

MOSFET

Metal Oxide Semiconductor Field Effect Transistor

CoolMOS™ C7

650V CoolMOS™ C7 Power Transistor
IPW65R045C7

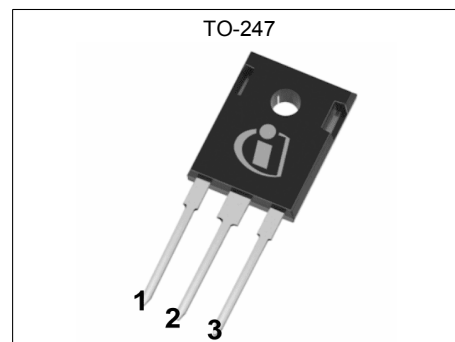
Data Sheet

Rev. 2.1
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™ C7 series combines the experience of the leading SJ MOSFET supplier with high class innovation. The product portfolio provides all benefits of fast switching superjunction MOSFETs offering better efficiency, reduced gate charge, easy implementation and outstanding reliability.



Features

- Increased MOSFET dv/dt ruggedness
- Better efficiency due to best in class FOM $R_{DS(on)} \cdot E_{oss}$ and $R_{DS(on)} \cdot Q_g$
- Best in class $R_{DS(on)}$ /package
- Easy to use/drive
- Pb-free plating, halogen free mold compound
- Qualified for industrial grade applications according to JEDEC (J-STD20 and JESD22)

Benefits

- Enabling higher system efficiency
- Enabling higher frequency / increased power density solutions
- System cost / size savings due to reduced cooling requirements
- Higher system reliability due to lower operating temperatures

Applications

PFC stages and hard switching PWM stages for e.g. Computing, Server, Telecom, UPS and Solar.

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

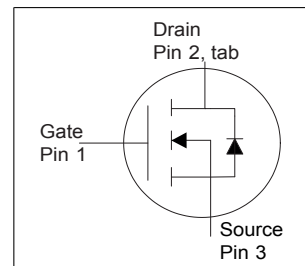


Table 1 Key Performance Parameters

Parameter	Value	Unit
$V_{DS} @ T_{j,max}$	700	V
$R_{DS(on),max}$	45	mΩ
$Q_{g,typ}$	93	nC
$I_{D,pulse}$	212	A
$E_{oss@400V}$	11.7	μJ
Body diode di/dt	60	A/μs

Type / Ordering Code	Package	Marking	Related Links
IPW65R045C7	PG-TO 247	65C7045	see Appendix A

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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	-	-	46 29	A	$T_C=25^\circ\text{C}$ $T_C=100^\circ\text{C}$
Pulsed drain current ²⁾	$I_{D,pulse}$	-	-	212	A	$T_C=25^\circ\text{C}$
Avalanche energy, single pulse	E_{AS}	-	-	249	mJ	$I_D=12\text{A}$; $V_{DD}=50\text{V}$
Avalanche energy, repetitive	E_{AR}	-	-	1.25	mJ	$I_D=12\text{A}$; $V_{DD}=50\text{V}$
Avalanche current, single pulse	I_{AS}	-	-	12.0	A	-
MOSFET dv/dt ruggedness	dv/dt	-	-	100	V/ns	$V_{DS}=0\dots400\text{V}$
Gate source voltage (static)	V_{GS}	-20	-	20	V	static;
Gate source voltage (dynamic)	V_{GS}	-30	-	30	V	AC ($f>1\text{ Hz}$)
Power dissipation	P_{tot}	-	-	227	W	$T_C=25^\circ\text{C}$
Storage temperature	T_{stg}	-55	-	150	$^\circ\text{C}$	-
Operating junction temperature	T_j	-55	-	150	$^\circ\text{C}$	-
Mounting torque	-	-	-	60	Ncm	M3 and M3.5 screws
Continuous diode forward current	I_S	-	-	46	A	$T_C=25^\circ\text{C}$
Diode pulse current ²⁾	$I_{S,pulse}$	-	-	212	A	$T_C=25^\circ\text{C}$
Reverse diode dv/dt ³⁾	dv/dt	-	-	1.5	V/ns	$V_{DS}=0\dots400\text{V}$, $I_{SD}\leq I_S$, $T_j=25^\circ\text{C}$
Maximum diode commutation speed	di/dt	-	-	60	A/ μs	$V_{DS}=0\dots400\text{V}$, $I_{SD}\leq I_S$, $T_j=25^\circ\text{C}$
Insulation withstand voltage	V_{ISO}	-	-	n.a.	V	V_{rms} , $T_C=25^\circ\text{C}$, $t=1\text{min}$

¹⁾ Limited by $T_{j,max}$.

