

MOSFET

600V CoolMOS™ CE Power Transistor

CoolMOS™ is a revolutionary technology for high voltage power MOSFETs, designed according to the superjunction (SJ) principle and pioneered by Infineon Technologies. CoolMOS™ CE is a price-performance optimized platform enabling to target cost sensitive applications in Consumer and Lighting markets by still meeting highest efficiency standards. The new series provides all benefits of a fast switching Superjunction MOSFET while not sacrificing ease of use and offering the best cost down performance ratio available on the market.

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 standard grade applications

Applications

Adapter, Charger and Lighting

Please note: For MOSFET paralleling the use of ferrite beads on the gate or separate totem poles is generally recommended.



Table 1 Key Performance Parameters

| Parameter | Value | Unit |
|----------------------|-------|------------|
| $V_{DS} @ T_{j,max}$ | 650 | V |
| $R_{DS(on),max}$ | 3.4 | Ω |
| $Q_{g,typ}$ | 4.6 | nC |
| $I_{D,pulse}$ | 3.9 | A |
| $E_{oss}@400V$ | 0.57 | μJ |
| Body diode di/dt | 500 | A/ μs |

| Type / Ordering Code | Package | Marking | Related Links |
|----------------------|-----------|---------|----------------|
| IPN60R3K4CE | PG-SOT223 | 60S3K4 | see Appendix A |

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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 ¹⁾ | I_D | - | - | 2.6 1.6 | A | $T_C = 25^\circ\text{C}$ $T_C = 100^\circ\text{C}$ |
| Pulsed drain current ²⁾ | $I_{D,pulse}$ | - | - | 3.9 | A | $T_C = 25^\circ\text{C}$ |
| Avalanche energy, single pulse | E_{AS} | - | - | 6 | mJ | $I_D = 0.3\text{A}$; $V_{DD} = 50\text{V}$ |
| Avalanche energy, repetitive | E_{AR} | - | - | 0.04 | mJ | $I_D = 0.3\text{A}$; $V_{DD} = 50\text{V}$ |
| Avalanche current, repetitive | I_{AR} | - | - | 0.3 | A | - |
| MOSFET dv/dt ruggedness | dv/dt | - | - | 50 | V/ns | $V_{DS} = 0 \dots 480\text{V}$ |
| Gate source voltage | V_{GS} | -20 -30 | - | 20 30 | V | static; AC ($f > 1\text{ Hz}$) |
| Power dissipation | P_{tot} | - | - | 5.0 | W | $T_C = 25^\circ\text{C}$ |
| Operating and storage temperature | T_j, T_{stg} | -40 | - | 150 | $^\circ\text{C}$ | - |
| Continuous diode forward current | I_S | - | - | 0.8 | A | $T_C = 25^\circ\text{C}$ |
| Diode pulse current ²⁾ | $I_{S,pulse}$ | - | - | 3.9 | A | $T_C = 25^\circ\text{C}$ |
| Reverse diode dv/dt ³⁾ | dv/dt | - | - | 15 | V/ns | $V_{DS} = 0 \dots 400\text{V}$, $I_{SD} \leq I_S$, $T_j = 25^\circ\text{C}$ |
| Maximum diode commutation speed ³⁾ | di/dt | - | - | 500 | A/ μs | $V_{DS} = 0 \dots 400\text{V}$, $I_{SD} \leq I_S$, $T_j = 25^\circ\text{C}$ |

2 Thermal characteristics

Table 3 Thermal characteristics

| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|--|------------|--------|------|------|--------------------|---|
| | | Min. | Typ. | Max. | | |
| Thermal resistance, junction - solder point | R_{thJS} | - | - | 25.2 | $^\circ\text{C/W}$ | - |
| Thermal resistance, junction - ambient for minimal footprint | R_{thJA} | - | - | 160 | $^\circ\text{C/W}$ | minimal footprint |
| Thermal resistance, junction - ambient soldered on copper area | R_{thJA} | - | - | 75 | $^\circ\text{C/W}$ | Device on 40mm*40mm*1.5 epoxy PCB FR4 with 6cm ² (one layer 70 μm thick) copper area for drain connection and cooling. PCB is vertical without blown air. |
| Soldering temperature, wavesoldering only allowed at leads | T_{sold} | - | - | 260 | $^\circ\text{C}$ | reflow MSL3 |

¹⁾ DPAK equivalent. Limited by $T_{j,max}$. Maximum duty cycle $D=0.5$

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

³⁾ $V_{DClink}=400\text{V}$; $V_{DS,peak} < V_{(BR)DSS}$; identical low side and high side switch with identical R_G

3 Electrical characteristics

Table 4 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 | $V_{GS(th)}$ | 2.50 | 3 | 3.50 | V | $V_{DS}=V_{GS}, I_D=0.04mA$ |
| Zero gate voltage drain current | I_{DSS} | - | - | 1 | μA | $V_{DS}=600V, V_{GS}=0V, T_j=25^\circ C$ $V_{DS}=600V, V_{GS}=0V, T_j=150^\circ C$ |
| Gate-source leakage current | I_{GSS} | - | - | 100 | nA | $V_{GS}=20V, V_{DS}=0V$ |
| Drain-source on-state resistance | $R_{DS(on)}$ | - | 3.06 | 3.40 | Ω | $V_{GS}=10V, I_D=0.5A, T_j=25^\circ C$ $V_{GS}=10V, I_D=0.5A, T_j=150^\circ C$ |
| Gate resistance | R_G | - | 15 | - | Ω | $f=1\text{ MHz, open drain}$ |

