

MOSFET

Metal Oxide Semiconductor Field Effect Transistor

CoolMOS™ E6 600V

600V CoolMOS™ E6 Power Transistor
IPx60R190E6

Data Sheet

Rev. 2.3
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
- 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.

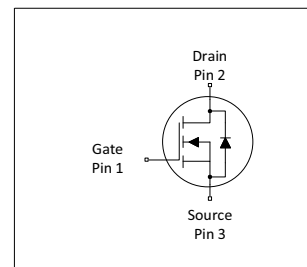
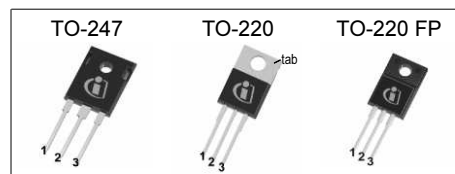


Table 1 Key Performance Parameters

| Parameter | Value | Unit |
|----------------------|-------|------------|
| $V_{DS} @ T_{j,max}$ | 650 | V |
| $R_{DS(on),max}$ | 0.19 | Ω |
| Q_g,typ | 63 | nC |
| $I_{D,pulse}$ | 59 | A |
| $E_{oss} @ 400V$ | 5.2 | μJ |
| Body diode di/dt | 500 | A/ μs |

| Type / Ordering Code | Package | Marking | Related Links |
|----------------------|-------------------|---------|----------------|
| IPW60R190E6 | PG-TO 247 | 6R190E6 | see Appendix A |
| IPP60R190E6 | PG-TO 220 | | |
| IPA60R190E6 | PG-TO 220 FullPAK | | |



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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 | | | 20.2 | A | $T_C = 25^\circ\text{C}$ |
| | | | | 12.8 | | $T_C = 100^\circ\text{C}$ |
| Pulsed drain current ²⁾ | $I_{D,pulse}$ | | | 59 | A | $T_C = 25^\circ\text{C}$ |
| Avalanche energy, single pulse | E_{AS} | | | 418 | mJ | $I_D = 3.4\text{A}$, $V_{DD} = 50\text{V}$ (see table 11) |
| Avalanche energy, repetitive | E_{AR} | | | 0.63 | mJ | $I_D = 3.4\text{A}$, $V_{DD} = 50\text{V}$ |
| Avalanche current, repetitive | I_{AR} | | | 3.4 | 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-247, TO-220 | P_{tot} | | | 151.0 | W | $T_C = 25^\circ\text{C}$ |
| Power dissipation (FullPAK) TO-220 FP | P_{tot} | | | 34.0 | W | $T_C = 25^\circ\text{C}$ |
| Operating and storage temperature | T_j, T_{stg} | -55 | | 150 | $^\circ\text{C}$ | |
| Mounting torque (non FullPAK) TO-247, 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 | | | 17.5 | A | $T_C = 25^\circ\text{C}$ |
| Diode pulse current | $I_{S,pulse}$ | | | 59 | A | $T_C = 25^\circ\text{C}$ |
| Reverse diode dv/dt ³⁾ | dv/dt | | | 15 | V/ns | $V_{DS} = 0 \dots 400\text{V}$, $I_{SD} \leq I_D$, $T_j = 25^\circ\text{C}$ |
| Maximum diode commutation speed | di/dt | | | 500 | A/ μs | (see table 9) |

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-247, TO-220

| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|--|------------|--------|------|------|------|--------------------------------------|
| | | Min. | Typ. | Max. | | |
| Thermal resistance, junction - case | R_{thJC} | | | 0.83 | °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} | | | 3.7 | °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 |

4 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 | $V_{(BR)DSS}$ | 600 | | | V | $V_{GS} = 0V, I_D = 0.25\text{mA}$ |
| Gate threshold voltage | $V_{GS(th)}$ | 2.5 | 3 | 3.5 | V | $V_{DS} = V_{GS}, I_D = 0.63\text{mA}$ |
| Zero gate voltage drain current | I_{DSS} | | | 1 | μA | $V_{DS} = 600V, V_{GS} = 0V, T_j = 25^\circ\text{C}$ |
| | | | 10 | | | $V_{DS} = 600V, V_{GS} = 0V, T_j = 150^\circ\text{C}$ |
| Gate-source leakage current | I_{GSS} | | | 100 | nA | $V_{GS} = 20V, V_{DS} = 0V$ |
| Drain-source on-state resistance | $R_{DS(on)}$ | | 0.170 | 0.19 | Ω | $V_{GS} = 10V, I_D = 9.5A, T_j = 25^\circ\text{C}$ |
| | | | 0.440 | | | $V_{GS} = 10V, I_D = 9.5A, T_j = 150^\circ\text{C}$ |
| Gate resistance | R_G | | 6 | | Ω | $f = 1\text{MHz}$, open drain |

Table 6 Dynamic characteristics

| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|--|--------------|--------|------|------|------|--|
| | | Min. | Typ. | Max. | | |
| Input capacitance | C_{iss} | | 1400 | | pF | $V_{GS} = 0V, V_{DS} = 100V, f = 1\text{MHz}$ |
| Output capacitance | C_{oss} | | 85 | | pF | |
| Effective output capacitance, energy related ¹⁾ | $C_{o(er)}$ | | 56 | | pF | $V_{GS} = 0V, V_{DS} = 0 \dots 480V$ |
| Effective output capacitance, time related ²⁾ | $C_{o(tr)}$ | | 266 | | pF | $I_D = \text{constant}, V_{GS} = 0V, V_{DS} = 0 \dots 480V$ |
| Turn-on delay time | $t_{d(on)}$ | | 12 | | ns | $V_{DD} = 400V, V_{GS} = 13V, I_D = 9.5A, R_G = 3.4\Omega$ (see table 10) |
| Rise time | t_r | | 10 | | ns | |
| Turn-off delay time | $t_{d(off)}$ | | 90 | | ns | |
| Fall time | t_f | | 8 | | ns | |

Table 7 Gate charge characteristics

| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|-----------------------|---------------|--------|------|------|------|---|
| | | Min. | Typ. | Max. | | |
| Gate to source charge | Q_{gs} | | 7.6 | | nC | $V_{DD} = 480V, I_D = 9.5A, V_{GS} = 0 \text{ to } 10V$ |
| Gate to drain charge | Q_{gd} | | 32 | | nC | |
| Gate charge total | Q_g | | 63 | | nC | |
| Gate plateau voltage | $V_{plateau}$ | | 5.4 | | V | |

