}$ | 600 | | | V | $V_{GS} = 0V, I_D = 0.25mA$ |
| Gate threshold voltage | $V_{GS(th)}$ | 2.5 | 3 | 3.5 | V | $V_{DS} = V_{GS}, I_D = 0.3mA$ |
| Zero gate voltage drain current | I_{DSS} | | | 1 | μA | $V_{DS} = 600V, V_{GS} = 0V, T_j = 25^\circ C$ |
| | | | 10 | | | $V_{DS} = 600V, V_{GS} = 0V, T_j = 150^\circ C$ |
| Gate-source leakage current | I_{GSS} | | | 100 | nA | $V_{GS} = 20V, V_{DS} = 0V$ |
| Drain-source on-state resistance | $R_{DS(on)}$ | | 0.340 | 0.38 | Ω | $V_{GS} = 10V, I_D = 3.8A, T_j = 25^\circ C$ |
| | | | 0.890 | | | $V_{GS} = 10V, I_D = 3.8A, T_j = 150^\circ C$ |
| Gate resistance | R_G | | 7.5 | | Ω | $f = 1MHz, \text{open drain}$ |

Table 7 Dynamic characteristics

| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|--|--------------|--------|------|------|------|--|
| | | Min. | Typ. | Max. | | |
| Input capacitance | C_{iss} | | 700 | | pF | $V_{GS} = 0V, V_{DS} = 100V, f = 1MHz$ |
| Output capacitance | C_{oss} | | 46 | | pF | |
| Effective output capacitance, energy related ¹⁾ | $C_{o(er)}$ | | 30 | | pF | $V_{GS} = 0V, V_{DS} = 0 \dots 480V$ |
| Effective output capacitance, time related ²⁾ | $C_{o(tr)}$ | | 136 | | pF | $I_D = \text{constant}, V_{GS} = 0V, V_{DS} = 0 \dots 480V$ |
| Turn-on delay time | $t_{d(on)}$ | | 11 | | ns | $V_{DD} = 400V, V_{GS} = 13V, I_D = 4.8A, R_G = 3.4\Omega$ (see table 22) |
| Rise time | t_r | | 9 | | ns | |
| Turn-off delay time | $t_{d(off)}$ | | 56 | | ns | |
| Fall time | t_f | | 8 | | ns | |

Table 8 Gate charge characteristics

| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|-----------------------|---------------|--------|------|------|------|---|
| | | Min. | Typ. | Max. | | |
| Gate to source charge | Q_{gs} | | 4 | | nC | $V_{DD} = 480V, I_D = 4.8A, V_{GS} = 0 \text{ to } 10V$ |
| Gate to drain charge | Q_{gd} | | 16 | | nC | |
| Gate charge total | Q_g | | 32 | | nC | |
| Gate plateau voltage | $V_{plateau}$ | | 5.4 | | V | |

¹⁾ $C_{o(er)}$ is a fixed capacitance that gives the same stored energy as C_{oss} while V_{DS} is rising from 0 to 80% $V_{(BR)DSS}$

²⁾ $C_{o(tr)}$ 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 | $V_{GS} = 0V, I_F = 4.8A, T_j = 25^\circ C$ |
| Reverse recovery time | t_{rr} | | 290 | | ns | $V_R = 400V, I_F = 4.8A,$ $di_F/dt = 100A/\mu s$ (see table 20) |
| Reverse recovery charge | Q_{rr} | | 3.3 | | μC | |
| Peak reverse recovery current | I_{rrm} | | 21 | | A | |

