



**THE DATASHEET OF
IPW60R041C6**



MOSFET

Metal Oxide Semiconductor Field Effect Transistor

CoolMOS C6

600V CoolMOS™ C6 Power Transistor
IPW60R041C6

Data Sheet

Rev. 2.1, 2010-07-12
Final

Industrial & Multimarket

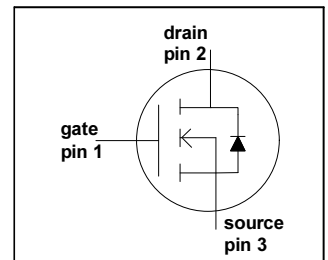
1 Description

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 offered 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
- JEDEC¹⁾ qualified, Pb-free plating, Halogen free



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.

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 |
| $R_{DS(on),max}$ | 0.041 | Ω |
| $Q_{g,typ}$ | 290 | nC |
| $I_{D,pulse}$ | 272 | A |
| $E_{oss} @ 400V$ | 22 | μJ |
| Body diode di/dt | 300 | A/ μs |

Related Links

- [IFX C6 Product Brief](#)
- [IFX C6 Portfolio](#)
- [IFX CoolMOS Webpage](#)
- [IFX Design tools](#)

| Type | Package | Marking |
|-------------|----------|---------|
| IPW60R041C6 | PG-TO247 | 6R041C6 |

1) J-STD20 and JESD22

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2 Maximum ratings

at $T_j = 25\text{ °C}$, unless otherwise specified.

Table 2 Maximum ratings

| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|---|----------------|--------|------|------|------------|---|
| | | Min. | Typ. | Max. | | |
| Continuous drain current ¹⁾ | I_D | - | - | 77.5 | A | $T_C = 25\text{ °C}$ |
| | | | | 49 | | $T_C = 100\text{ °C}$ |
| Pulsed drain current ²⁾ | $I_{D,pulse}$ | - | - | 272 | A | $T_C = 25\text{ °C}$ |
| Avalanche energy, single pulse | E_{AS} | - | - | 1954 | mJ | $I_D = 13.4\text{ A}, V_{DD} = 50\text{ V}$ (see table 17) |
| Avalanche energy, repetitive | E_{AR} | - | - | 2.96 | | $I_D = 13.4\text{ A}, V_{DD} = 50\text{ V}$ |
| Avalanche current, repetitive | I_{AR} | - | - | 13.4 | 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 | P_{tot} | - | - | 481 | W | $T_C = 25\text{ °C}$ |
| Operating and storage temperature | T_j, T_{stg} | -55 | - | 150 | °C | |
| Mounting torque | | - | - | 60 | Ncm | M3 and M3.5 screws |
| Continuous diode forward current | I_S | - | - | 67.2 | A | $T_C = 25\text{ °C}$ |
| Diode pulse current ²⁾ | $I_{S,pulse}$ | - | - | 272 | A | $T_C = 25\text{ °C}$ |
| Reverse diode dv/dt ³⁾ | dv/dt | - | - | 15 | V/ns | $V_{DS} = 0 \dots 400\text{ V}, I_{SD} \leq I_D,$ $T_j = 25\text{ °C}$ |
| Maximum diode commutation speed ³⁾ | di/dt | - | - | 300 | A/ μ s | (see table 18) |

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

| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|--|------------|--------|------|------|------|---------------------------------------|
| | | Min. | Typ. | Max. | | |
| Thermal resistance, junction - case | R_{thJC} | - | - | 0.26 | °C/W | |
| Thermal resistance, junction - ambient | R_{thJA} | - | - | 62 | | leaded |
| Soldering temperature, wavesoldering only allowed at leads | T_{sold} | - | - | 260 | °C | 1.6 mm (0.063 in.) from case for 10 s |

4 Electrical characteristics

Electrical characteristics, at $T_J=25\text{ °C}$, unless otherwise specified.