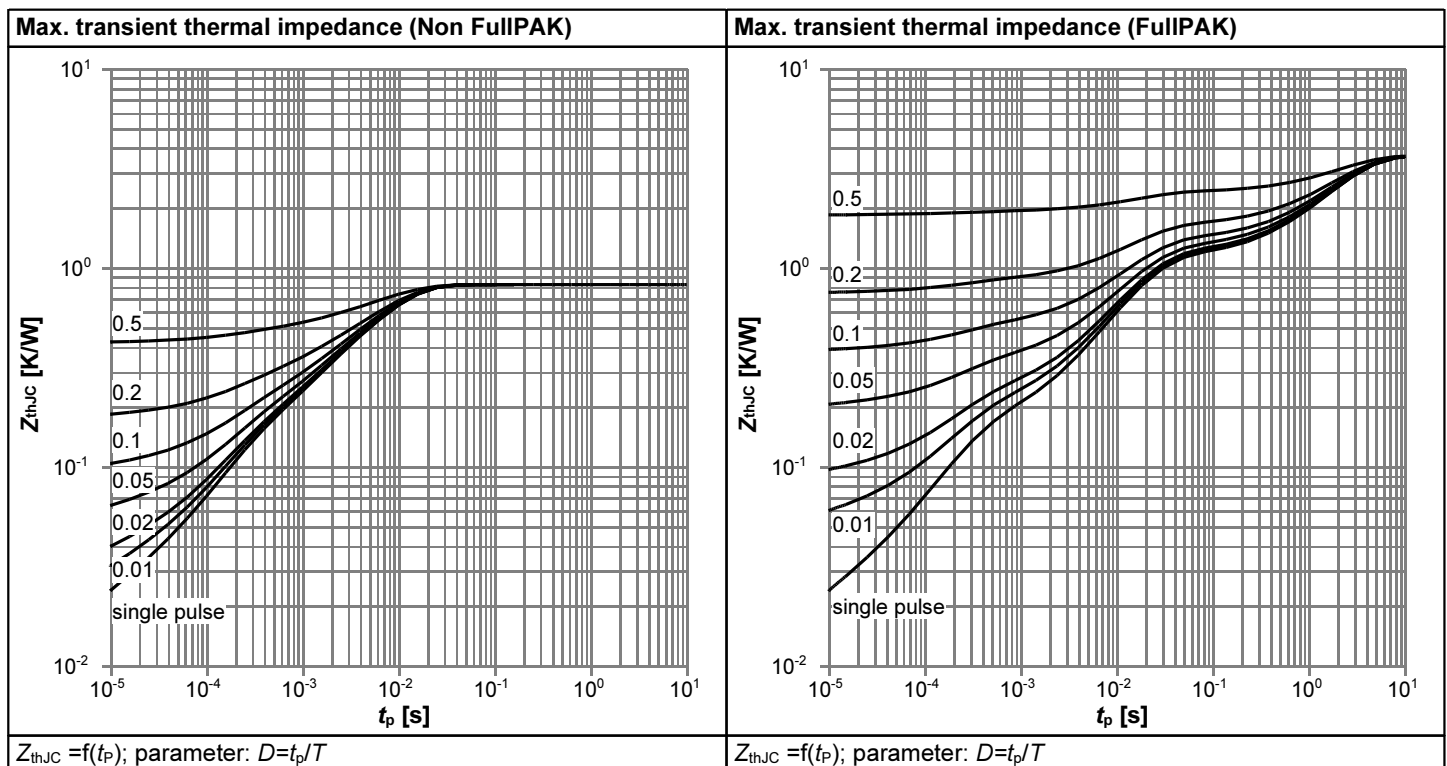
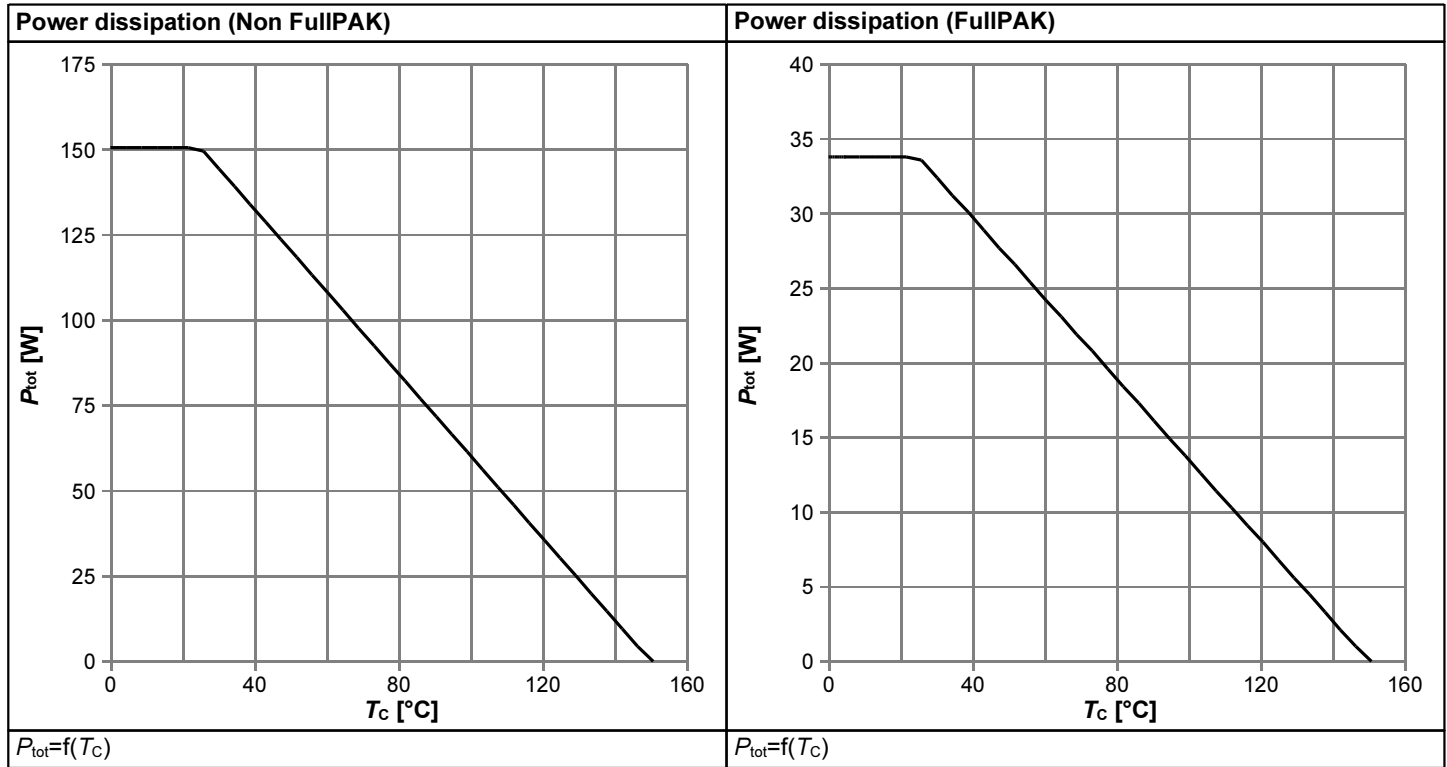
¹⁾ $C_{o(er)}$ is a fixed capacitance that gives the same stored energy as C_{oss} while V_{DS} is rising from 0 to 80% $V_{(BR)DSS}$