Table 5 Dynamic characteristics

| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|--|--------------|--------|------|------|------|---|
| | | Min. | Typ. | Max. | | |
| Input capacitance | C_{iss} | - | 93 | - | pF | $V_{GS}=0V, V_{DS}=100V, f=1MHz$ |
| Output capacitance | C_{oss} | - | 9 | - | pF | $V_{GS}=0V, V_{DS}=100V, f=1MHz$ |
| Effective output capacitance, energy related ¹⁾ | $C_{o(er)}$ | - | 6.4 | - | pF | $V_{GS}=0V, V_{DS}=0...480V$ |
| Effective output capacitance, time related ²⁾ | $C_{o(tr)}$ | - | 21 | - | pF | $I_D=constant, V_{GS}=0V, V_{DS}=0...480V$ |
| Turn-on delay time | $t_{d(on)}$ | - | 8 | - | ns | $V_{DD}=400V, V_{GS}=13V, I_D=0.6A, R_G=20\Omega$ |
| Rise time | t_r | - | 10 | - | ns | $V_{DD}=400V, V_{GS}=13V, I_D=0.6A, R_G=20\Omega$ |
| Turn-off delay time | $t_{d(off)}$ | - | 40 | - | ns | $V_{DD}=400V, V_{GS}=13V, I_D=0.6A, R_G=20\Omega$ |
| Fall time | t_f | - | 60 | - | ns | $V_{DD}=400V, V_{GS}=13V, I_D=0.6A, R_G=20\Omega$ |

Table 6 Gate charge characteristics

| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|-----------------------|---------------|--------|------|------|------|---|
| | | Min. | Typ. | Max. | | |
| Gate to source charge | Q_{gs} | - | 0.5 | - | nC | $V_{DD}=480V, I_D=0.6A, V_{GS}=0\text{ to }10V$ |
| Gate to drain charge | Q_{gd} | - | 2.6 | - | nC | $V_{DD}=480V, I_D=0.6A, V_{GS}=0\text{ to }10V$ |
| Gate charge total | Q_g | - | 4.6 | - | nC | $V_{DD}=480V, I_D=0.6A, V_{GS}=0\text{ to }10V$ |
| Gate plateau voltage | $V_{plateau}$ | - | 5.4 | - | V | $V_{DD}=480V, I_D=0.6A, V_{GS}=0\text{ to }10V$ |