Table 4 Static characteristics

| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|----------------------------------|---------------|--------|-------|-------|---------------|--|
| | | Min. | Typ. | Max. | | |
| Drain-source breakdown voltage | $V_{(BR)DSS}$ | 600 | - | - | V | $V_{GS}=0\text{ V}$, $I_D=0.25\text{ mA}$ |
| Gate threshold voltage | $V_{GS(th)}$ | 2.5 | 3 | 3.5 | | $V_{DS}=V_{GS}$, $I_D=2.96\text{ mA}$ |
| Zero gate voltage drain current | I_{DSS} | - | - | 5 | μA | $V_{DS}=600\text{ V}$, $V_{GS}=0\text{ V}$, $T_J=25\text{ °C}$ |
| | | - | 50 | - | | $V_{DS}=600\text{ V}$, $V_{GS}=0\text{ V}$, $T_J=150\text{ °C}$ |
| Gate-source leakage current | I_{GSS} | - | - | 100 | nA | $V_{GS}=20\text{ V}$, $V_{DS}=0\text{ V}$ |
| Drain-source on-state resistance | $R_{DS(on)}$ | - | 0.037 | 0.041 | Ω | $V_{GS}=10\text{ V}$, $I_D=44.4\text{ A}$, $T_J=25\text{ °C}$ |
| | | - | 0.096 | - | | $V_{GS}=10\text{ V}$, $I_D=44.4\text{ A}$, $T_J=150\text{ °C}$ |
| Gate resistance | R_G | - | 0.7 | - | 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} | - | 6530 | - | pF | $V_{GS}=0\text{ V}$, $V_{DS}=100\text{ V}$, $f=1\text{ MHz}$ |
| Output capacitance | C_{oss} | - | 360 | - | | |
| Effective output capacitance, energy related ¹⁾ | $C_{o(er)}$ | - | 235 | - | | |
| Effective output capacitance, time related ²⁾ | $C_{o(tr)}$ | - | 1210 | - | | $I_D=\text{constant}$, $V_{GS}=0\text{ V}$ $V_{DS}=0\dots480\text{ V}$ |
| Turn-on delay time | $t_{d(on)}$ | - | 23 | - | ns | $V_{DD}=400\text{ V}$, $V_{GS}=13\text{ V}$, $I_D=44.4\text{ A}$, $R_G=1.7\Omega$ (see table 16) |
| Rise time | t_r | - | 10 | - | | |
| Turn-off delay time | $t_{d(off)}$ | - | 130 | - | | |
| Fall time | t_f | - | 7 | - | | |

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 6 Gate charge characteristics

| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|-----------------------|---------------|--------|------|------|------|--|
| | | Min. | Typ. | Max. | | |
| Gate to source charge | Q_{gs} | - | 36 | - | nC | $V_{DD}=480\text{ V}$, $I_D=44.4\text{ A}$, $V_{GS}=0\text{ to }10\text{ V}$ |
| Gate to drain charge | Q_{gd} | - | 150 | - | | |
| Gate charge total | Q_g | - | 290 | - | | |
| Gate plateau voltage | $V_{plateau}$ | - | 5.4 | - | V | |

Table 7 Reverse diode characteristics

| Parameter | Symbol | Values | | | Unit | Note / Test Condition |
|-------------------------------|-----------|--------|------|------|---------------|---|
| | | Min. | Typ. | Max. | | |
| Diode forward voltage | V_{SD} | - | 0.9 | - | V | $V_{GS}=0\text{ V}$, $I_F=44.4\text{ A}$, $T_j=25\text{ °C}$ |
| Reverse recovery time | t_{rr} | - | 950 | - | ns | $V_R=400\text{ V}$, $I_F=44.4\text{ A}$, |
| Reverse recovery charge | Q_{rr} | - | 32 | - | μC | $di_F/dt=100\text{ A}/\mu\text{s}$ (see table 18) |
| Peak reverse recovery current | I_{rrm} | - | 62 | - | A | |

5 Electrical characteristics diagrams

Table 8

| Power dissipation | Max. transient thermal impedance |
|--------------------|--|
| | |
| $P_{tot} = f(T_c)$ | $Z_{(th)JC} = f(t_p)$; parameter: $D = t_p / T$ |