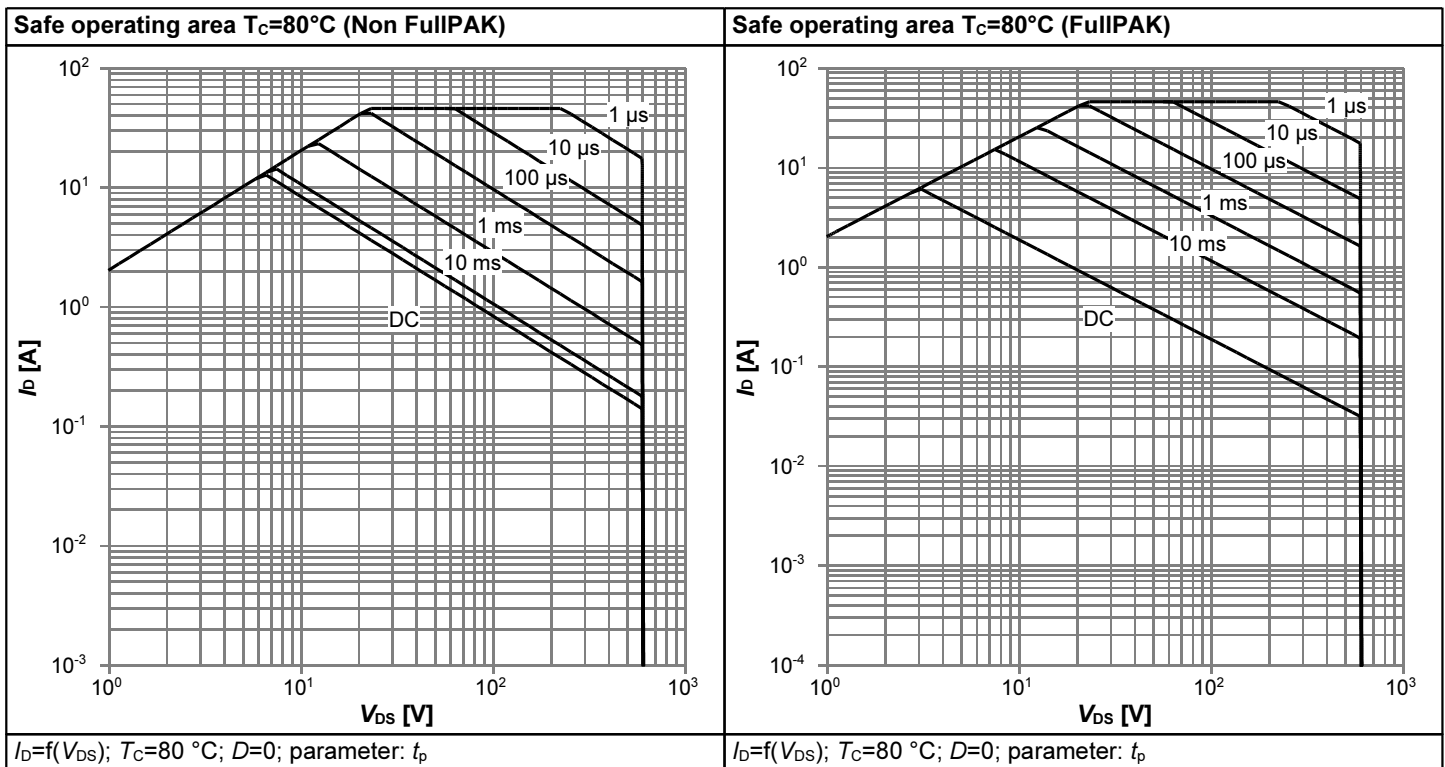
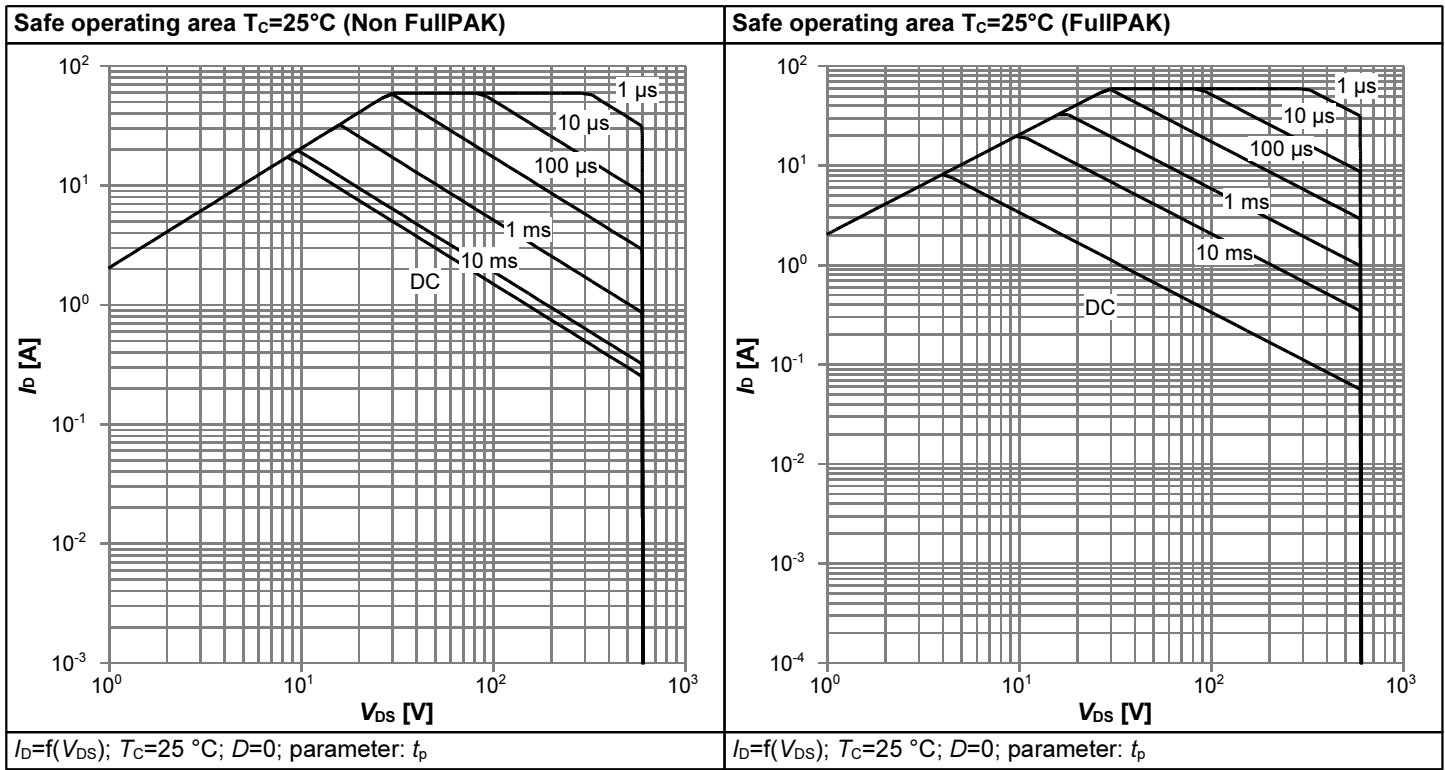
²⁾ $C_{o(tr)}$ is a fixed capacitance that gives the same charging time as C_{oss} while V_{DS} is rising from 0 to 80% $V_{(BR)DSS}$