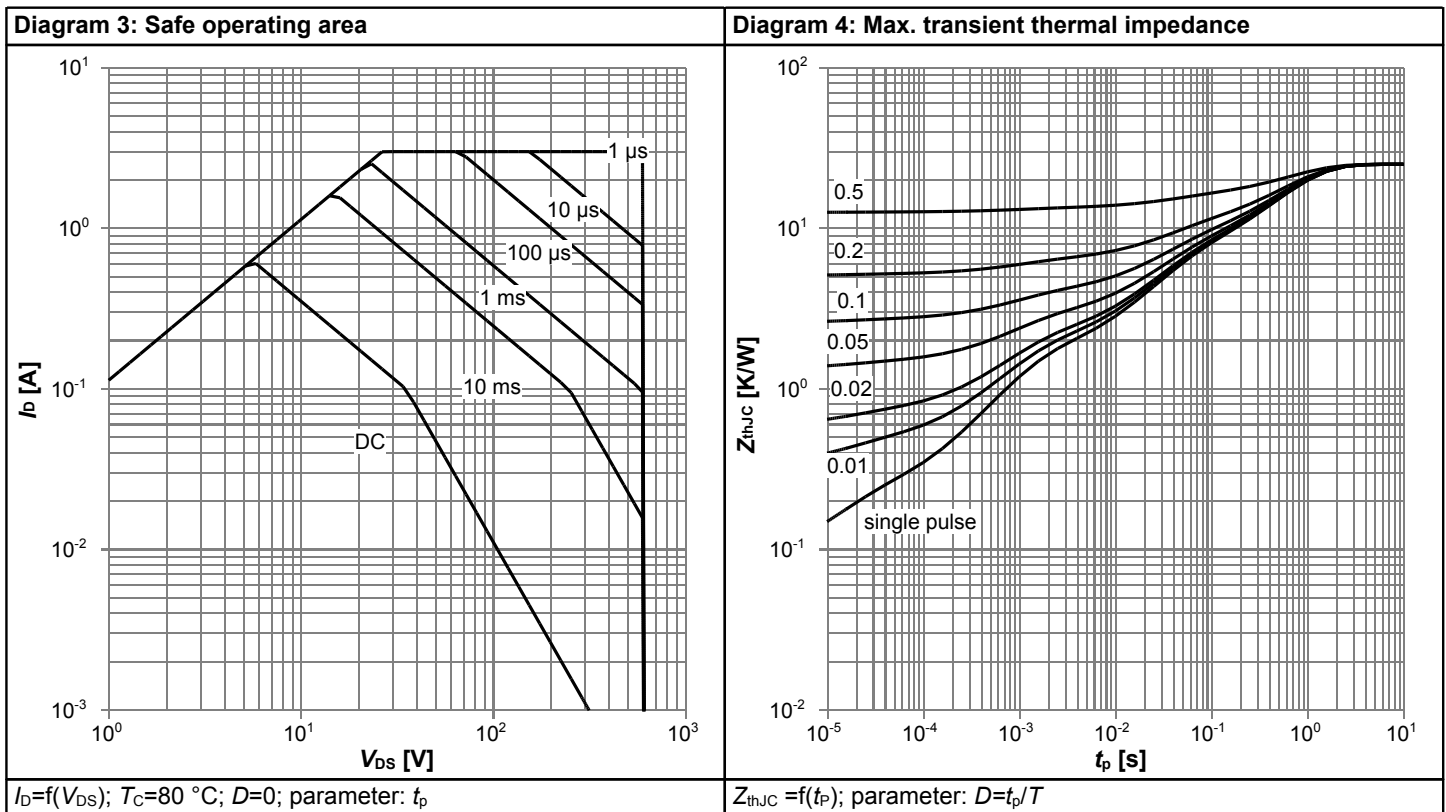
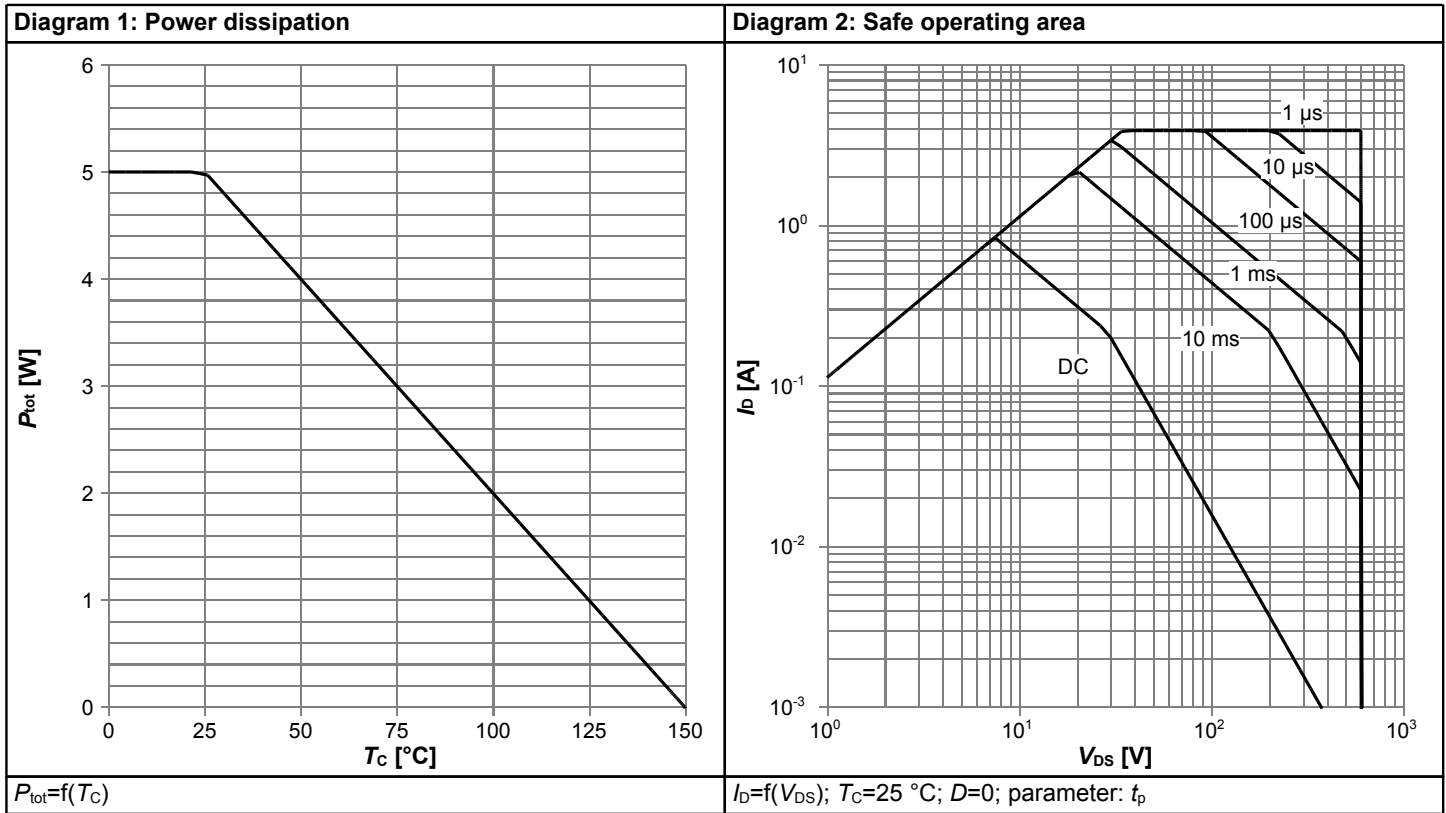
¹⁾ $C_{o(er)}$ is a fixed capacitance that gives the same stored energy as C_{oss} while V_{DS} is rising from 0 to 480V