5 Electrical characteristics diagrams

Table 10

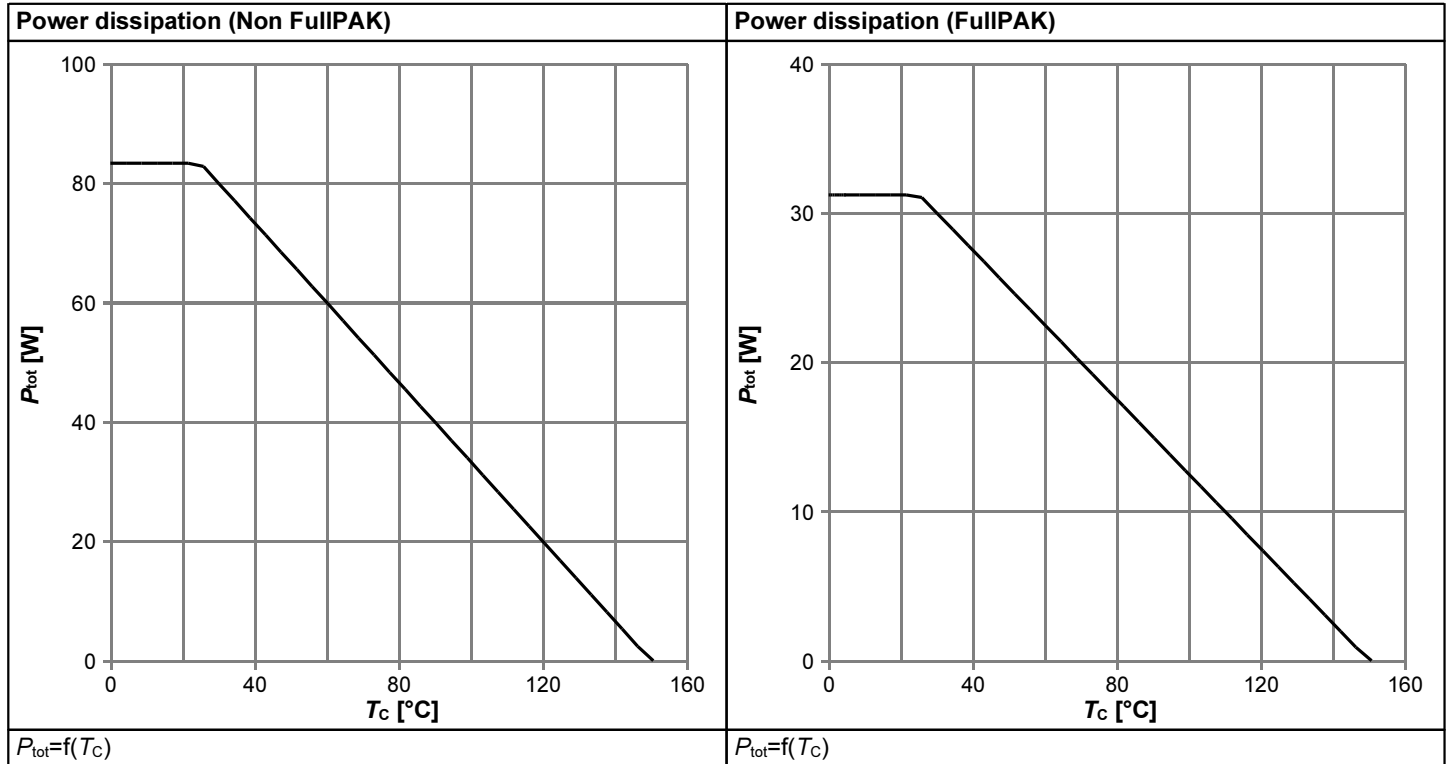


Table 11

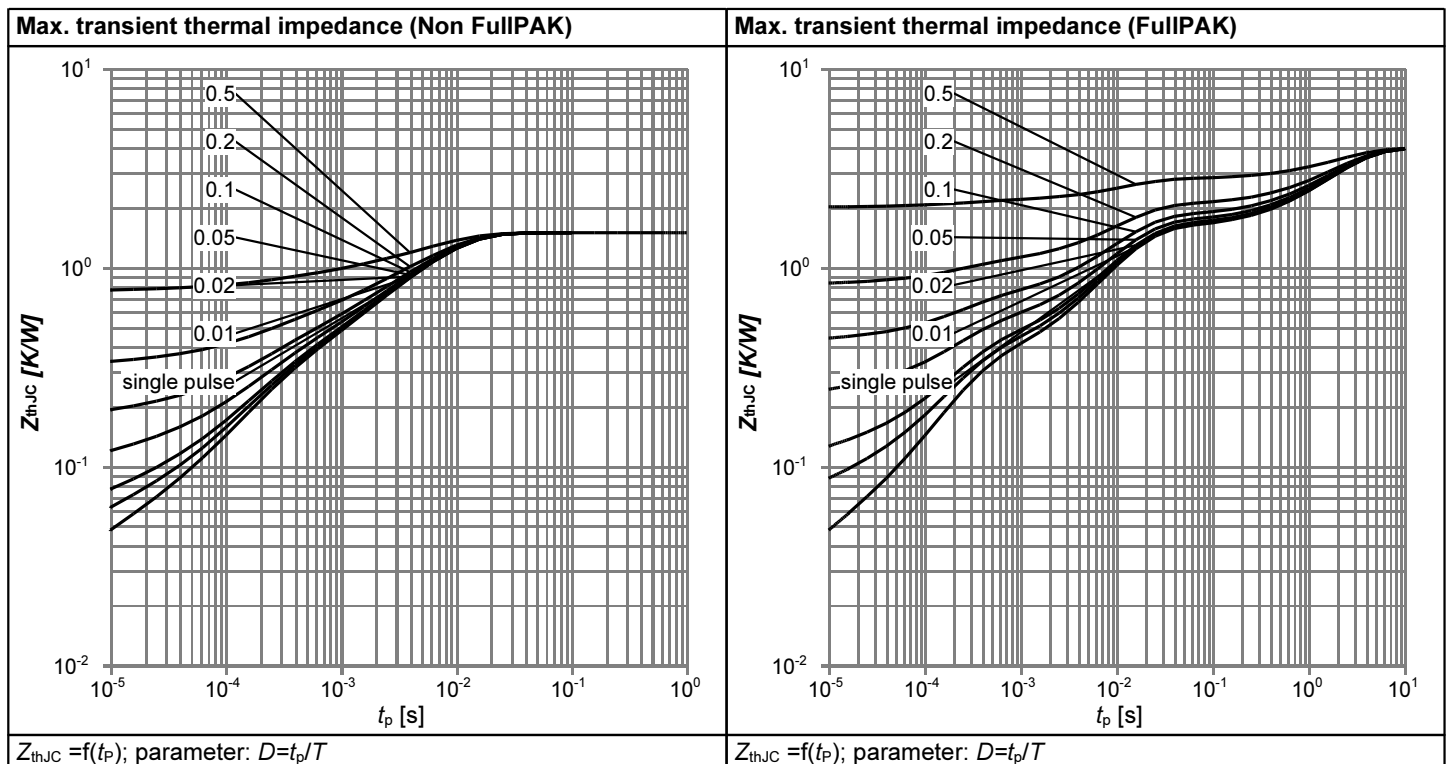


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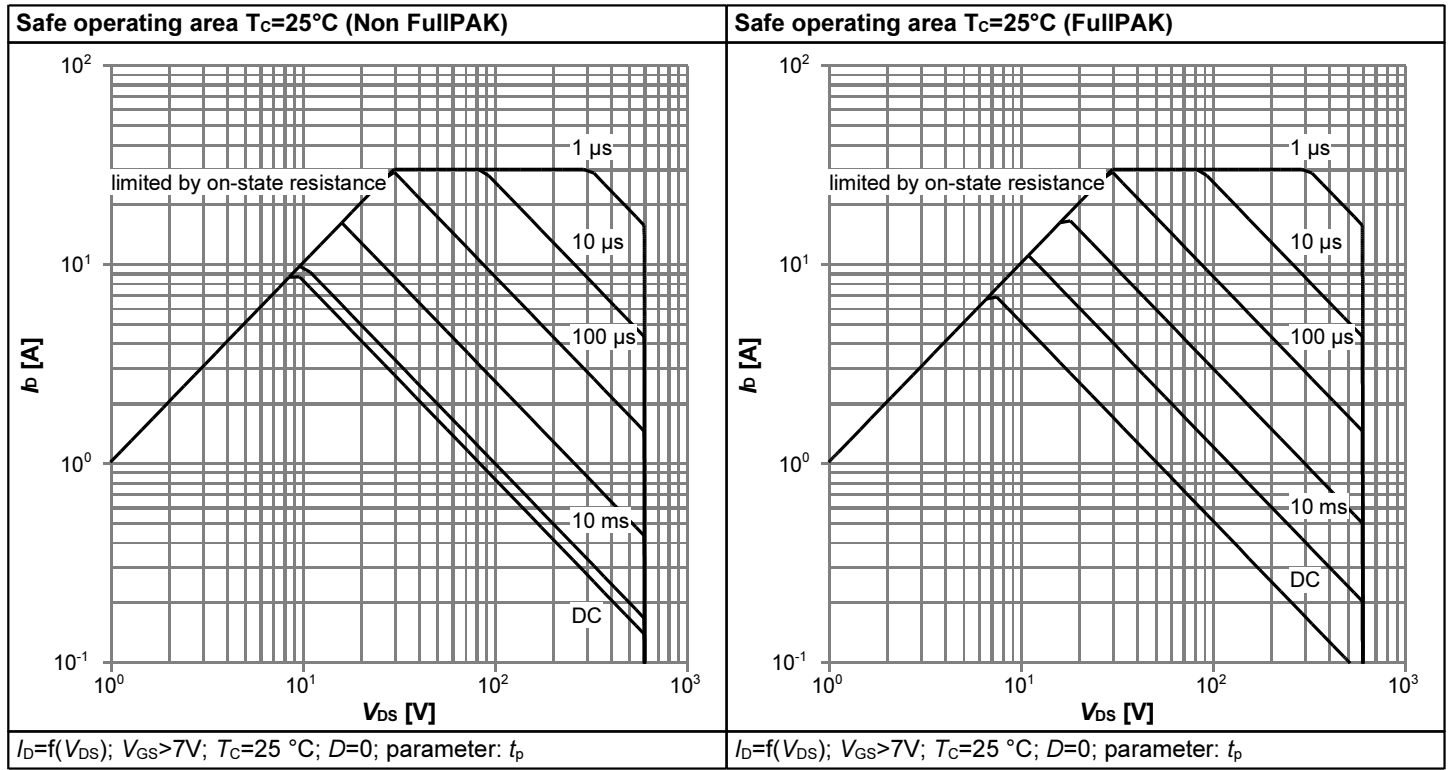