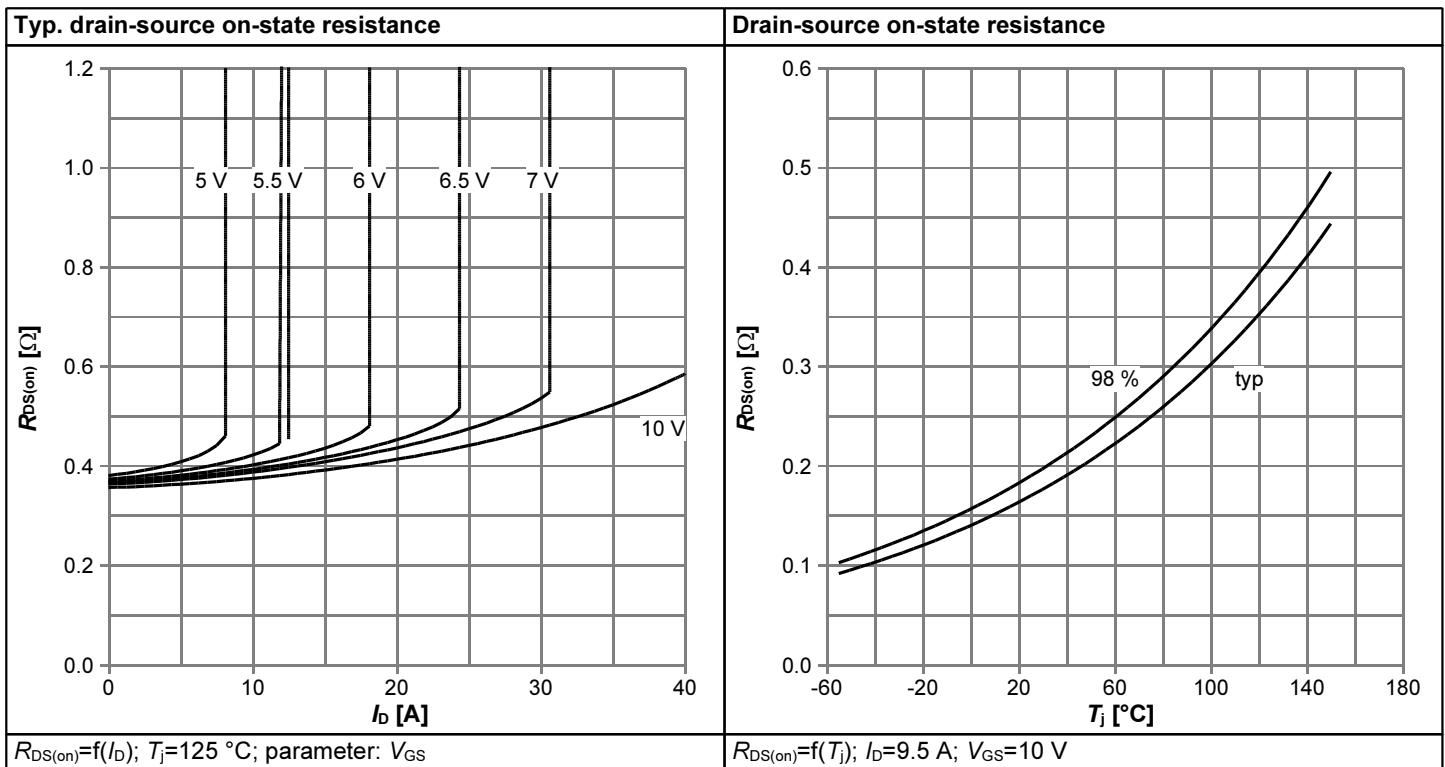
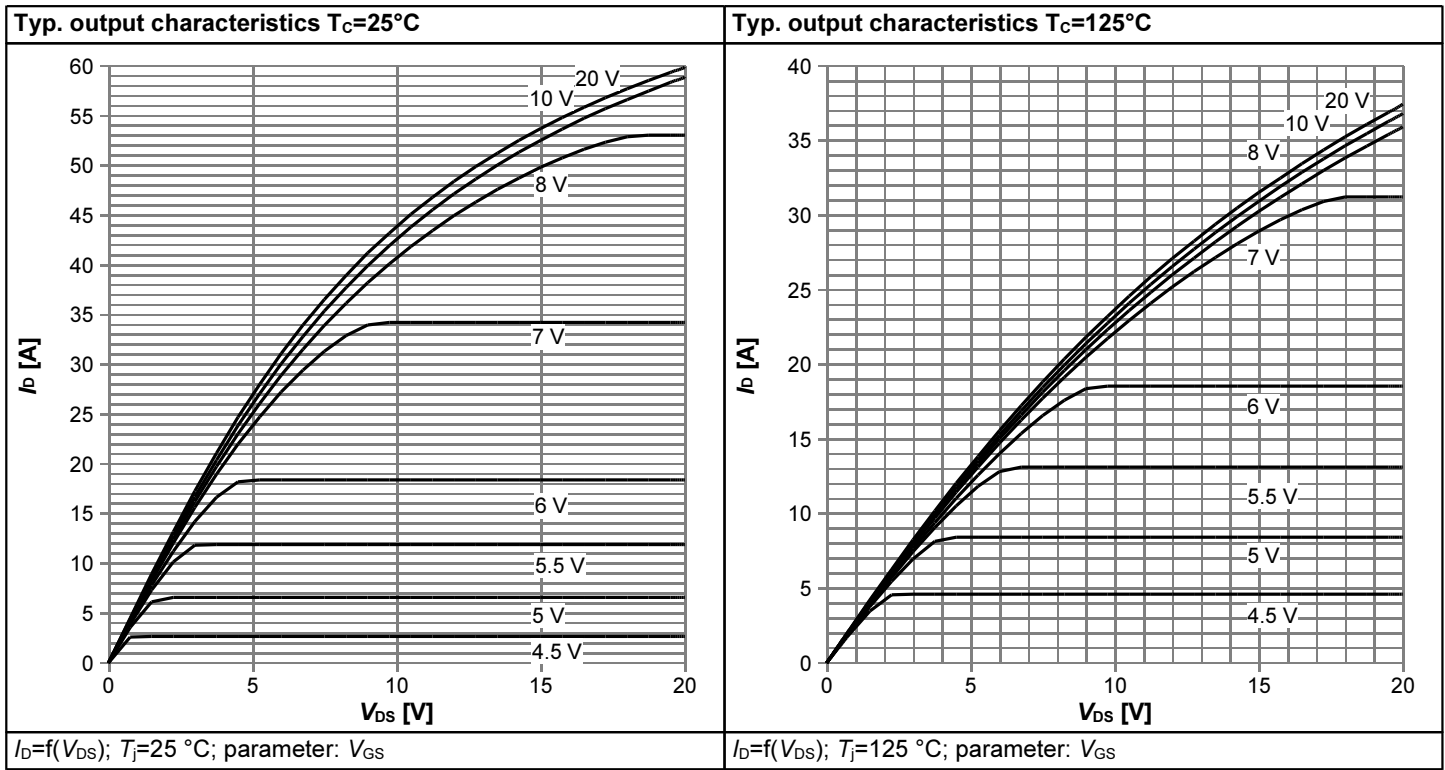
Table 8 Reverse diode characteristics