Table 9

| Safe operating area $T_c = 25\text{ °C}$ | Safe operating area $T_c = 80\text{ °C}$ |
|--|--|
| | |
| $I_D = f(V_{DS}); T_c = 25\text{ °C}; D = 0$; parameter t_p | $I_D = f(V_{DS}); T_c = 80\text{ °C}; D = 0$; parameter t_p |

Table 10

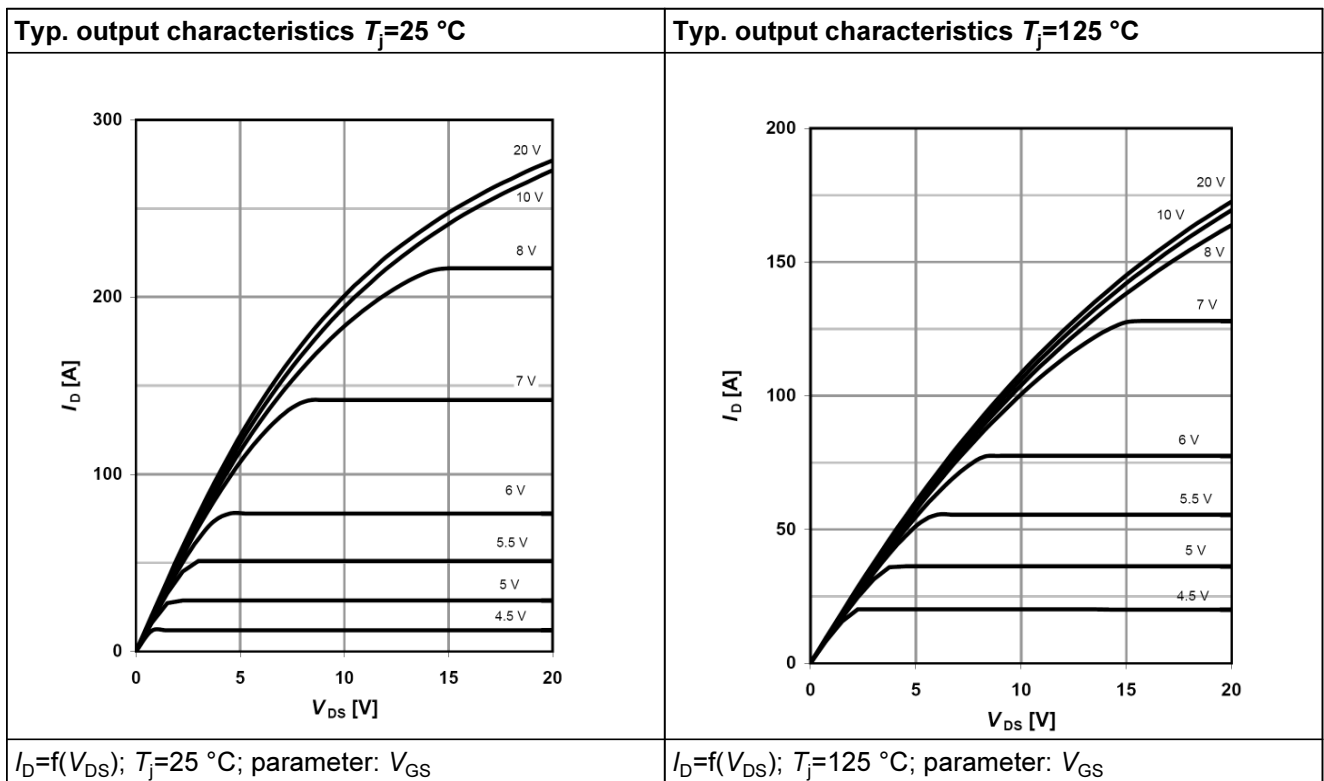


Table 11

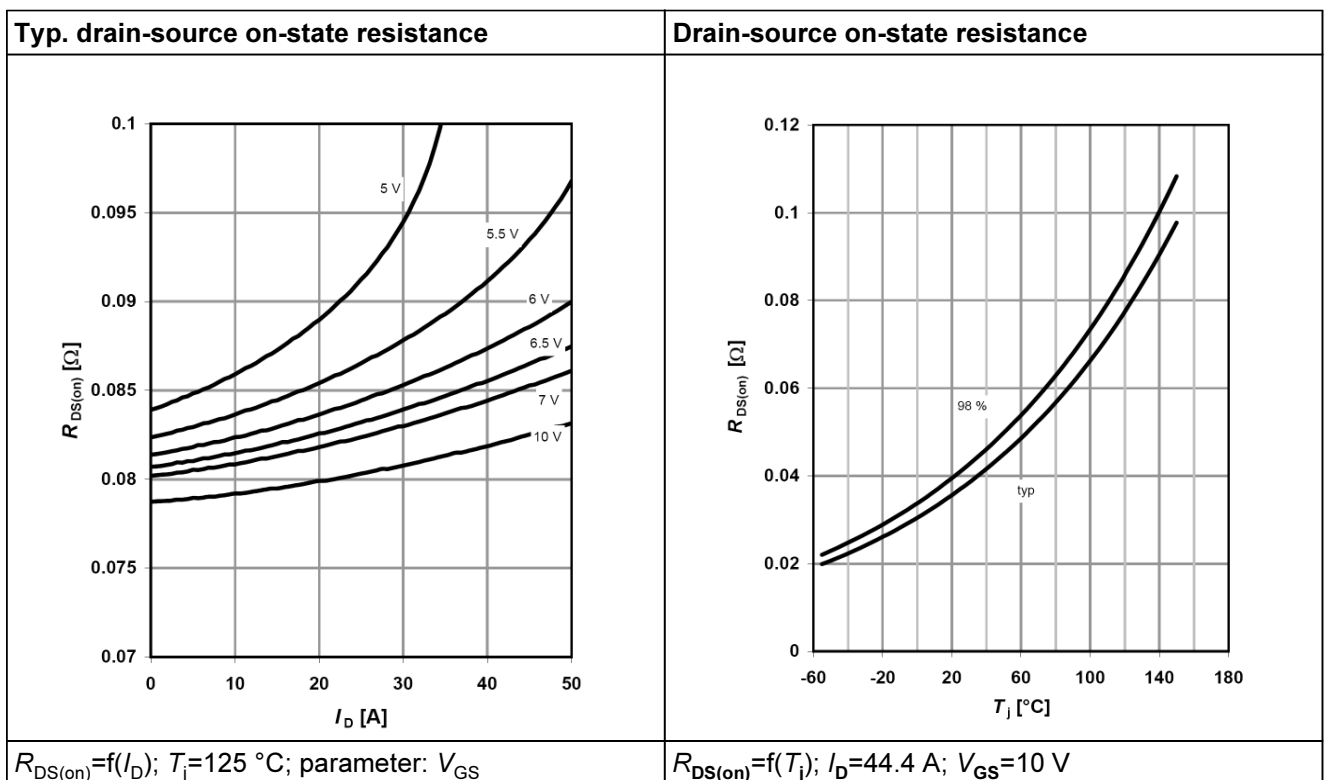


Table 12

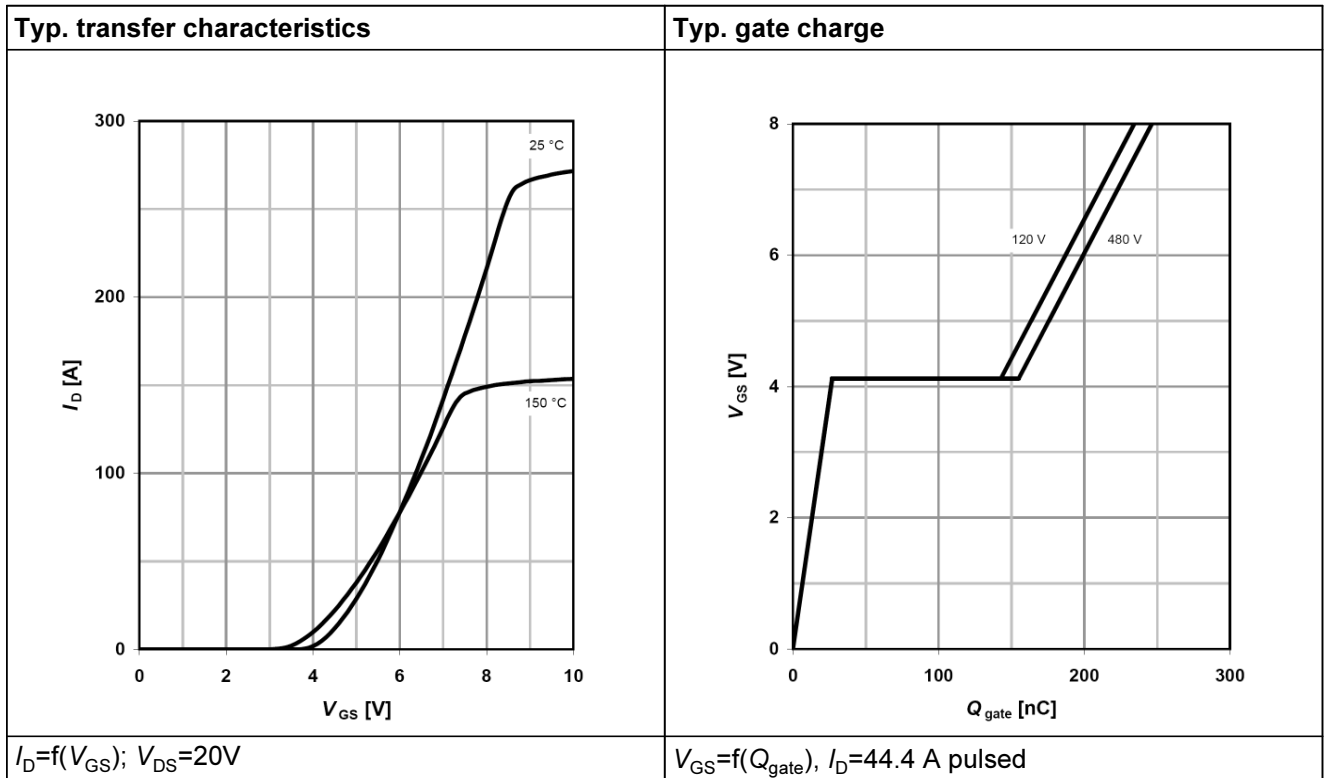


Table 13

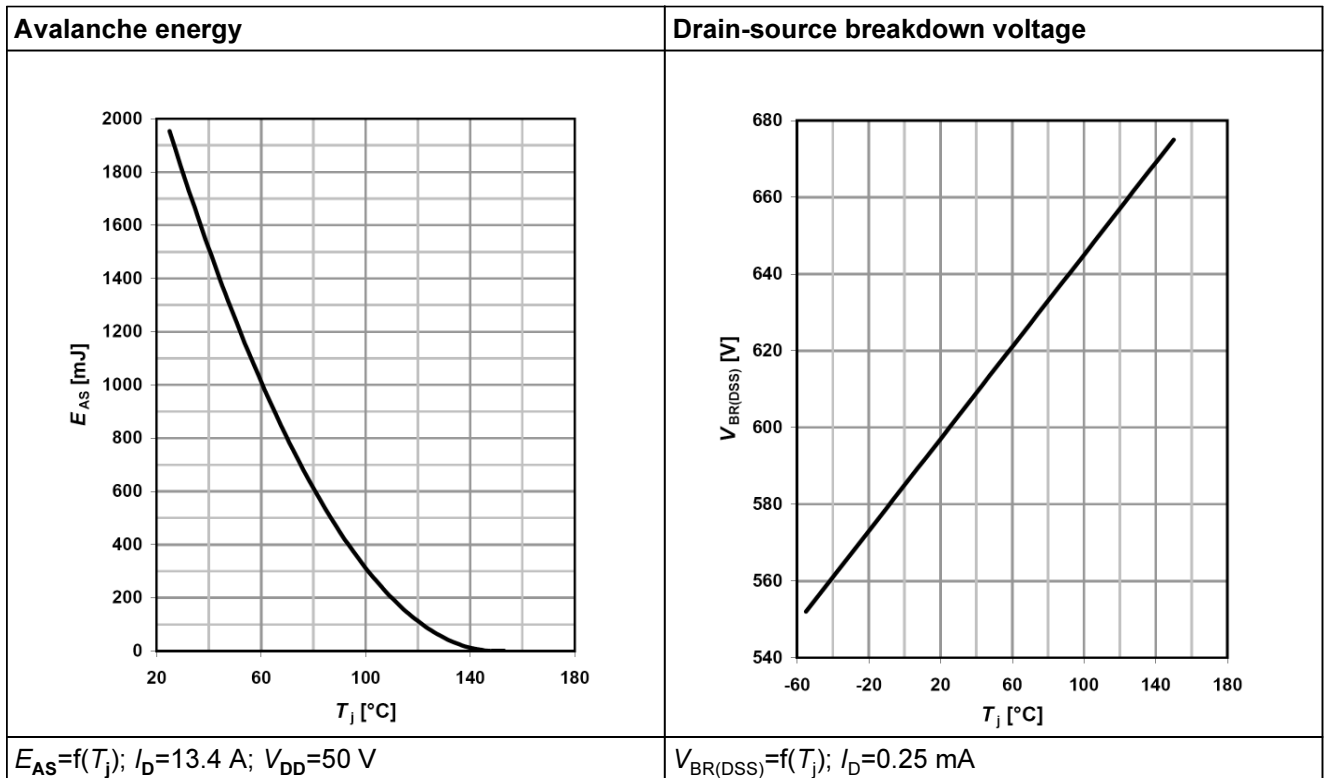


Table 14

| Typ. capacitances | Typ. C_{oss} stored energy |
|--|--|