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 480V

Table 7 Reverse diode characteristics

| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|-------------------------------|-----------|--------|------|------|---------|--|
| | | Min. | Typ. | Max. | | |
| Diode forward voltage | V_{SD} | - | 0.9 | - | V | $V_{GS}=0V, I_F=0.6A, T_i=25^{\circ}C$ |
| Reverse recovery time | t_{rr} | - | 160 | - | ns | $V_R=400V, I_F=0.6A, di_F/dt=100A/\mu s$ |
| Reverse recovery charge | Q_{rr} | - | 0.42 | - | μC | $V_R=400V, I_F=0.6A, di_F/dt=100A/\mu s$ |
| Peak reverse recovery current | I_{rrm} | - | 5.1 | - | A | $V_R=400V, I_F=0.6A, di_F/dt=100A/\mu s$ |

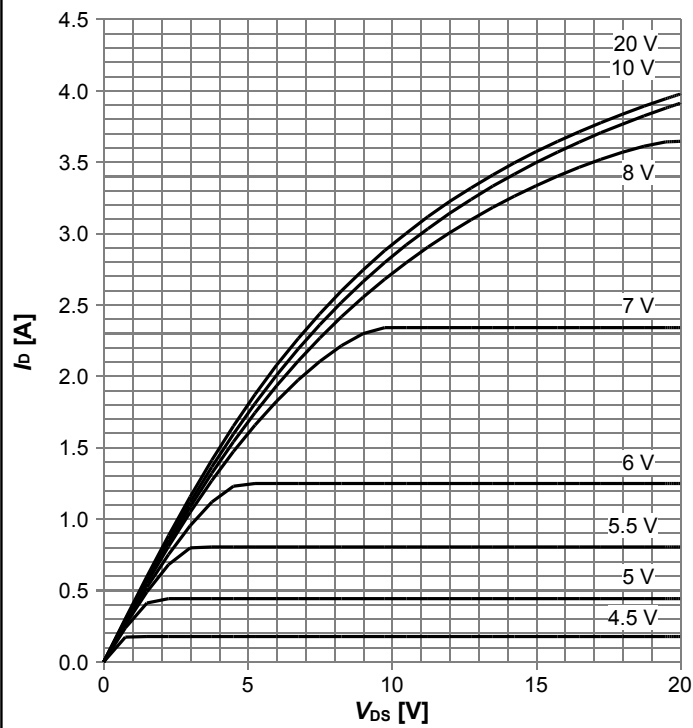
4 Electrical characteristics diagrams



600V CoolMOS™ CE Power Transistor

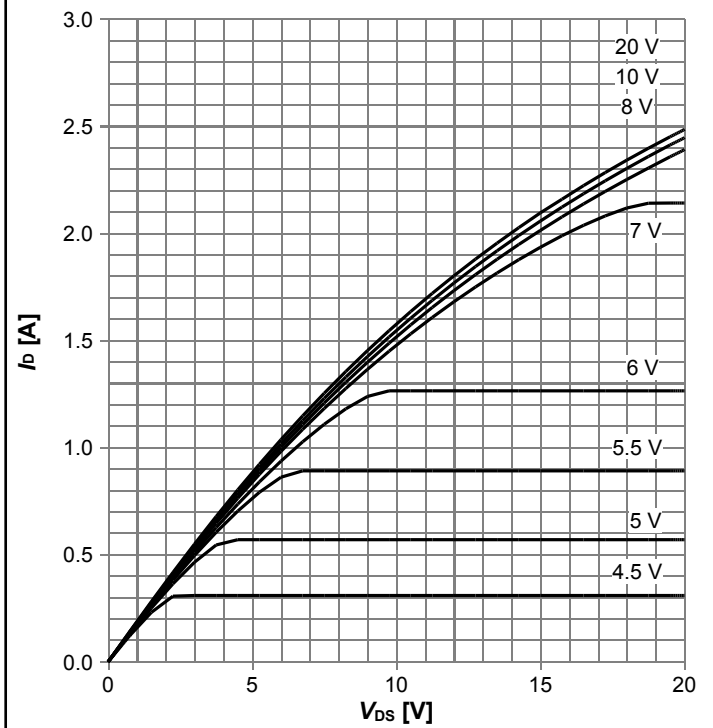
IPN60R3K4CE

Diagram 5: Typ. output characteristics



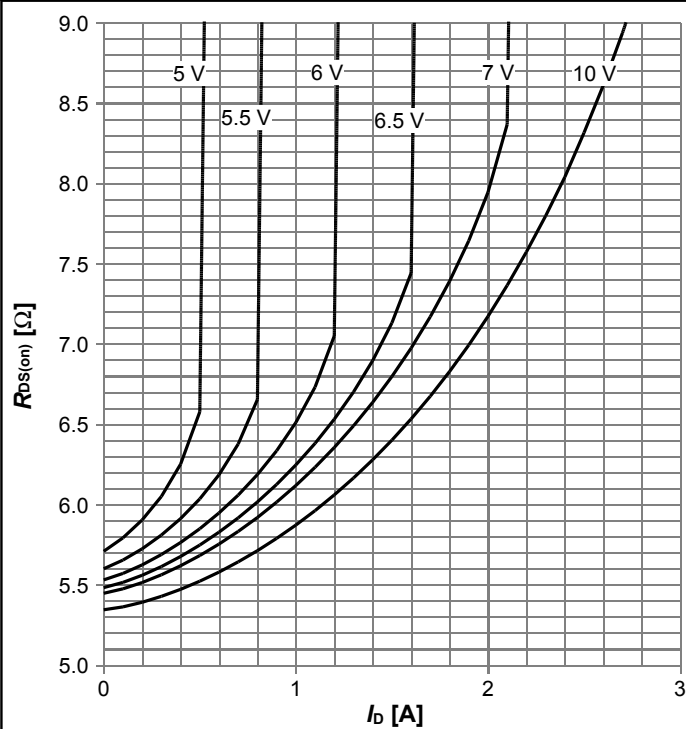
$I_D=f(V_{DS}); T_j=25\text{ }^\circ\text{C};$ parameter: V_{GS}

Diagram 6: Typ. output characteristics



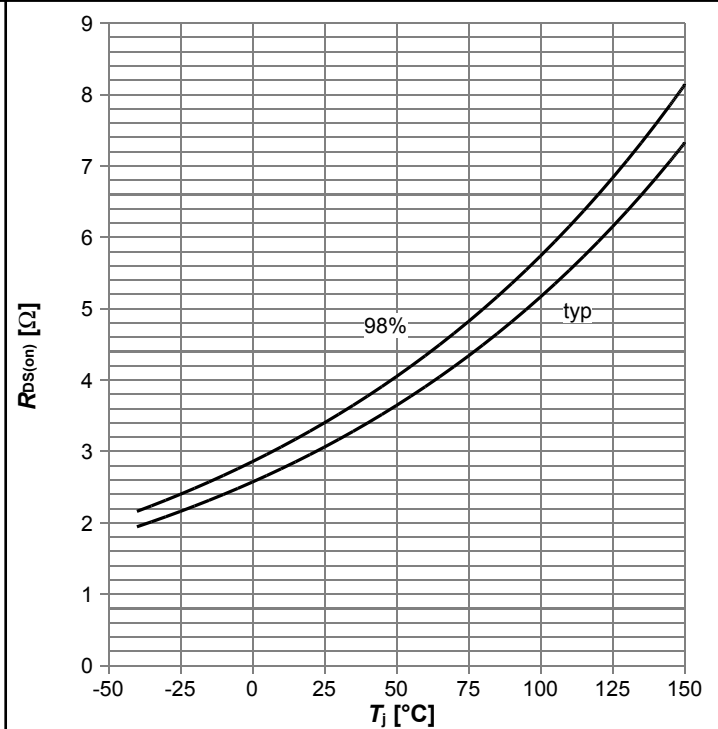
$I_D=f(V_{DS}); T_j=125\text{ }^\circ\text{C};$ parameter: V_{GS}

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



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

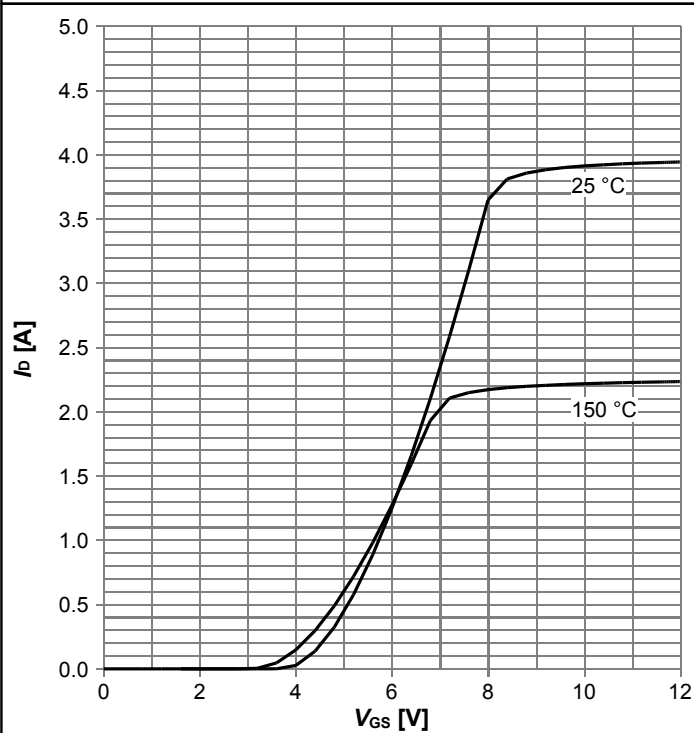
Diagram 8: Drain-source on-state resistance



