

# 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

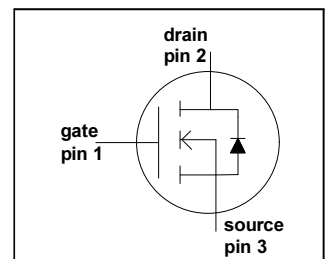
## 1 Description

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
- JEDEC<sup>1)</sup> 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 | $\Omega$   |
| $Q_{g,typ}$          | 290   | nC         |
| $I_{D,pulse}$        | 272   | A          |
| $E_{oss} @ 400V$     | 22    | $\mu J$    |
| Body diode $di/dt$   | 300   | A/ $\mu s$ |

### 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 <sup>1)</sup>        | $I_D$          | -      | -    | 77.5 | A                | $T_C = 25\text{ °C}$  |
|   |                |        |      | 49   |                  | $T_C = 100\text{ °C}$   |
| Pulsed drain current <sup>2)</sup>            | $I_{D,pulse}$  | -      | -    | 272  | A                | $T_C = 25\text{ °C}$  |
| Avalanche energy, single pulse                | $E_{AS}$       | -      | -    | 1954 | mJ               | $I_D = 13.4\text{ A}, V_{DD} = 50\text{ V}$<br>(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 <sup>2)</sup>             | $I_{S,pulse}$  | -      | -    | 272  | A                | $T_C = 25\text{ °C}$  |
| Reverse diode dv/dt <sup>3)</sup>             | dv/dt          | -      | -    | 15   | V/ns             | $V_{DS} = 0 \dots 400\text{ V}, I_{SD} \leq I_D,$<br>$T_j = 25\text{ °C}$ |
| Maximum diode commutation speed <sup>3)</sup> | $di/dt$        | -      | -    | 300  | A/ $\mu\text{s}$ | (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     | $\mu\text{A}$ | $V_{DS}=600\text{ V}$ , $V_{GS}=0\text{ V}$ ,<br>$T_J=25\text{ °C}$  |
|                                  |               | -      | 50    | -     |               | $V_{DS}=600\text{ V}$ , $V_{GS}=0\text{ V}$ ,<br>$T_J=150\text{ °C}$ |
| 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 | $\Omega$      | $V_{GS}=10\text{ V}$ , $I_D=44.4\text{ A}$ ,<br>$T_J=25\text{ °C}$   |
|                                  |               | -      | 0.096 | -     |               | $V_{GS}=10\text{ V}$ , $I_D=44.4\text{ A}$ ,<br>$T_J=150\text{ °C}$  |
| Gate resistance                  | $R_G$         | -      | 0.7   | -     | $\Omega$      | $f=1\text{ MHz}$ , open drain  |

**Table 5 Dynamic characteristics**

| Parameter  | Symbol       | Values |      |      | Unit | Note / Test Condition  |
|--|--------------|--------|------|------|------|--|
|  |              | Min.   | Typ. | Max. |      |  |
| Input capacitance  | $C_{iss}$    | -      | 6530 | -    | pF   | $V_{GS}=0\text{ V}$ , $V_{DS}=100\text{ V}$ ,<br>$f=1\text{ MHz}$  |
| Output capacitance   | $C_{oss}$    | -      | 360  | -    |      |  |
| Effective output capacitance, energy related <sup>1)</sup> | $C_{o(er)}$  | -      | 235  | -    |      |  |
| Effective output capacitance, time related <sup>2)</sup>   | $C_{o(tr)}$  | -      | 1210 | -    |      | $I_D=\text{constant}$ , $V_{GS}=0\text{ V}$<br>$V_{DS}=0\dots480\text{ V}$                                   |
| Turn-on delay time   | $t_{d(on)}$  | -      | 23   | -    | ns   | $V_{DD}=400\text{ V}$ ,<br>$V_{GS}=13\text{ V}$ , $I_D=44.4\text{ A}$ ,<br>$R_G=1.7\Omega$<br>(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   | $V_{DD}=480\text{ V}$ ,<br>$I_D=44.4\text{ A}$ ,<br>$V_{GS}=0\text{ to }10\text{ V}$ |
| 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             | $V_{GS}=0\text{ V}$ , $I_F=44.4\text{ A}$ ,<br>$T_j=25\text{ °C}$ |
| Reverse recovery time         | $t_{rr}$  | -      | 950  | -    | ns            | $V_R=400\text{ V}$ , $I_F=44.4\text{ A}$ ,                        |
| Reverse recovery charge       | $Q_{rr}$  | -      | 32   | -    | $\mu\text{C}$ | $di_F/dt=100\text{ A}/\mu\text{s}$<br>(see table 18)              |
| Peak reverse recovery current | $I_{rrm}$ | -      | 62   | -    | A             |   |