| <p>The graph shows three capacitance curves against drain-source voltage V_{DS} from 0 to 600 V. The y-axis is capacitance C in pF on a logarithmic scale from 10^0 to 10^5. C_{iss} is a horizontal line at 10^4 pF. C_{oss} starts at 10^4 pF and drops to about 2×10^2 pF at 600 V. C_{rss} starts at 10^4 pF, drops to a minimum of 10^1 pF at 100 V, and then rises to about 5×10^1 pF at 600 V.</p> | <p>The graph shows stored energy E_{oss} in μJ on the y-axis (0 to 40) versus V_{DS} in V on the x-axis (0 to 600). The curve starts at (0,0) and increases non-linearly, reaching approximately 35 μJ at 600 V.</p> |
| <p>$C=f(V_{DS}); V_{GS}=0\text{ V}; f=1\text{ MHz}$</p> | <p>$E_{Oss}=f(V_{DS})$</p> |

Table 15

| Forward characteristics of reverse diode |
|--|
| <p>The graph shows forward current I_F in A on a logarithmic y-axis (from 10^{-1} to 10^3) versus reverse diode voltage V_{SD} in V on a linear x-axis (0 to 2). Two curves are shown for 125°C and 25°C. Both curves show an exponential-like increase in current with voltage, with the 125°C curve shifted to the left of the 25°C curve.</p> |
| <p>$I_F=f(V_{SD});$ parameter: T_j</p> |

6 Test circuits

Table 16 Switching times test circuit and waveform for inductive load

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

Table 17 Unclamped inductive load test circuit and waveform

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

Table 18 Test circuit and waveform for diode characteristics

| Test circuit for diode characteristics | Diode recovery waveform |
|--|-------------------------|
| | |