Table 13

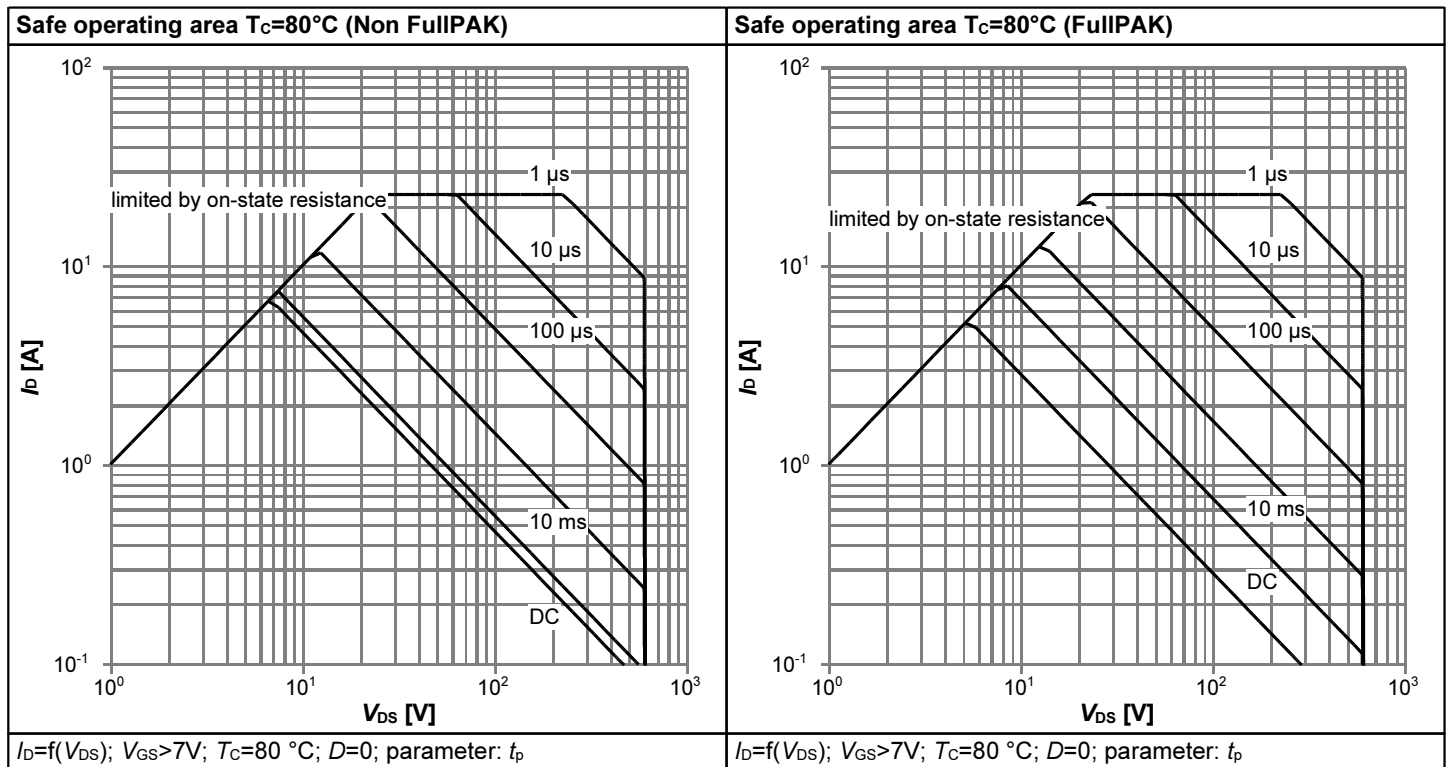


Table 14

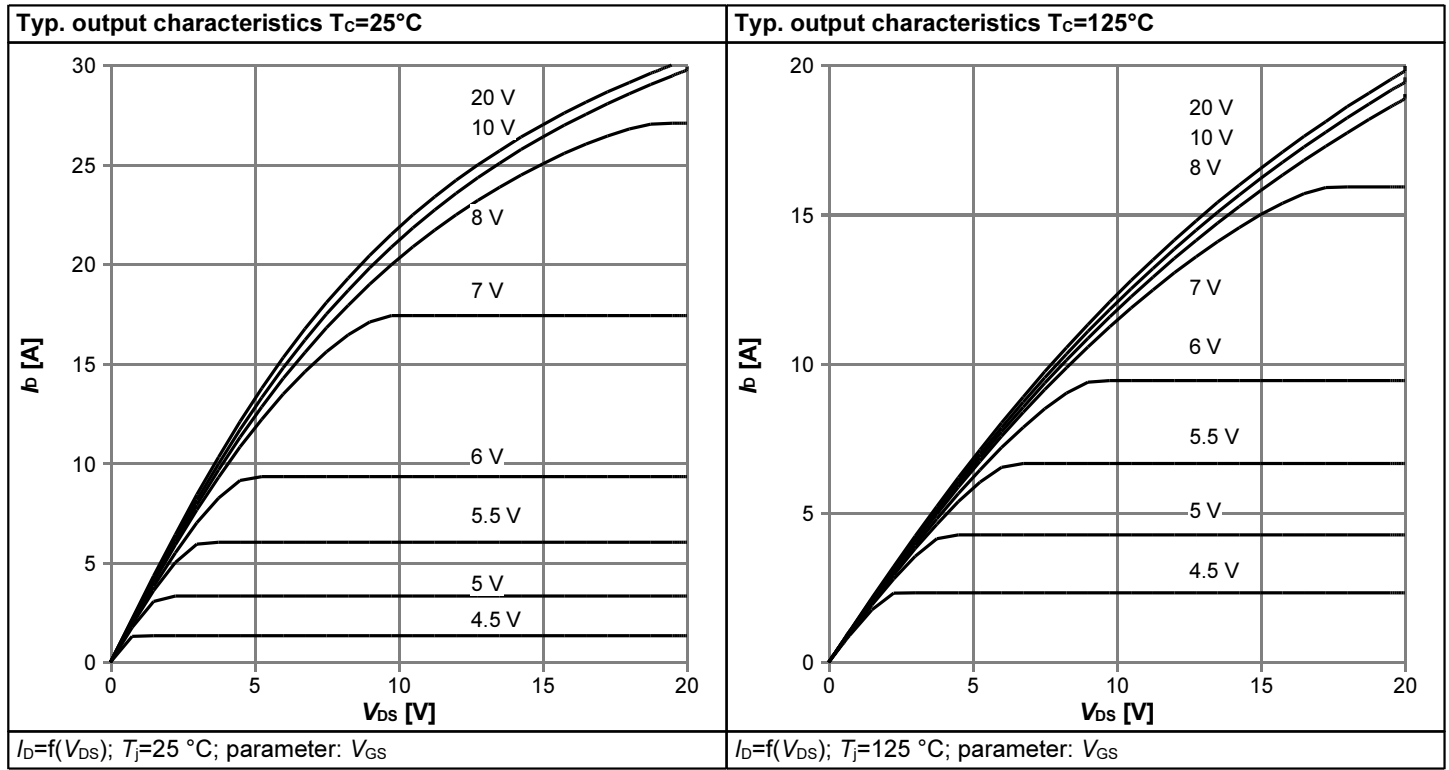


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