$R_{DS(on)}=f(T_j); I_D=0.5\text{ A}; V_{GS}=10\text{ V}$

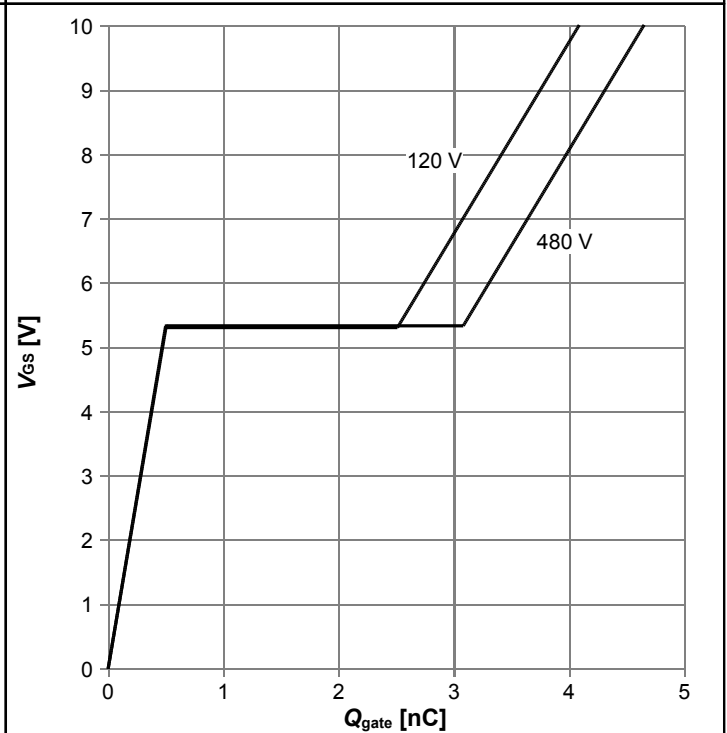
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Diagram 9: Typ. transfer characteristics



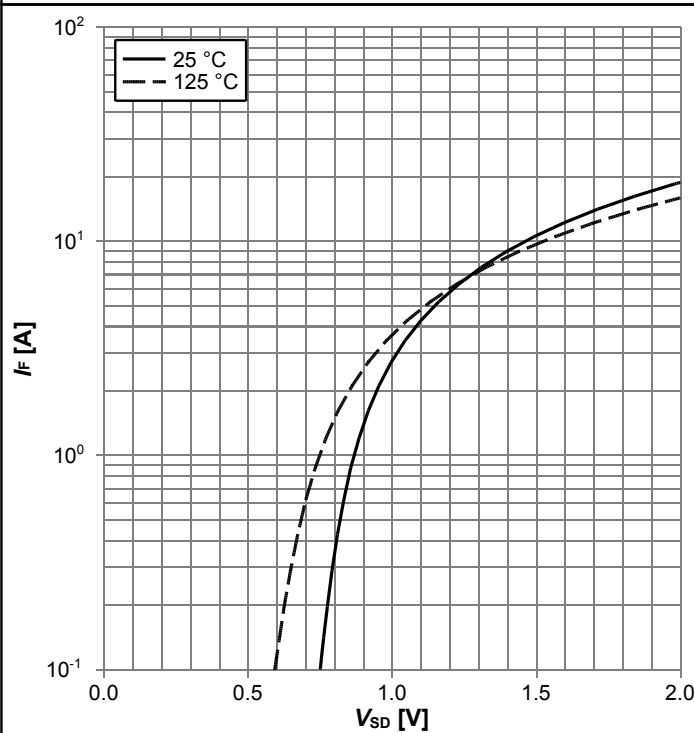
$I_D = f(V_{GS}); V_{DS} = 20V; \text{parameter: } T_j$

Diagram 10: Typ. gate charge



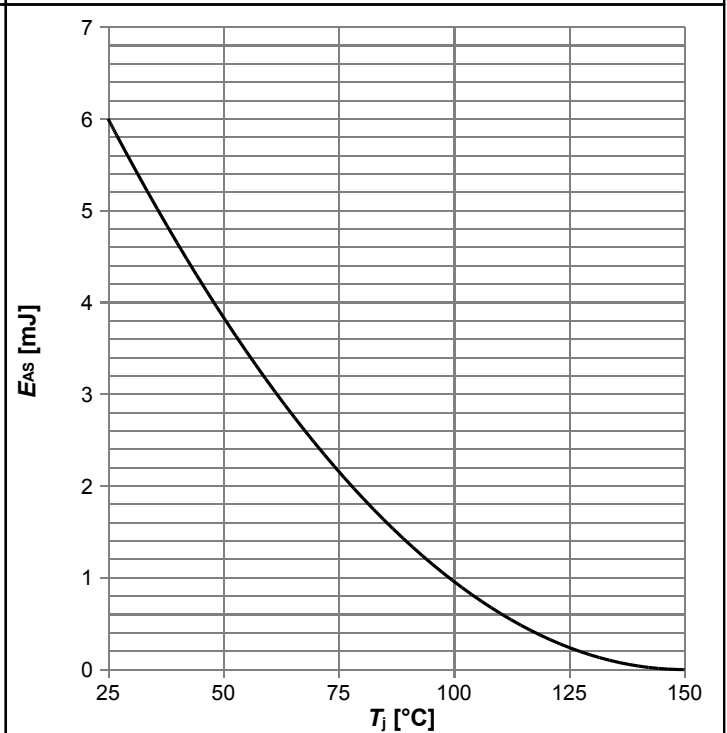
$V_{GS} = f(Q_{gate}); I_D = 0.6 \text{ A pulsed}; \text{parameter: } V_{DD}$