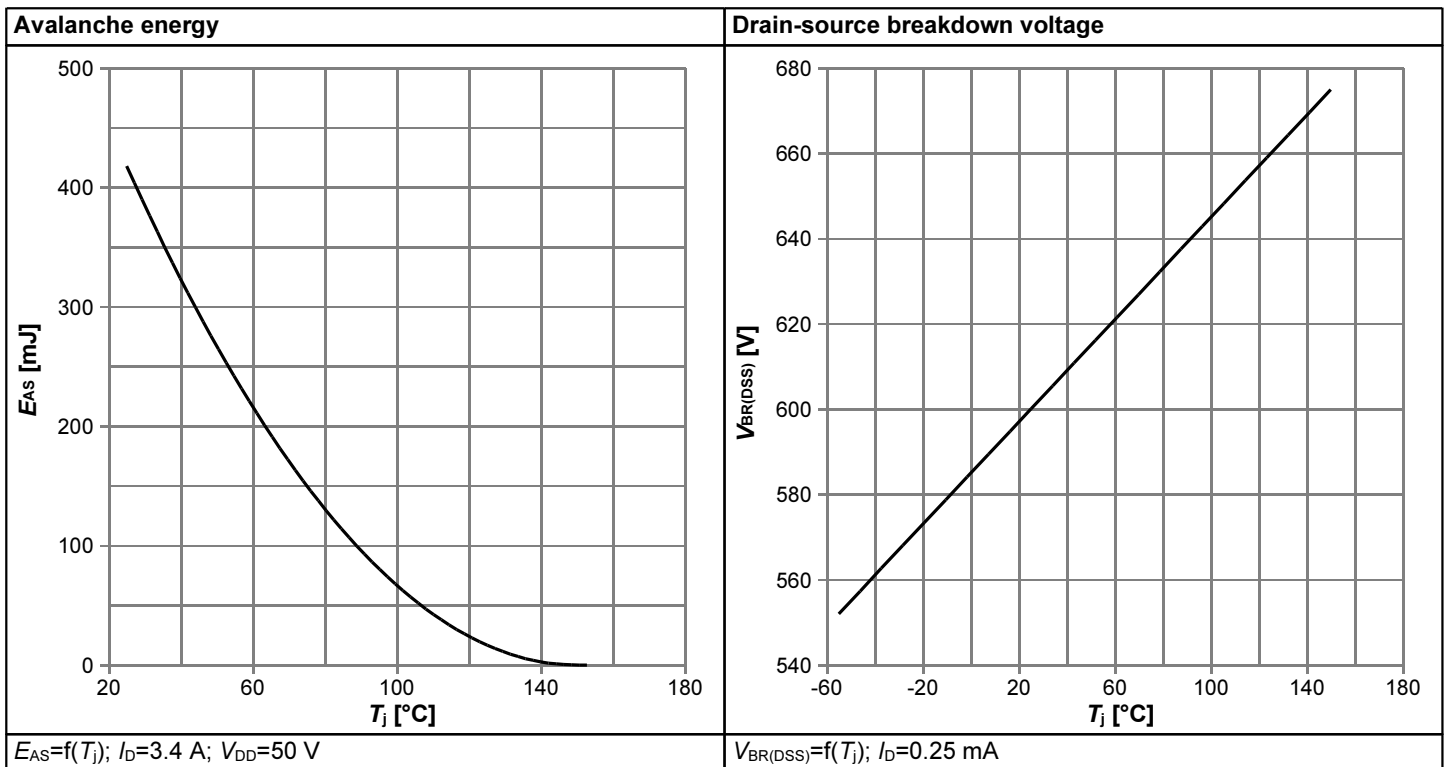
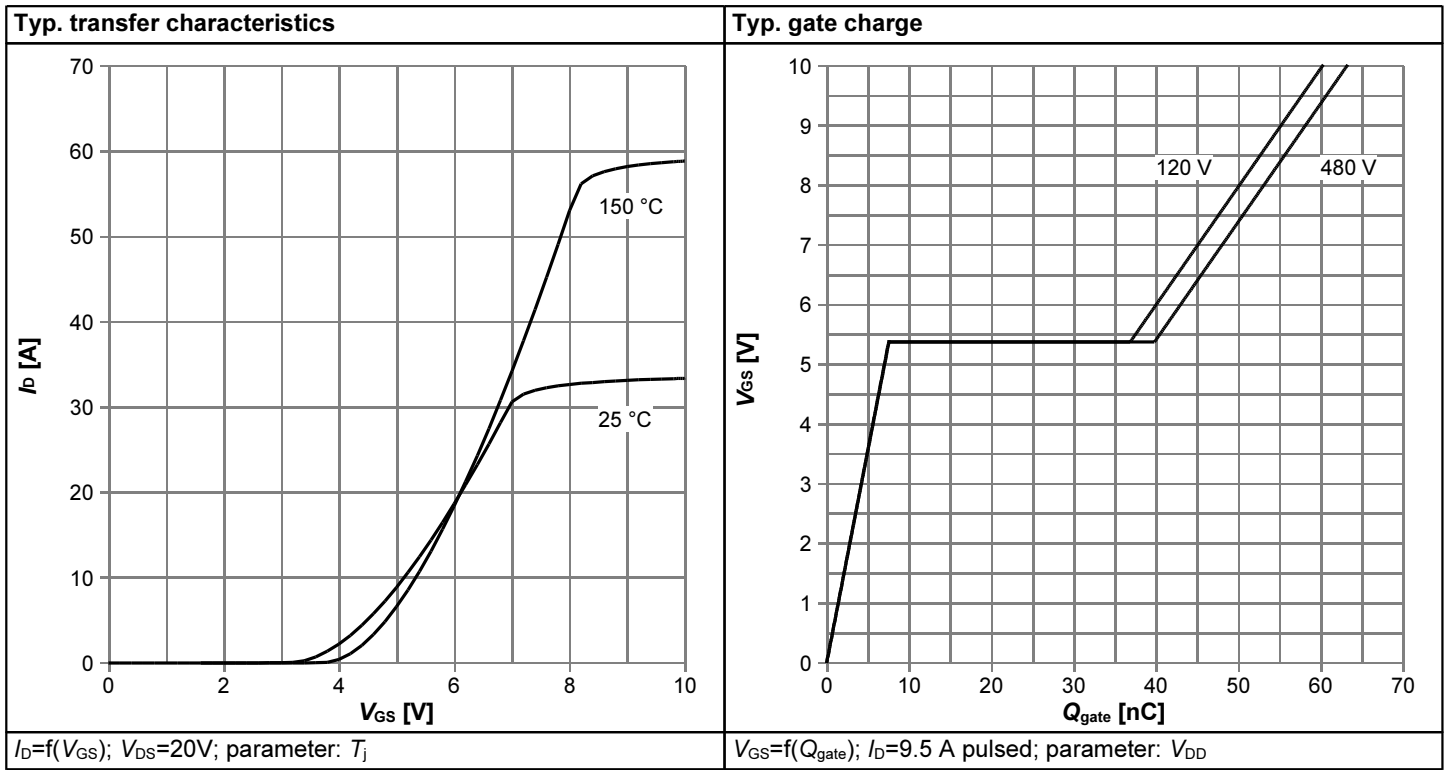
| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|-------------------------------|-----------|--------|------|------|---------|--|
| | | Min. | Typ. | Max. | | |
| Diode forward voltage | V_{SD} | | 0.9 | | V | $V_{GS} = 0V, I_F = 9.5A, T_j = 25^\circ C$ |
| Reverse recovery time | t_{rr} | | 430 | | ns | $V_R = 400V, I_F = 9.5A,$ $di_F/dt = 100A/\mu s$ (see table 9) |
| Reverse recovery charge | Q_{rr} | | 6.9 | | μC | |
| Peak reverse recovery current | I_{rrm} | | 30 | | A | |