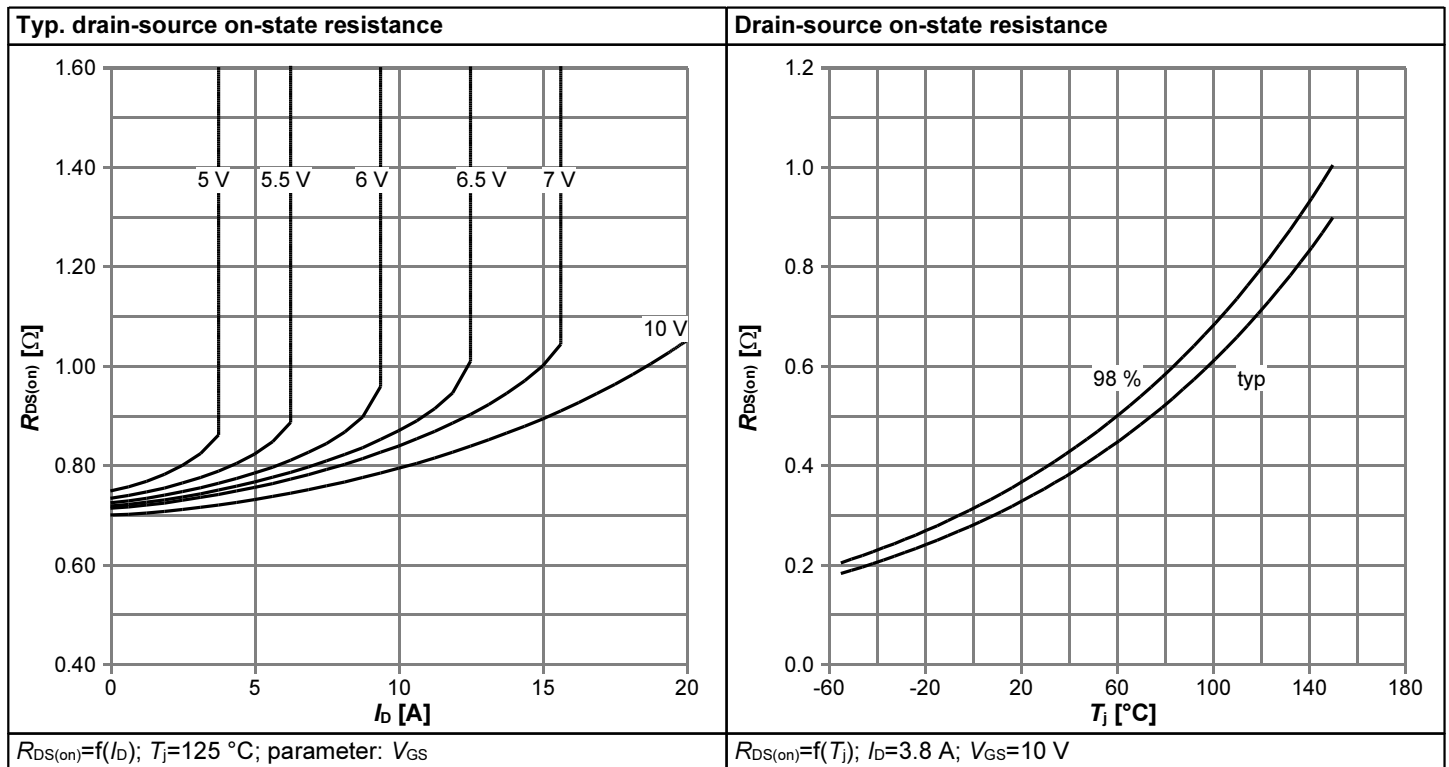


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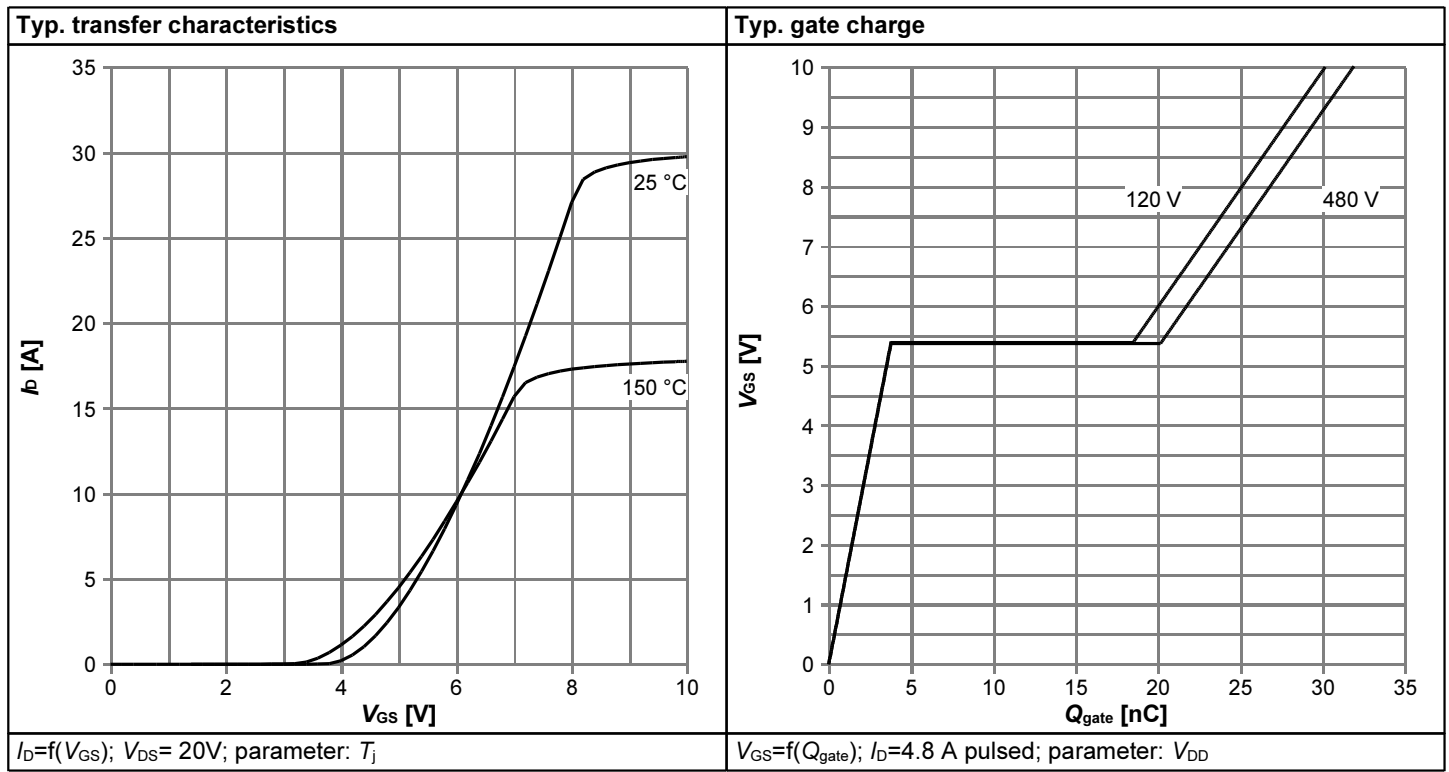