Diagram 11: Forward characteristics of reverse diode



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

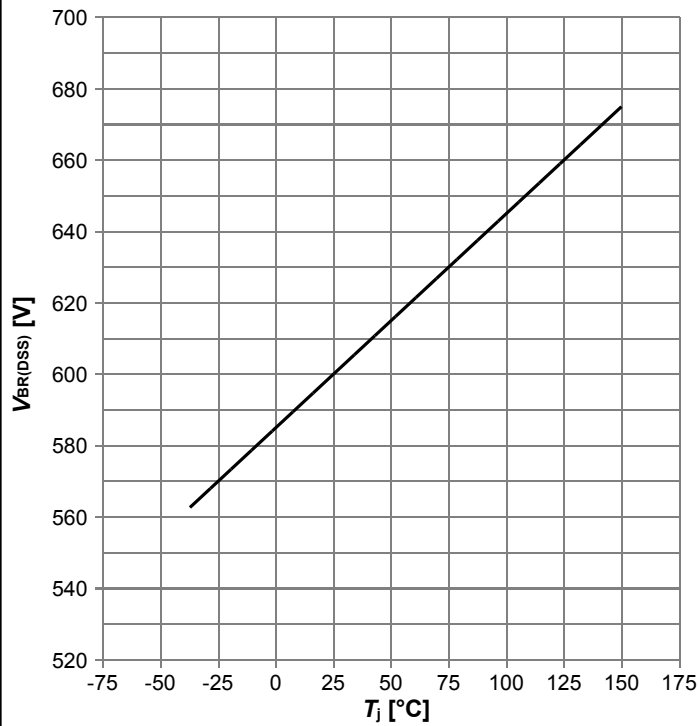
Diagram 12: Avalanche energy



$E_{AS} = f(T_j); I_D = 0.3 \text{ A}; V_{DD} = 50 \text{ V}$

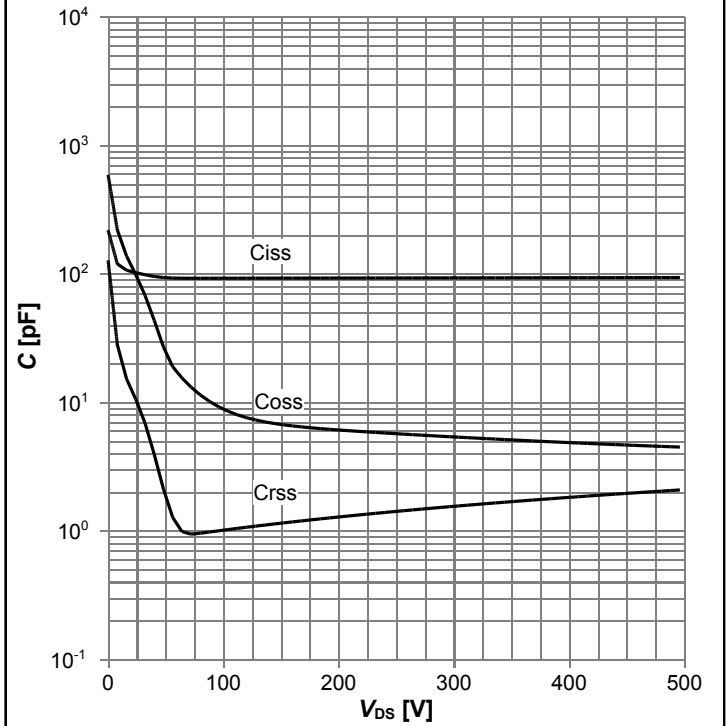
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Diagram 13: Drain-source breakdown voltage



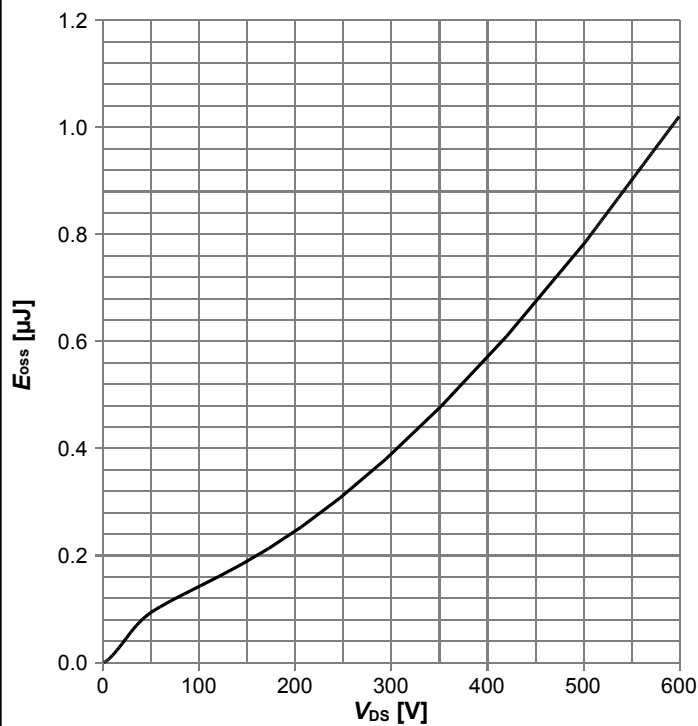
$V_{BR(DSS)}=f(T_j); I_D=0.25 \text{ mA}$