7 Package outlines

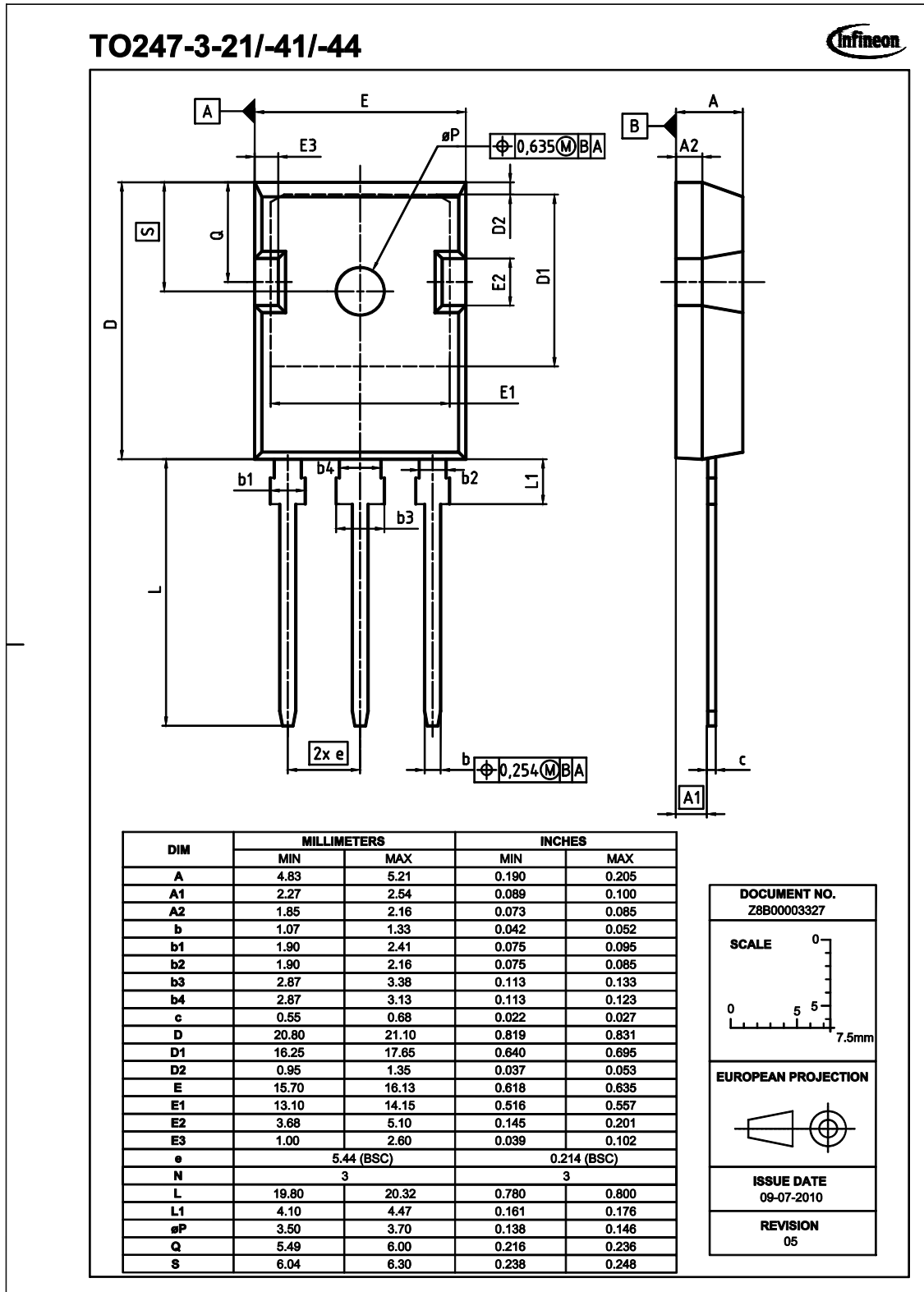


Figure 1 Outlines TO-247, dimensions in mm/inches

8 Revision History

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