Table 17

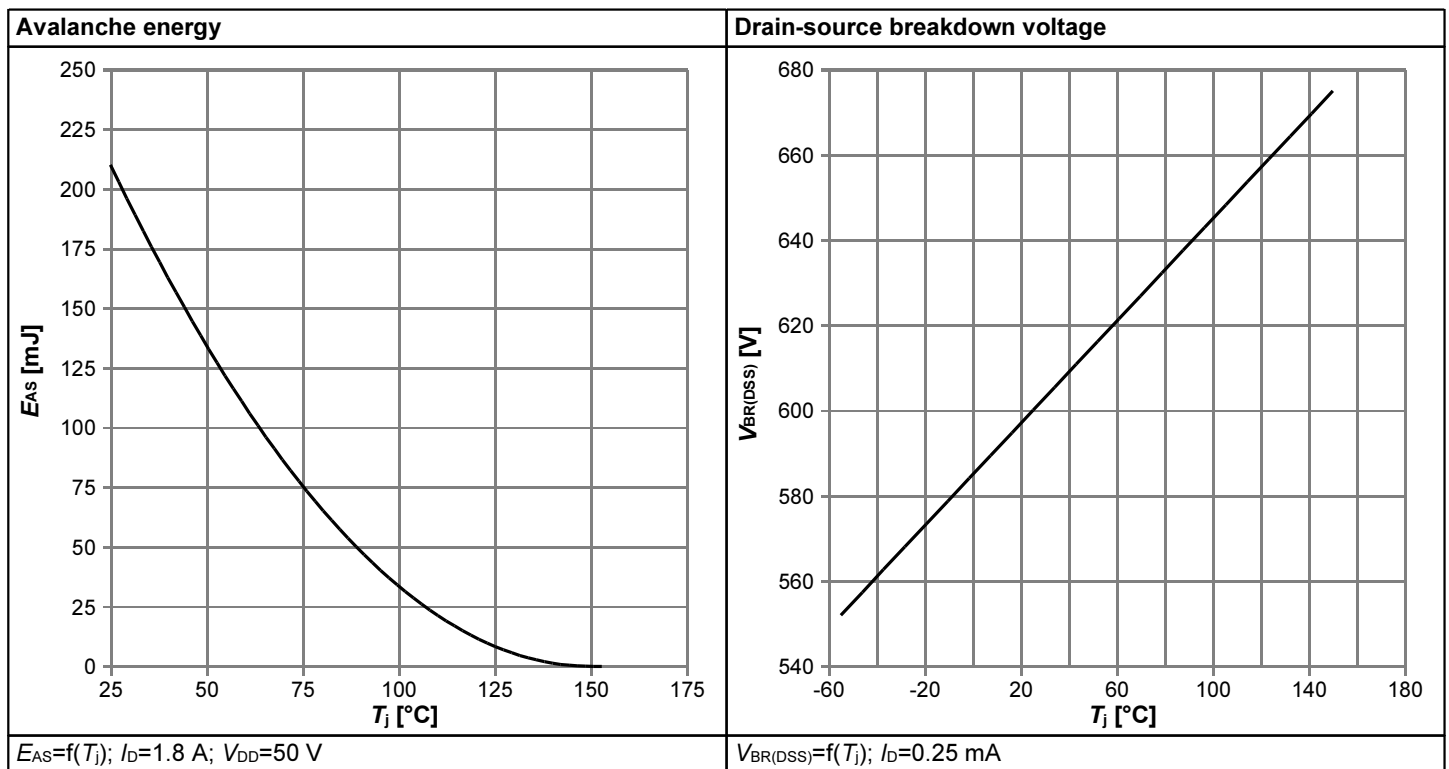


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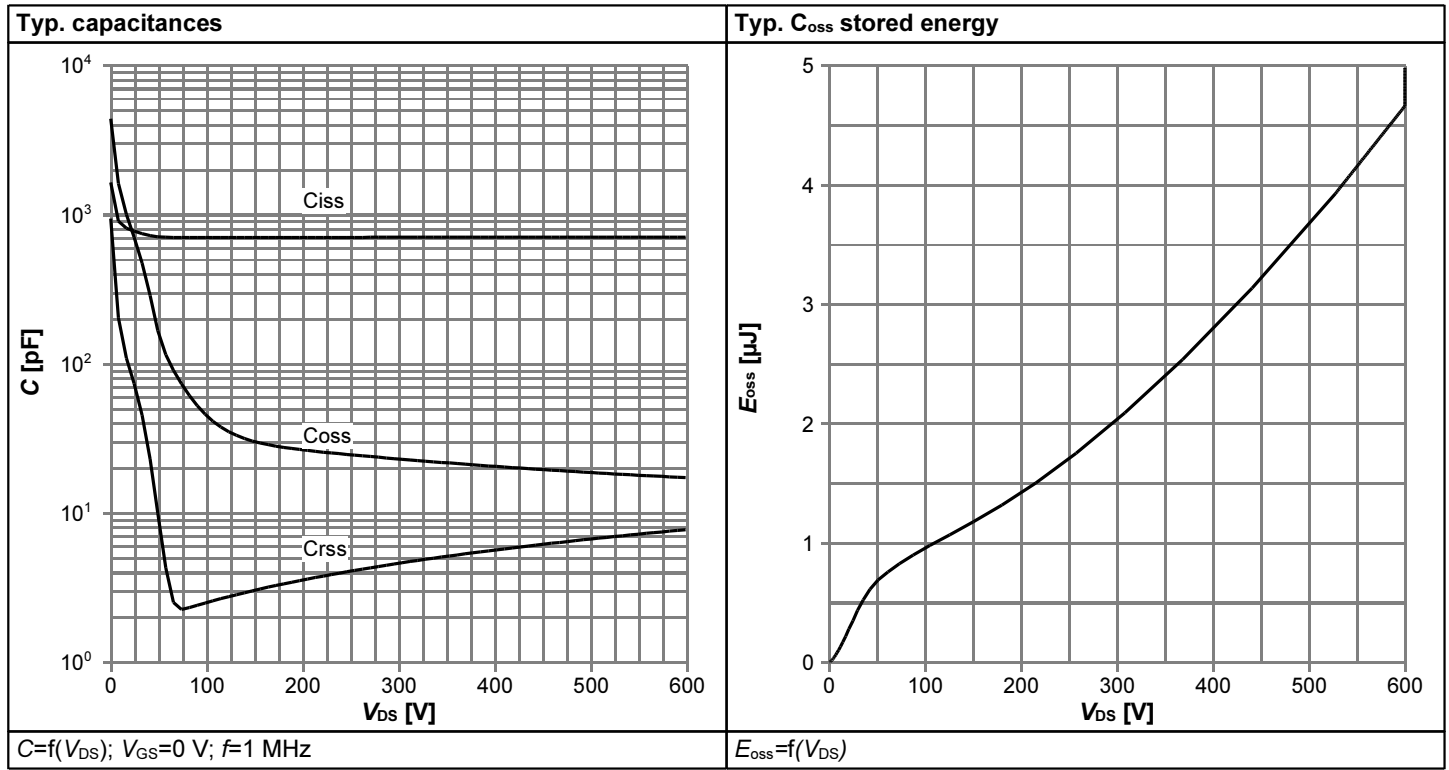
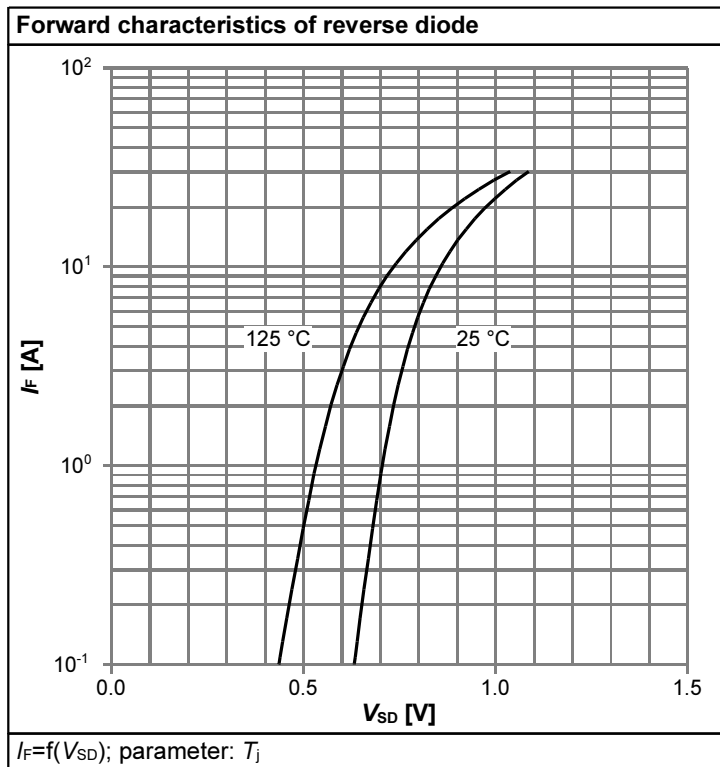


Table 19