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

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Thermal resistance, junction - case	R_{thJC}	-	-	0.55	°C/W	-
Thermal resistance, junction - ambient	R_{thJA}	-	-	62	°C/W	leaded
Thermal resistance, junction - ambient for SMD version	R_{thJA}	-	-	-	°C/W	n.a.
Soldering temperature, wavesoldering only allowed at leads	T_{sold}	-	-	260	°C	1.6mm (0.063 in.) from case for 10s

4 Electrical characteristics

at $T_j=25^\circ\text{C}$, unless otherwise specified

Table 4 Static characteristics

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Drain-source breakdown voltage	$V_{(BR)DSS}$	650	-	-	V	$V_{GS}=0V$, $I_D=1mA$
Gate threshold voltage	$V_{(GS)th}$	3	3.5	4	V	$V_{DS}=V_{GS}$, $I_D=1.25mA$
Zero gate voltage drain current	I_{DSS}	-	-	2	μA	$V_{DS}=650$, $V_{GS}=0V$, $T_j=25^\circ\text{C}$ $V_{DS}=650$, $V_{GS}=0V$, $T_j=150^\circ\text{C}$
Gate-source leakage current	I_{GSS}	-	-	100	nA	$V_{GS}=20V$, $V_{DS}=0V$
Drain-source on-state resistance	$R_{DS(on)}$	-	0.040 0.096	0.045 -	Ω	$V_{GS}=10V$, $I_D=24.9A$, $T_j=25^\circ\text{C}$ $V_{GS}=10V$, $I_D=24.9A$, $T_j=150^\circ\text{C}$
Gate resistance	R_G	-	0.85	-	Ω	$f=1MHz$, open drain

Table 5 Dynamic characteristics

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Input capacitance	C_{iss}	-	4340	-	pF	$V_{GS}=0V$, $V_{DS}=400V$, $f=250kHz$
Output capacitance	C_{oss}	-	70	-	pF	$V_{GS}=0V$, $V_{DS}=400V$, $f=250kHz$
Effective output capacitance, energy related ¹⁾	$C_{o(er)}$	-	146	-	pF	$V_{GS}=0V$, $V_{DS}=0...400V$
Effective output capacitance, time related ²⁾	$C_{o(tr)}$	-	1630	-	pF	$I_D=\text{constant}$, $V_{GS}=0V$, $V_{DS}=0...400V$
Turn-on delay time	$t_{d(on)}$	-	20	-	ns	$V_{DD}=400V$, $V_{GS}=13V$, $I_D=24.9A$, $R_G=3.3\Omega$
Rise time	t_r	-	14	-	ns	$V_{DD}=400V$, $V_{GS}=13V$, $I_D=24.9A$, $R_G=3.3\Omega$
Turn-off delay time	$t_{d(off)}$	-	82	-	ns	$V_{DD}=400V$, $V_{GS}=13V$, $I_D=24.9A$, $R_G=3.3\Omega$
Fall time	t_f	-	7	-	ns	$V_{DD}=400V$, $V_{GS}=13V$, $I_D=24.9A$, $R_G=3.3\Omega$

Table 6 Gate charge characteristics

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Gate to source charge	Q_{gs}	-	23	-	nC	$V_{DD}=400V$, $I_D=24.9A$, $V_{GS}=0$ to $10V$
Gate to drain charge	Q_{gd}	-	30	-	nC	$V_{DD}=400V$, $I_D=24.9A$, $V_{GS}=0$ to $10V$
Gate charge total	Q_g	-	93	-	nC	$V_{DD}=400V$, $I_D=24.9A$, $V_{GS}=0$ to $10V$
Gate plateau voltage	$V_{plateau}$	-	5.4	-	V	$V_{DD}=400V$, $I_D=24.9A$, $V_{GS}=0$ 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 400V