5 Electrical characteristics diagrams

Table 8

| Power dissipation  | Max. transient thermal impedance               |
|--------------------|--|
|                    |  |
| $P_{tot} = f(T_c)$ | $Z_{(thJC)} = f(t_p)$ ; 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

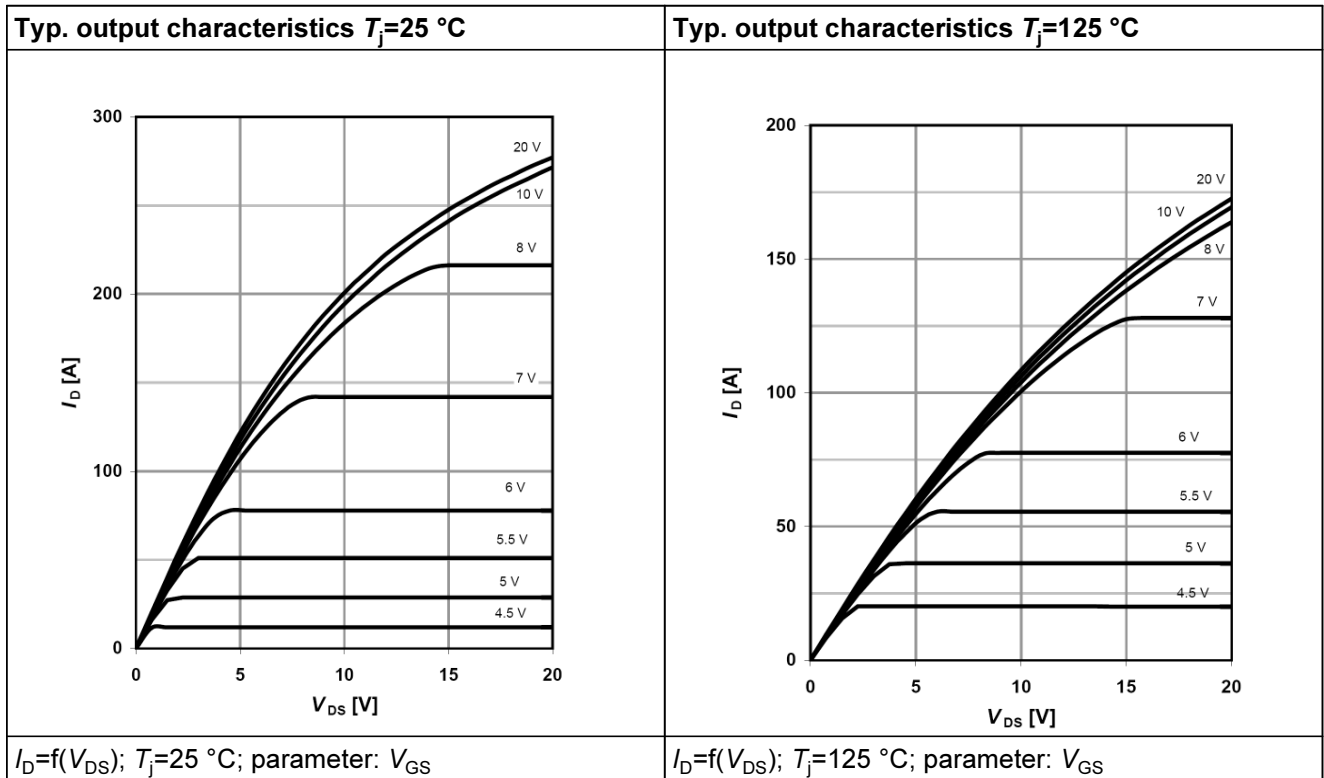


Table 11

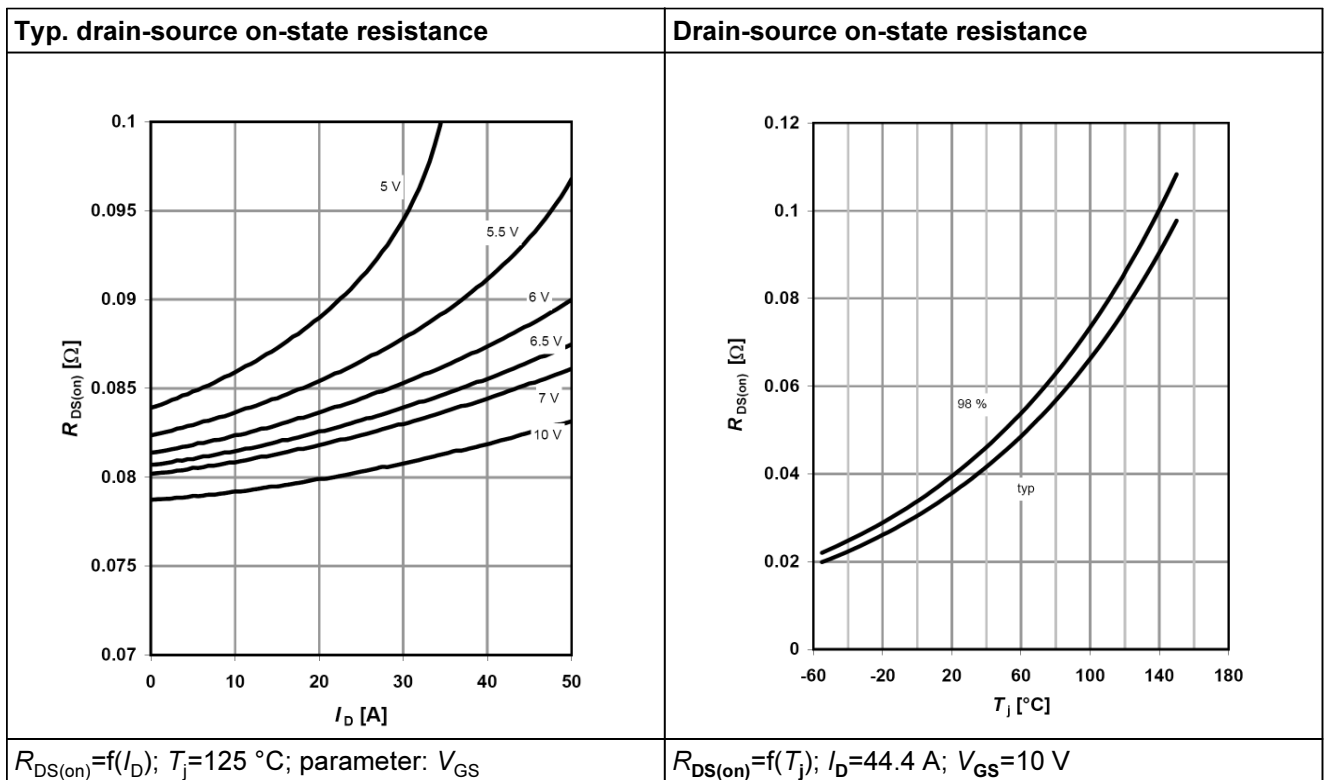




Table 12

| Typ. transfer characteristics | Typ. gate charge                                |
|-------------------------------|---|
|                               |   |
| $I_D=f(V_{GS}); V_{DS}=20V$   | $V_{GS}=f(Q_{gate}), I_D=44.4 \text{ A pulsed}$ |

Table 13

| Avalanche energy   | Drain-source breakdown voltage            |
|--|---|
|  |   |
| $E_{AS}=f(T_j); I_D=13.4 \text{ A}; V_{DD}=50 \text{ V}$ | $V_{BR(DSS)}=f(T_j); I_D=0.25 \text{ mA}$ |