6 Test Circuits

Table 20 Diode characteristics

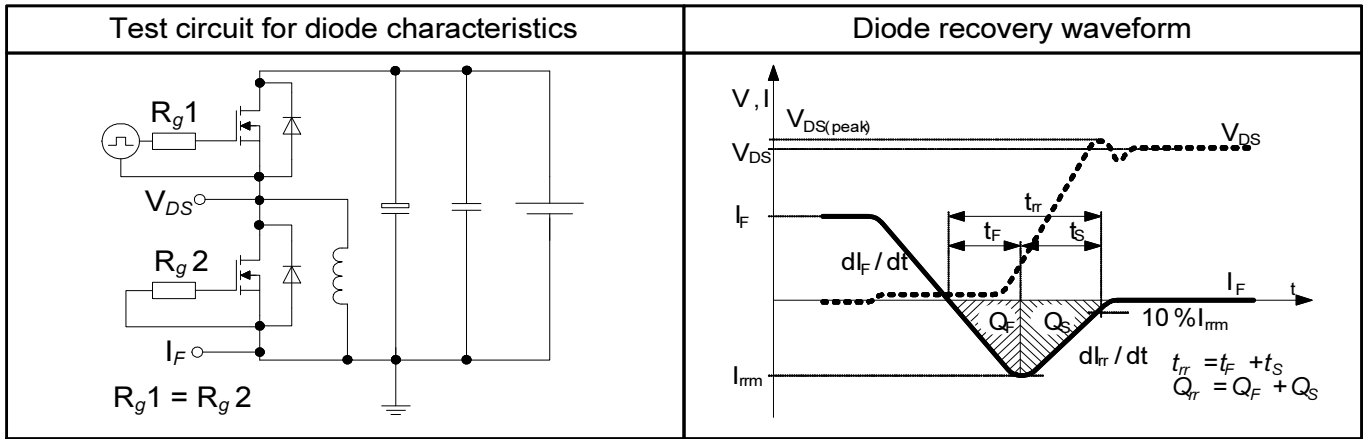


Table 21 Switching times

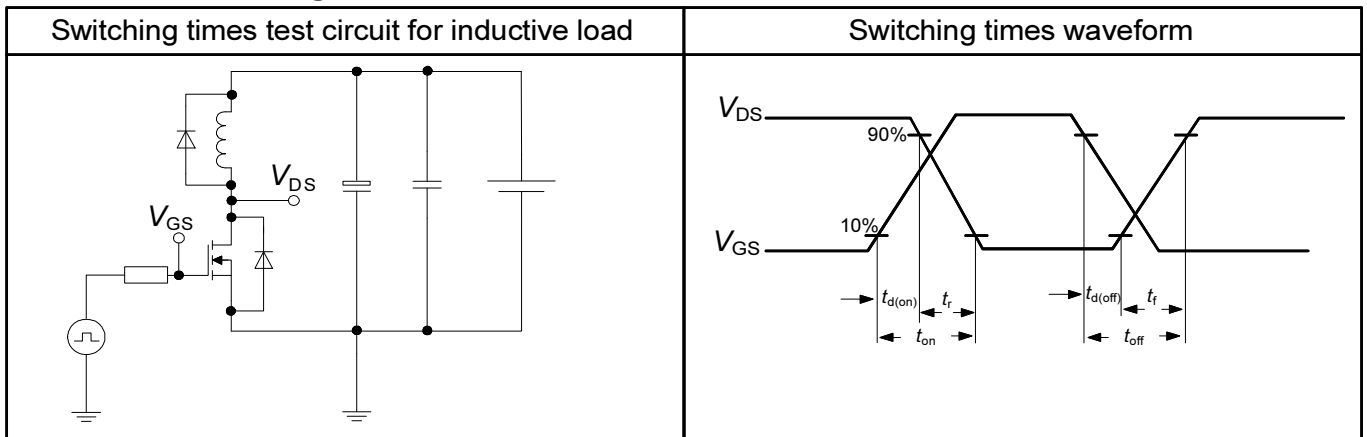
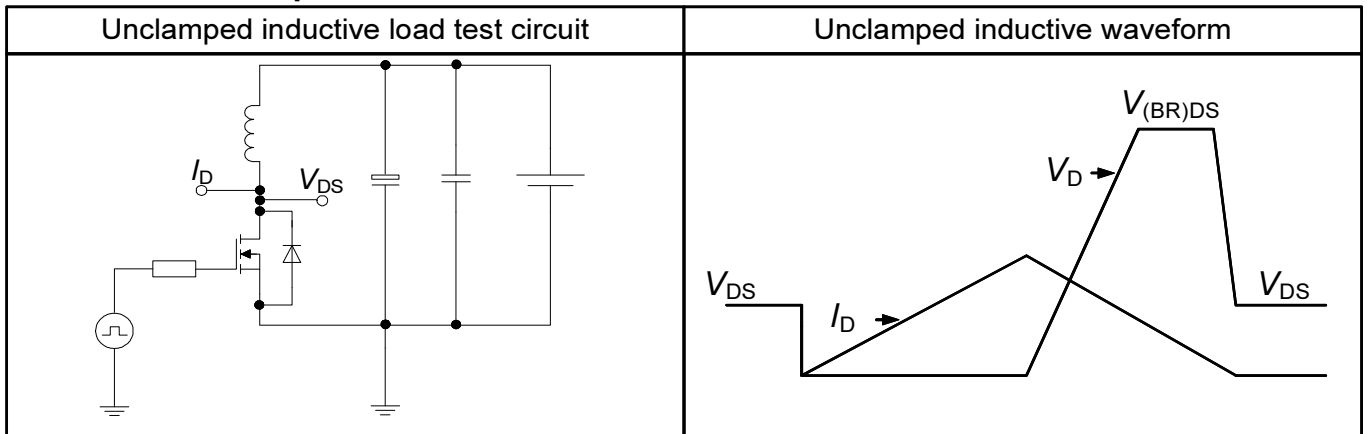