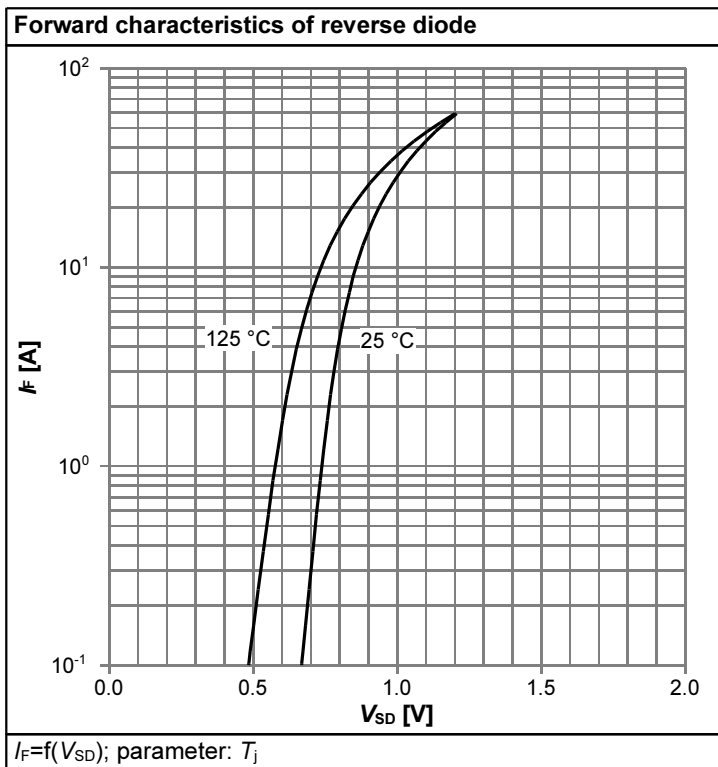
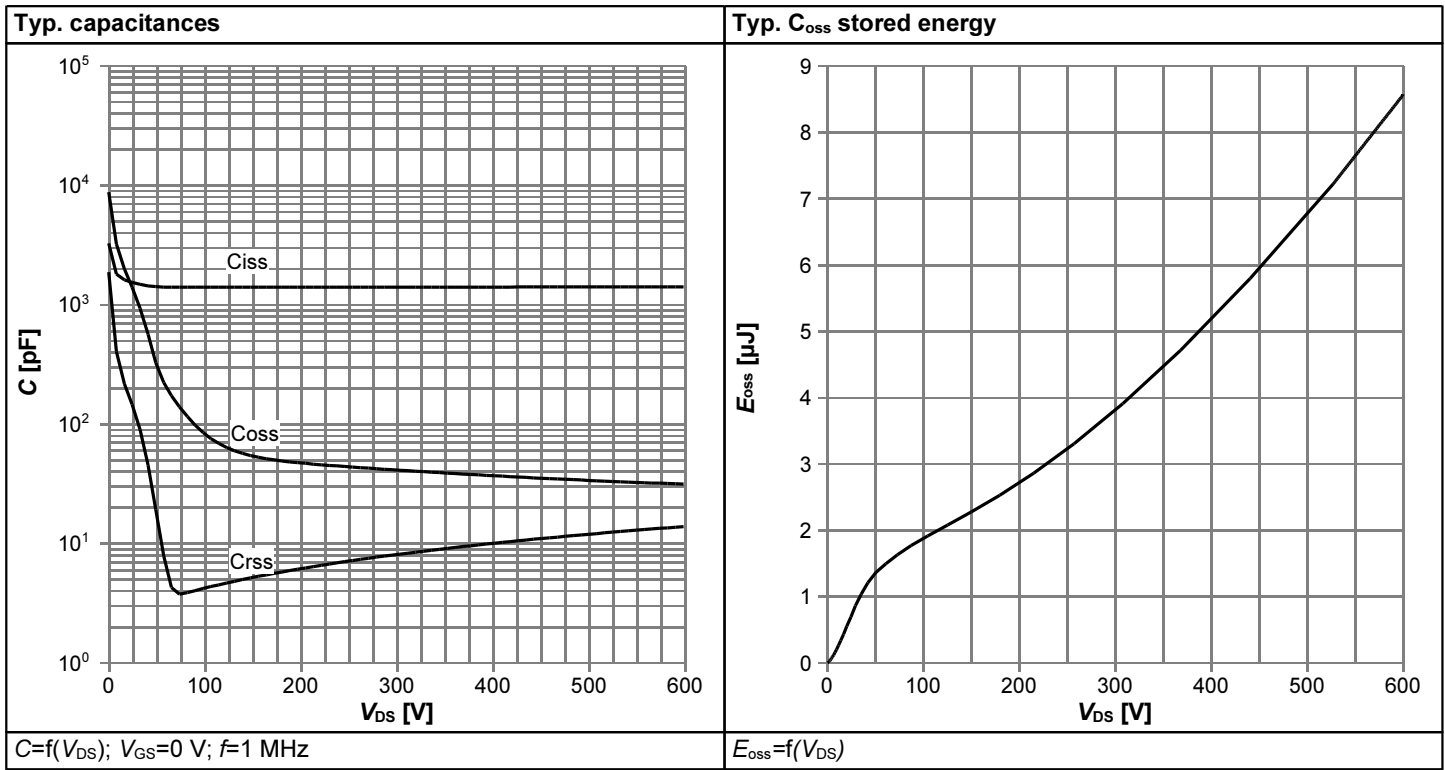
5 Electrical characteristics diagrams