Table 14

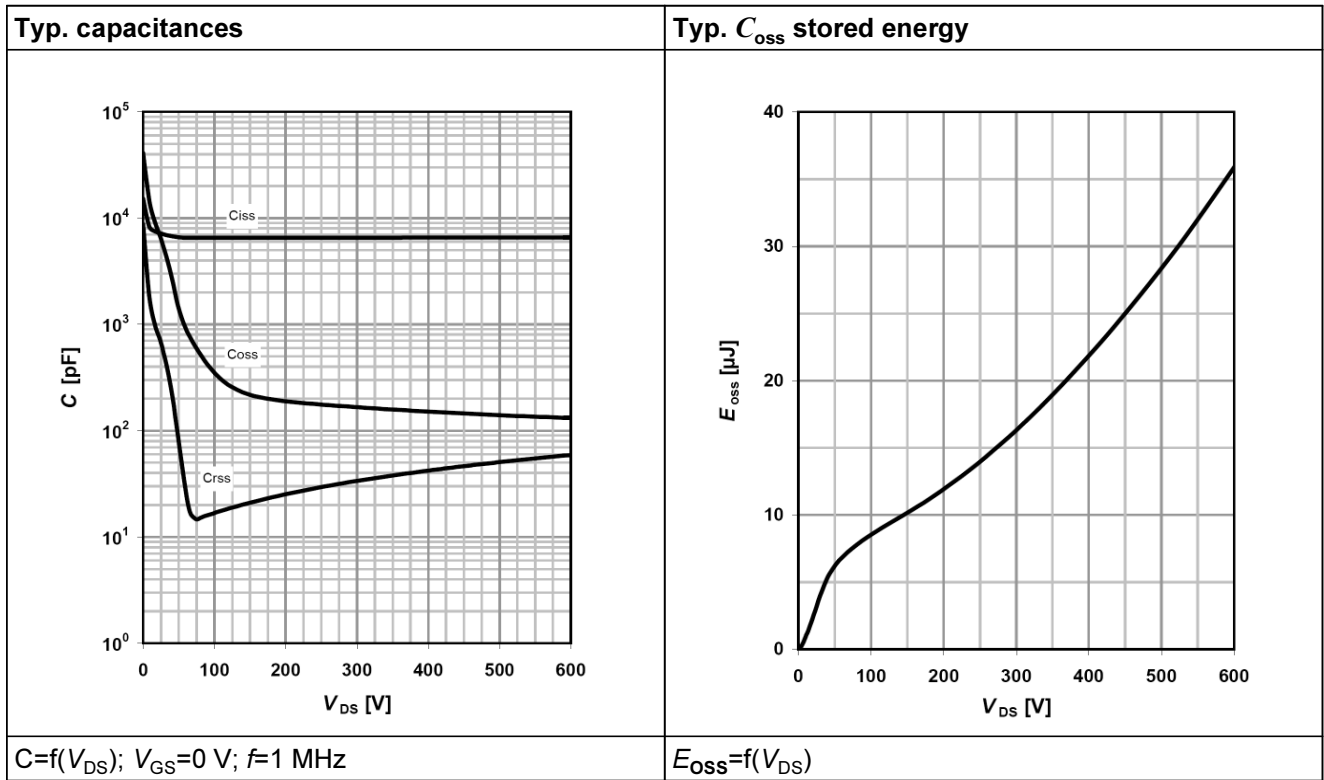
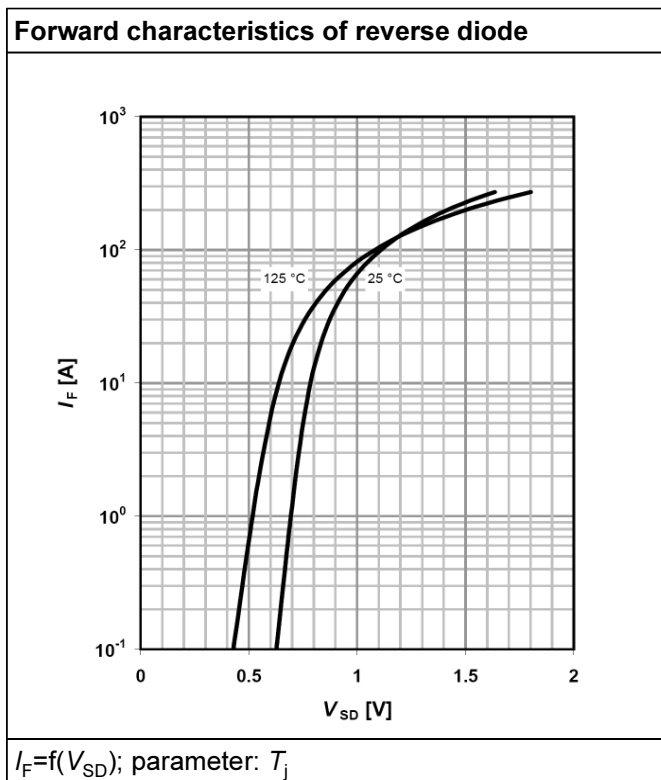