Table 22 Unclamped inductive load



7 Package Outlines

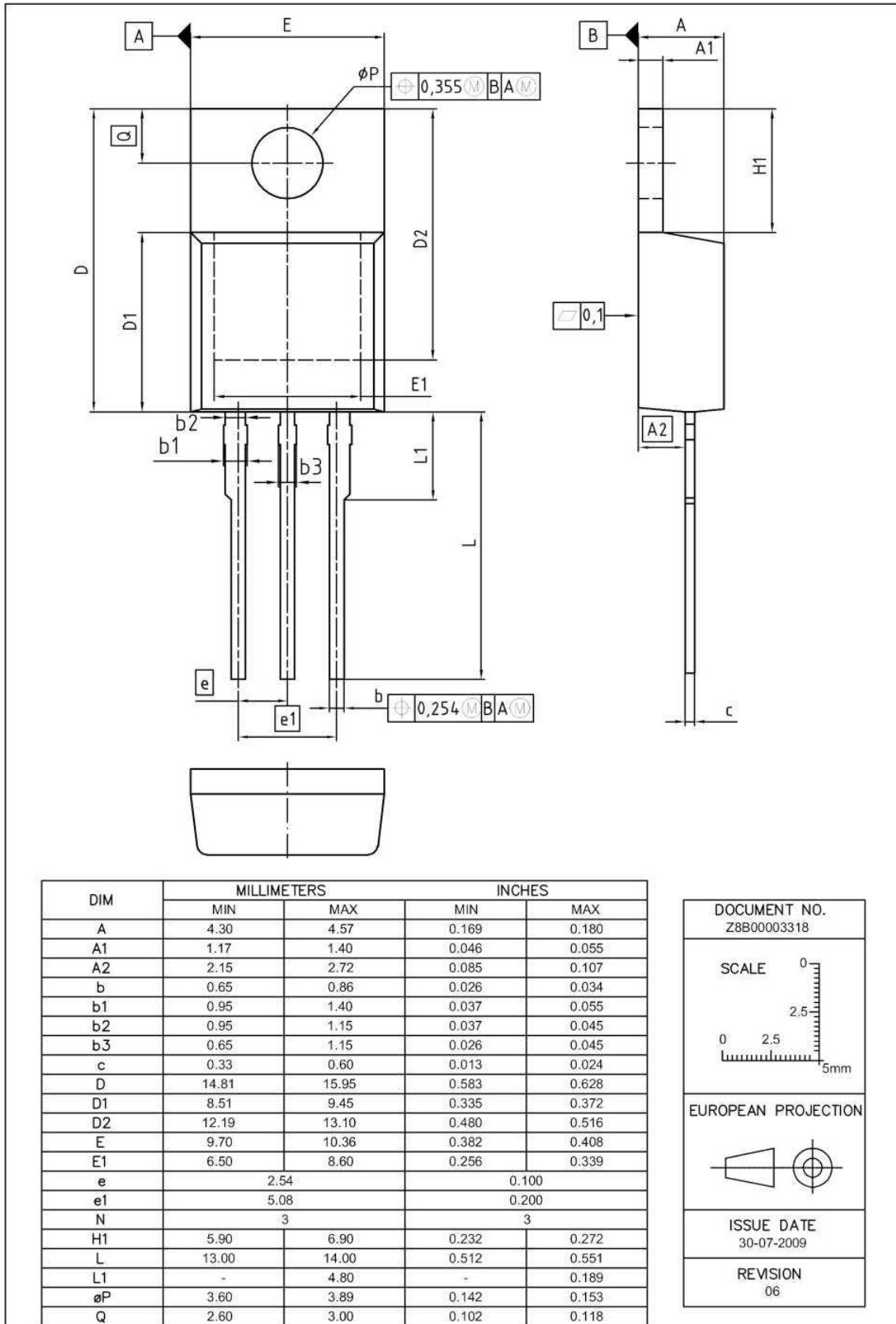


Figure 1 Outline PG-TO 220, dimensions in mm/inches

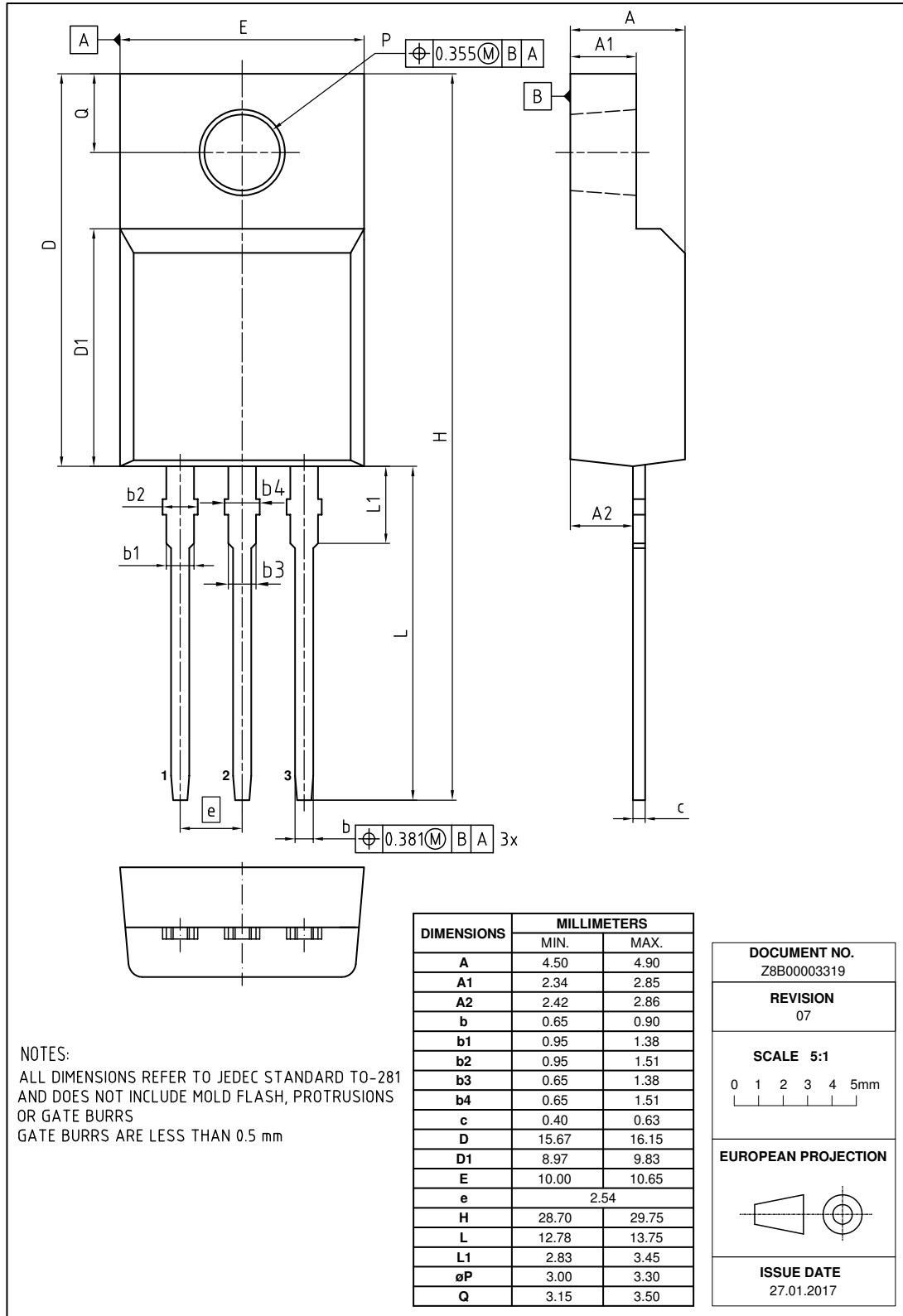


Figure 2 Outline PG-TO 220 FullPAK, dimensions in mm

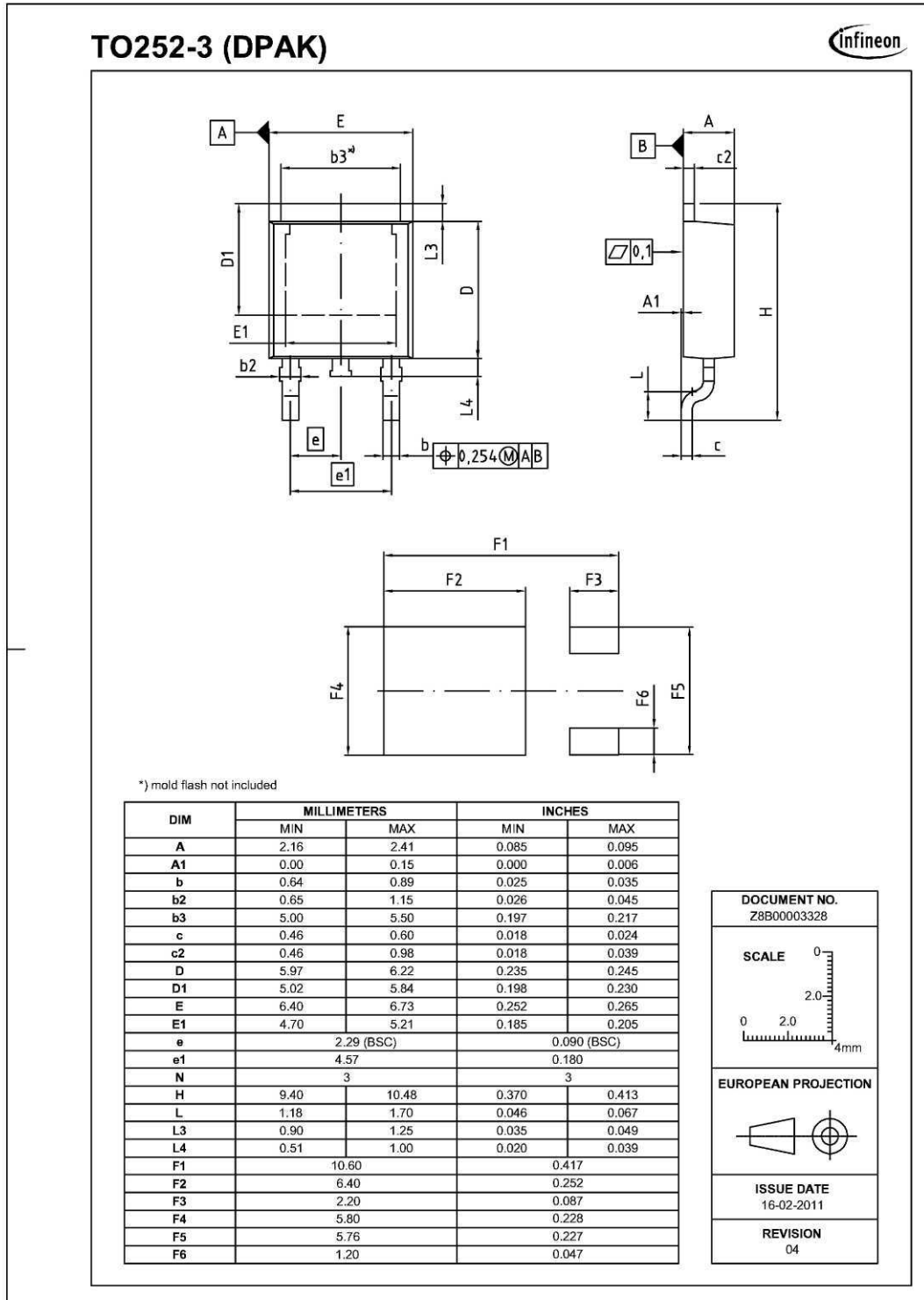


Figure 3 Outline PG-TO 252, dimensions in mm/inches

8 Appendix A

Table 23 Related Links

- **IFX CoolMOS Webpage:** www.infineon.com
- **IFX Design Tools:** www.infineon.com

Revision History

IPx60R380E6

Revision: 2018-03-04, Rev. 2.6

Previous Revision

| Revision | Date | Subjects (major changes since last revision) |
|----------|------------|---|
| 2.4 | 2013-05-15 | PG-TO252 Package Added |
| 2.5 | 2015-02-09 | PG-TO220 FullPAK package outline update (creation:2014-12-09) |
| 2.6 | 2018-03-04 | Outline PG-TO-220 FullPAK update |

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