6 Test Circuits

Table 9 Diode characteristics

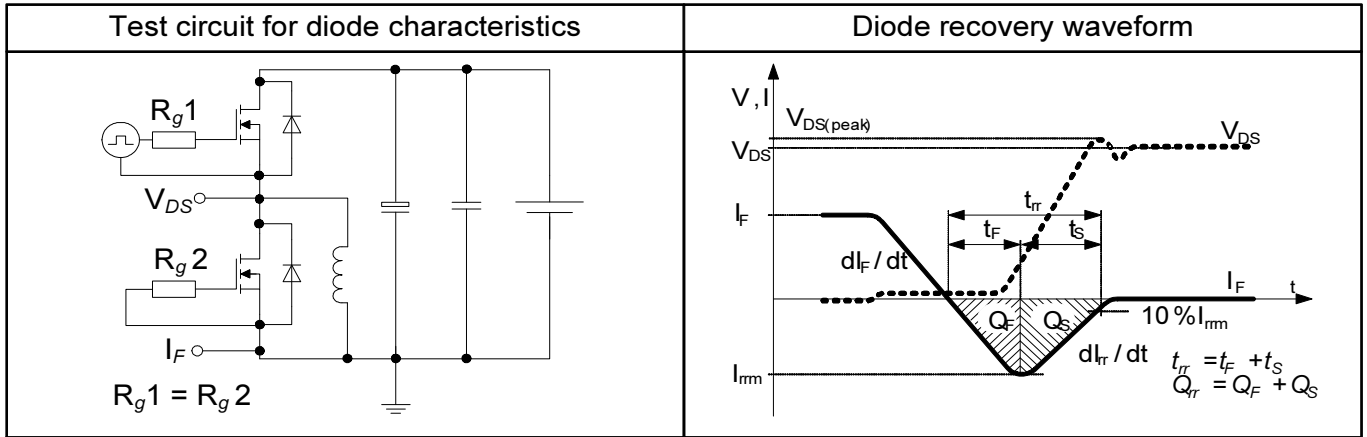


Table 10 Switching times

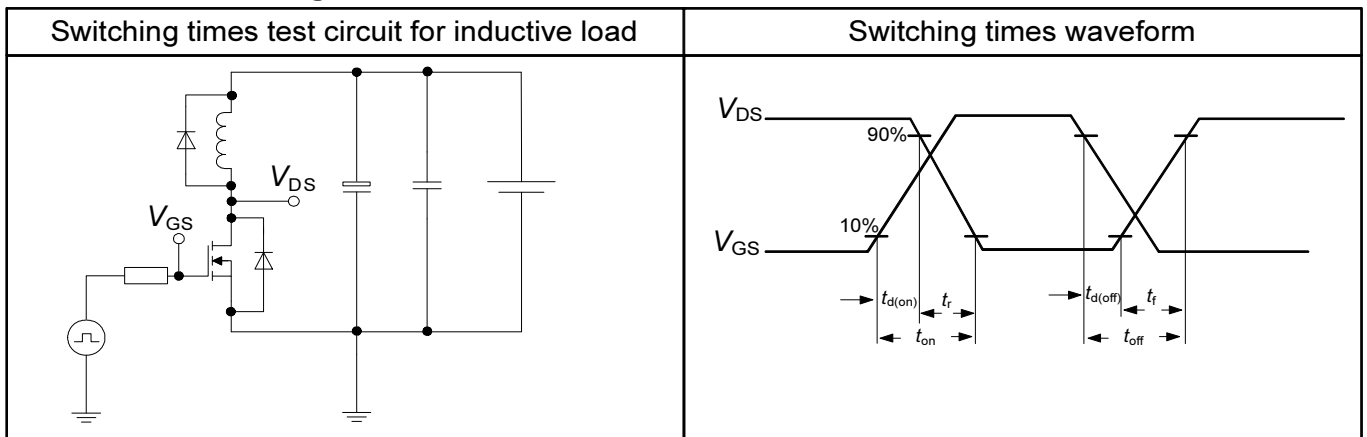
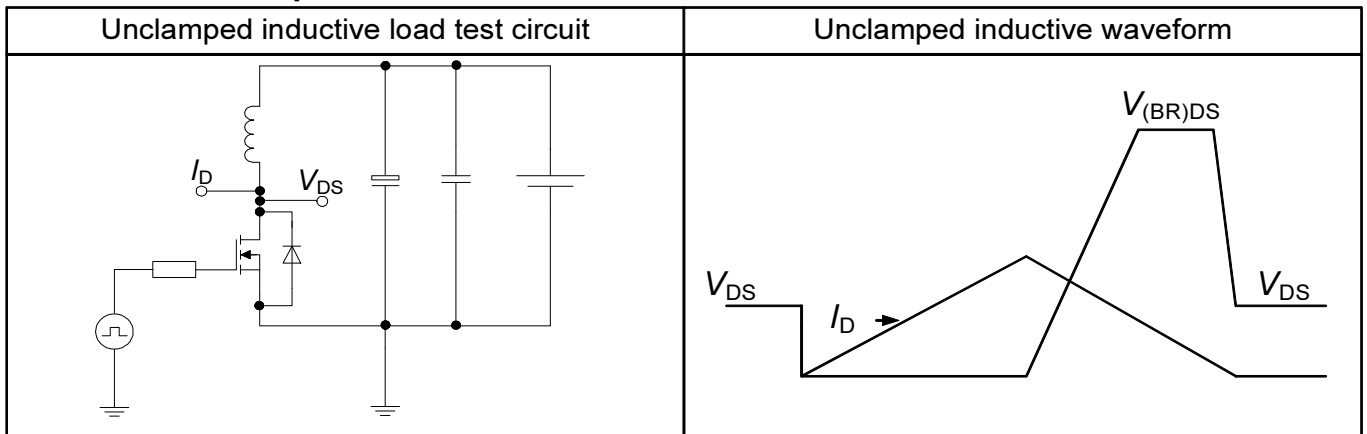