Table 15



## 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

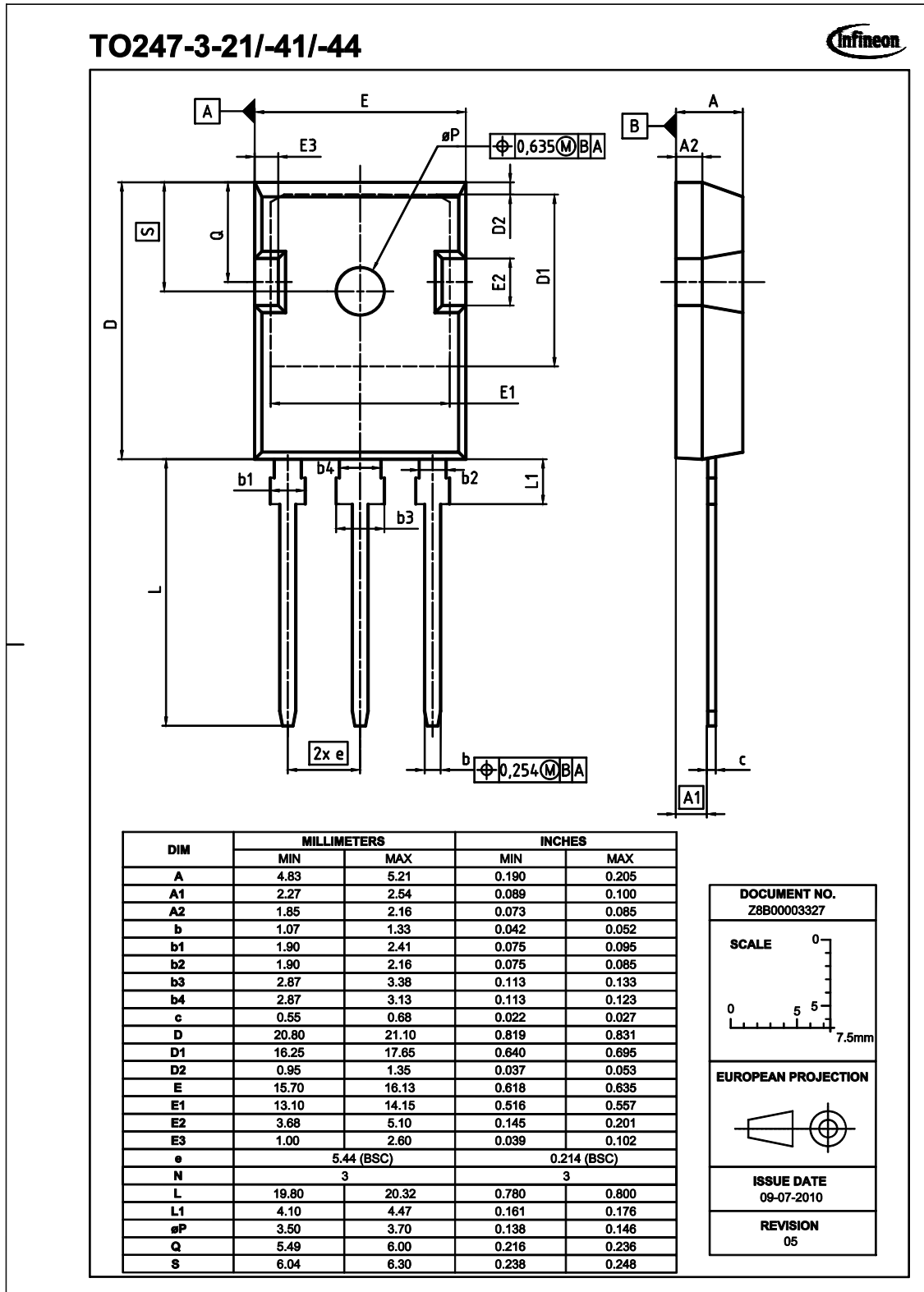


Figure 1 Outlines TO-247, dimensions in mm/inches

## 8 Revision History

| Revision | Reason |
|----------|--------|
|          |        |
|          |        |
|          |        |
|          |        |
|          |        |
|          |        |

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