Diagram 14: Typ. capacitances



$C=f(V_{DS}); V_{GS}=0 \text{ V}; f=1 \text{ MHz}$

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>$R_{g1} = R_{g2}$</p> | <p>$t_{tr} = t_F + t_S$ $Q_{tr} = Q_F + Q_S$</p> |

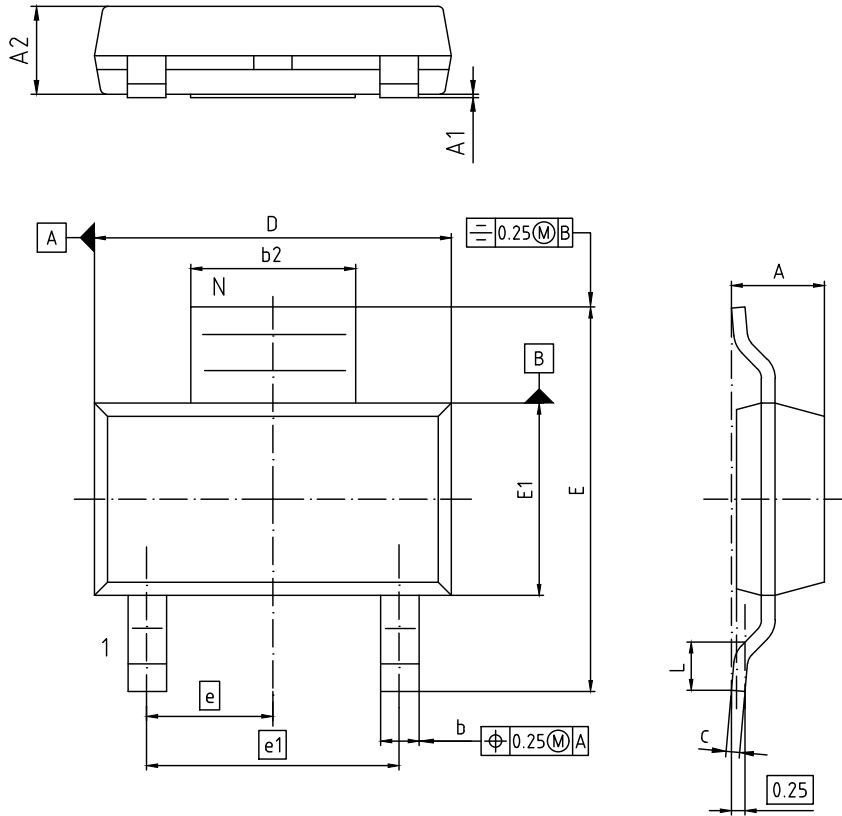
Table 9 Switching times

| 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



NOTES:
 1. ALL DIMENSIONS REFER TO JEDEC STANDARD TO-261

| DIM | MILLIMETERS | | INCHES | |
|-----|-------------|------|-------------|-------|
| | MIN | MAX | MIN | MAX |
| A | 1.52 | 1.80 | 0.060 | 0.071 |
| A1 | - | 0.10 | - | 0.004 |
| A2 | 1.50 | 1.70 | 0.059 | 0.067 |
| b | 0.60 | 0.80 | 0.024 | 0.031 |
| b2 | 2.95 | 3.10 | 0.116 | 0.122 |
| c | 0.24 | 0.32 | 0.009 | 0.013 |
| D | 6.30 | 6.70 | 0.248 | 0.264 |
| E | 6.70 | 7.30 | 0.264 | 0.287 |
| E1 | 3.30 | 3.70 | 0.130 | 0.146 |
| e | 2.3 BASIC | | 0.091 BASIC | |
| e1 | 4.6 BASIC | | 0.181 BASIC | |
| L | 0.75 | 1.10 | 0.030 | 0.043 |
| N | 3 | | 3 | |
| O | 0° | 10° | 0° | 10° |

| |
|------------------------------------|
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| SCALE |
| EUROPEAN PROJECTION |
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| REVISION 01 |

Figure 1 Outline PG-SOT223, dimensions in mm/inches

7 Appendix A

Table 11 Related Links

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

600V CoolMOS™ CE Power Transistor

IPN60R3K4CE

Revision History

IPN60R3K4CE

Revision: 2016-04-29, Rev. 2.0

Previous Revision

| Revision | Date | Subjects (major changes since last revision) |
|----------|------------|--|
| 2.0 | 2016-04-29 | Release of final version |

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