Table 11 Unclamped inductive load



7 Package Outlines

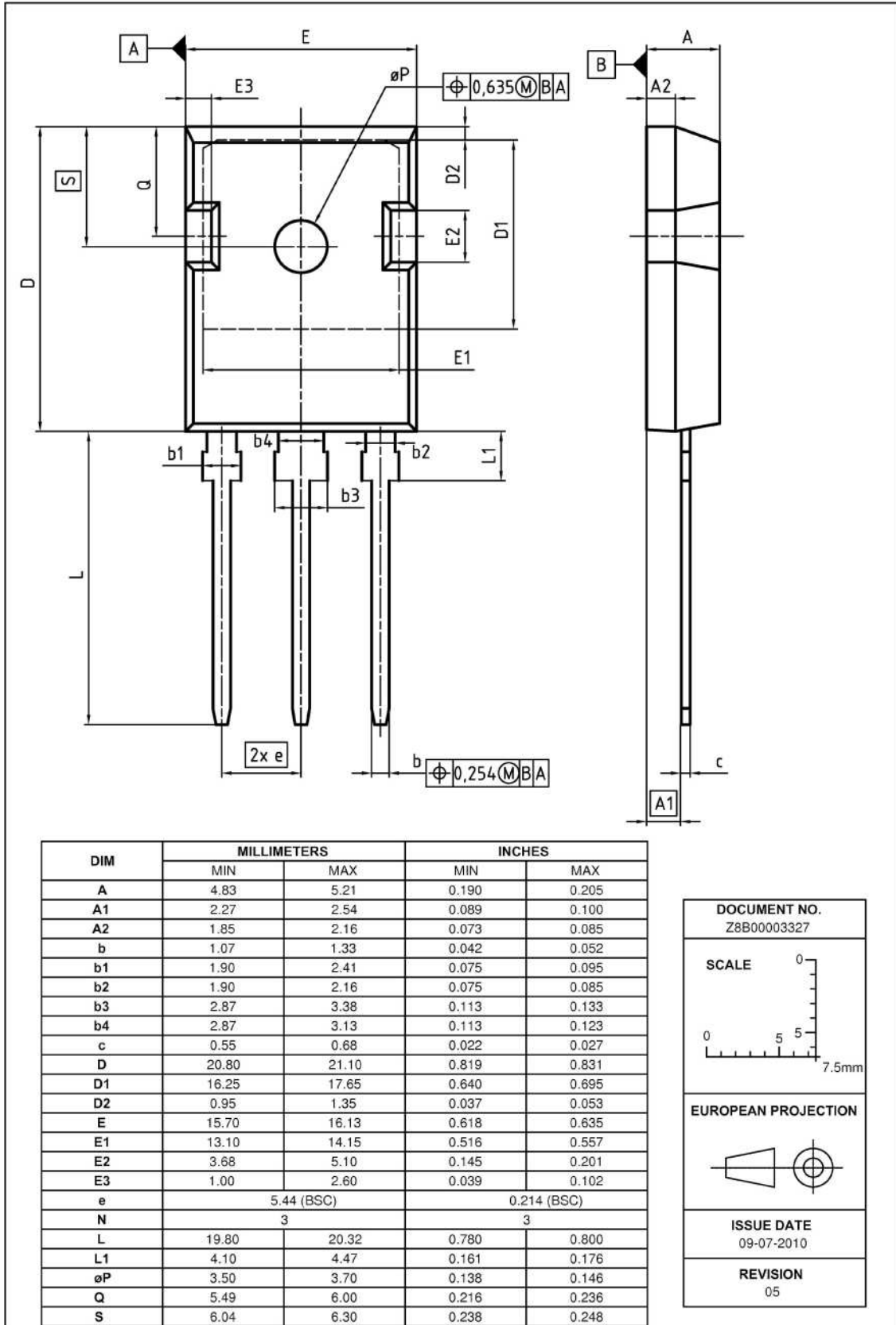


Figure 1 Outline PG-TO 247, dimensions in mm/inches

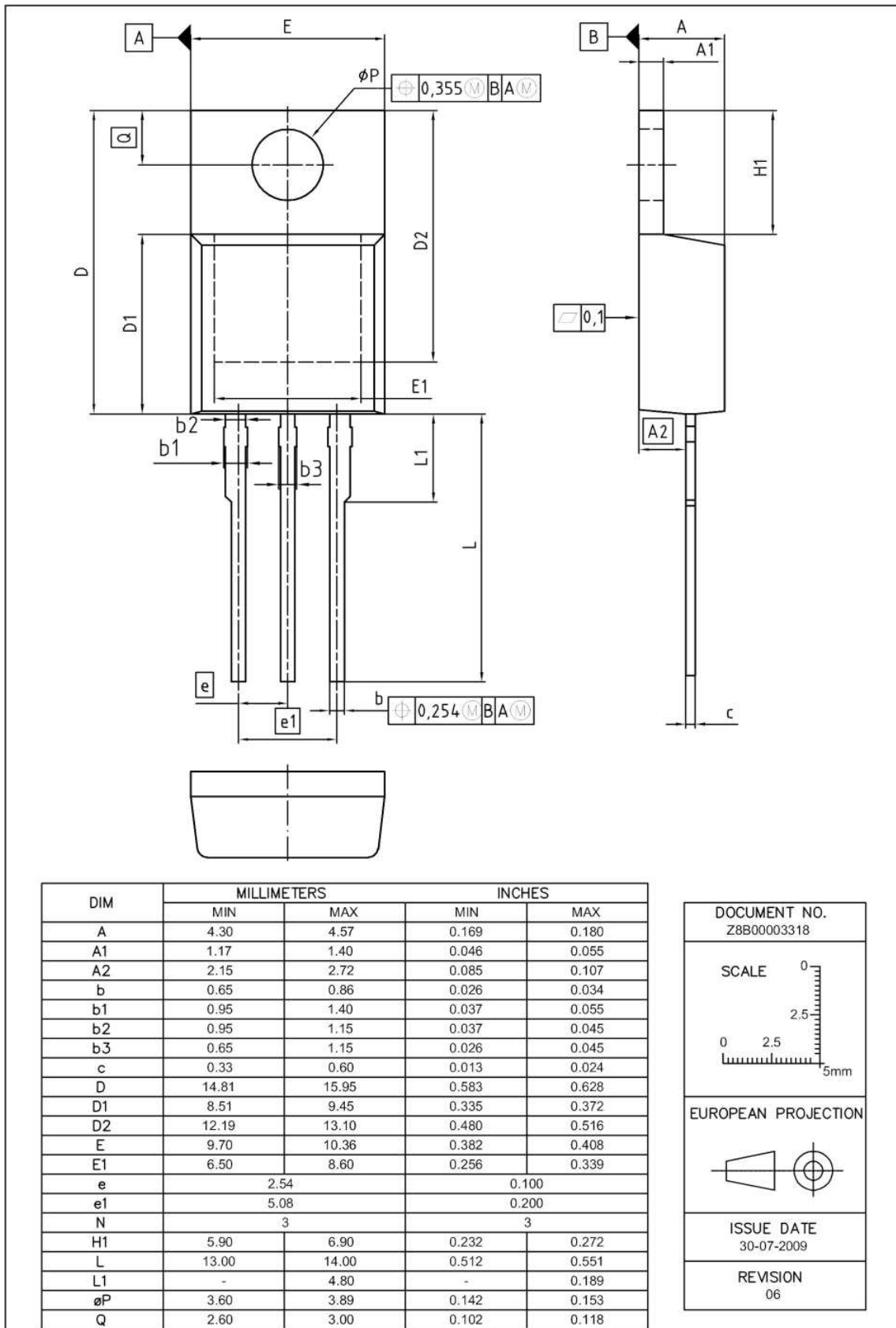


Figure 2 Outline PG-TO 220, dimensions in mm/inches

8 Appendix A

Table 12 Related Links

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

Revision History

IPx60R190E6

Revision: 2015-02-09, Rev. 2.3

Previous Revision

| Revision | Date | Subjects (major changes since last revision) |
|----------|------------|---|
| 2.0 | 2011-06-08 | Release of final data sheet |
| 2.1 | 2011-09-14 | - |
| 2.2 | 2014-07-15 | Package update and table reference correction |
| 2.3 | 2015-02-09 | PG-TO220 FullPAK package outline update (creation:2014-12-02) |

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