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 400V

Table 7 Reverse diode characteristics

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Diode forward voltage	V_{SD}	-	0.9	-	V	$V_{GS}=0V$, $I_F=24.9A$, $T_j=25^{\circ}C$
Reverse recovery time	t_{rr}	-	725	-	ns	$V_R=400V$, $I_F=46A$, $di_F/dt=60A/\mu s$
Reverse recovery charge	Q_{rr}	-	13	-	μC	$V_R=400V$, $I_F=46A$, $di_F/dt=60A/\mu s$
Peak reverse recovery current	I_{rrm}	-	36	-	A	$V_R=400V$, $I_F=46A$, $di_F/dt=60A/\mu s$

5 Electrical characteristics diagrams

Table 8

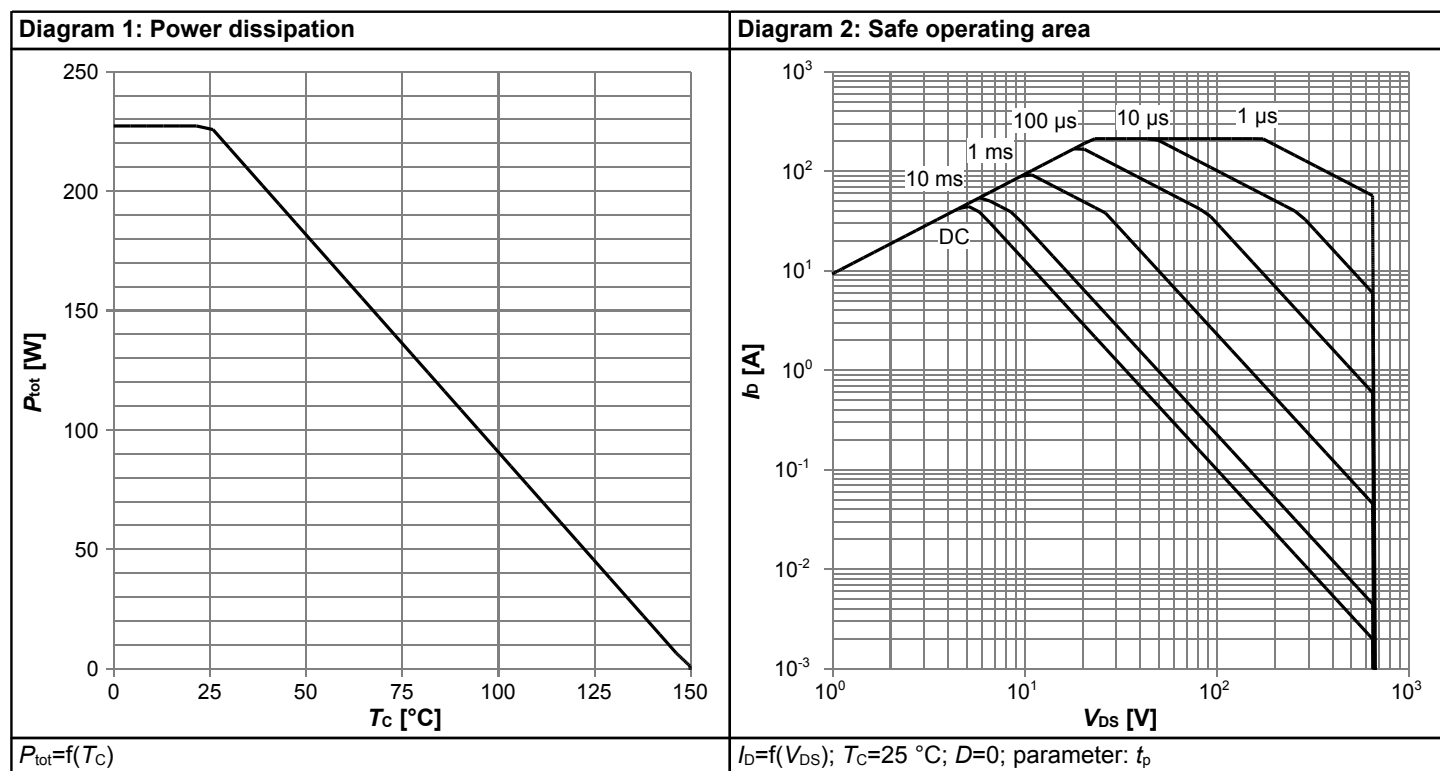


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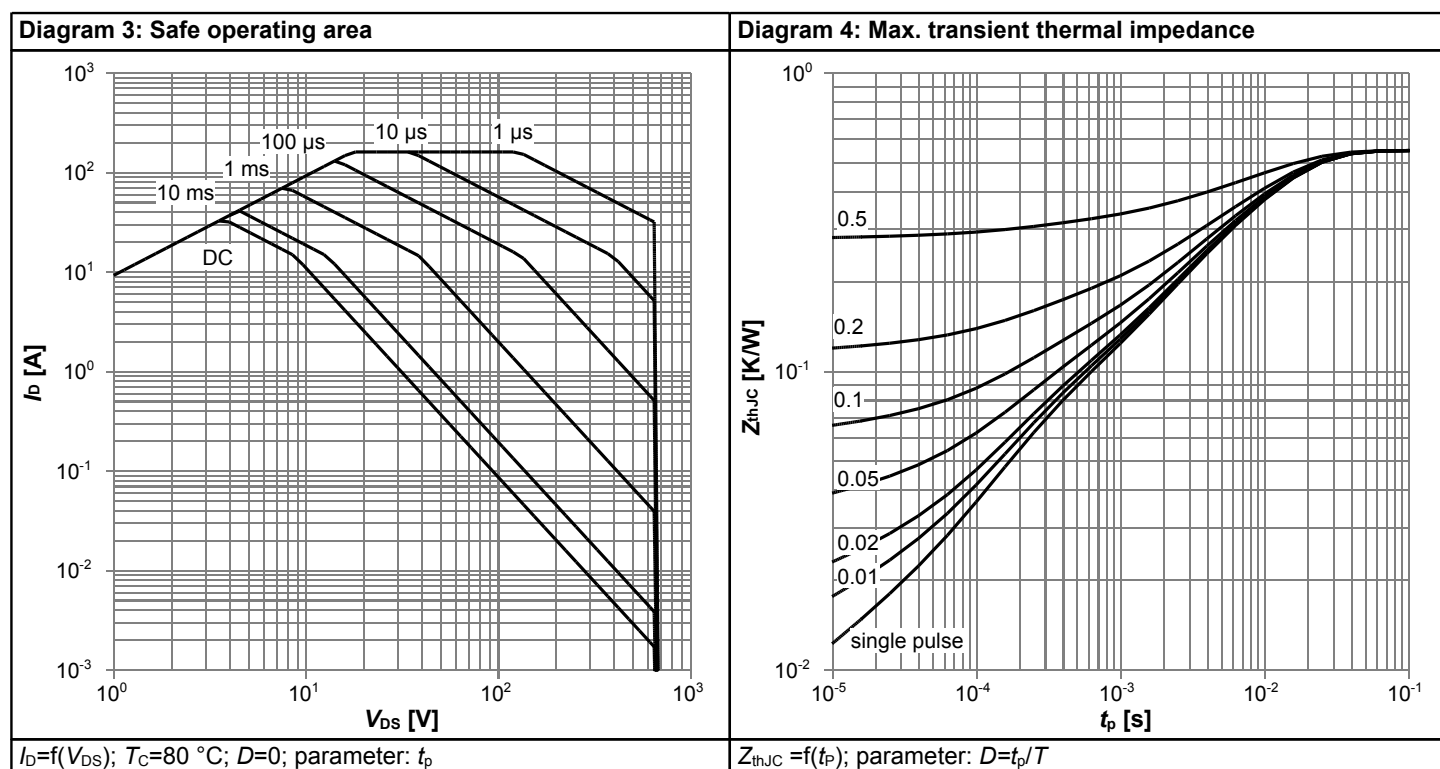


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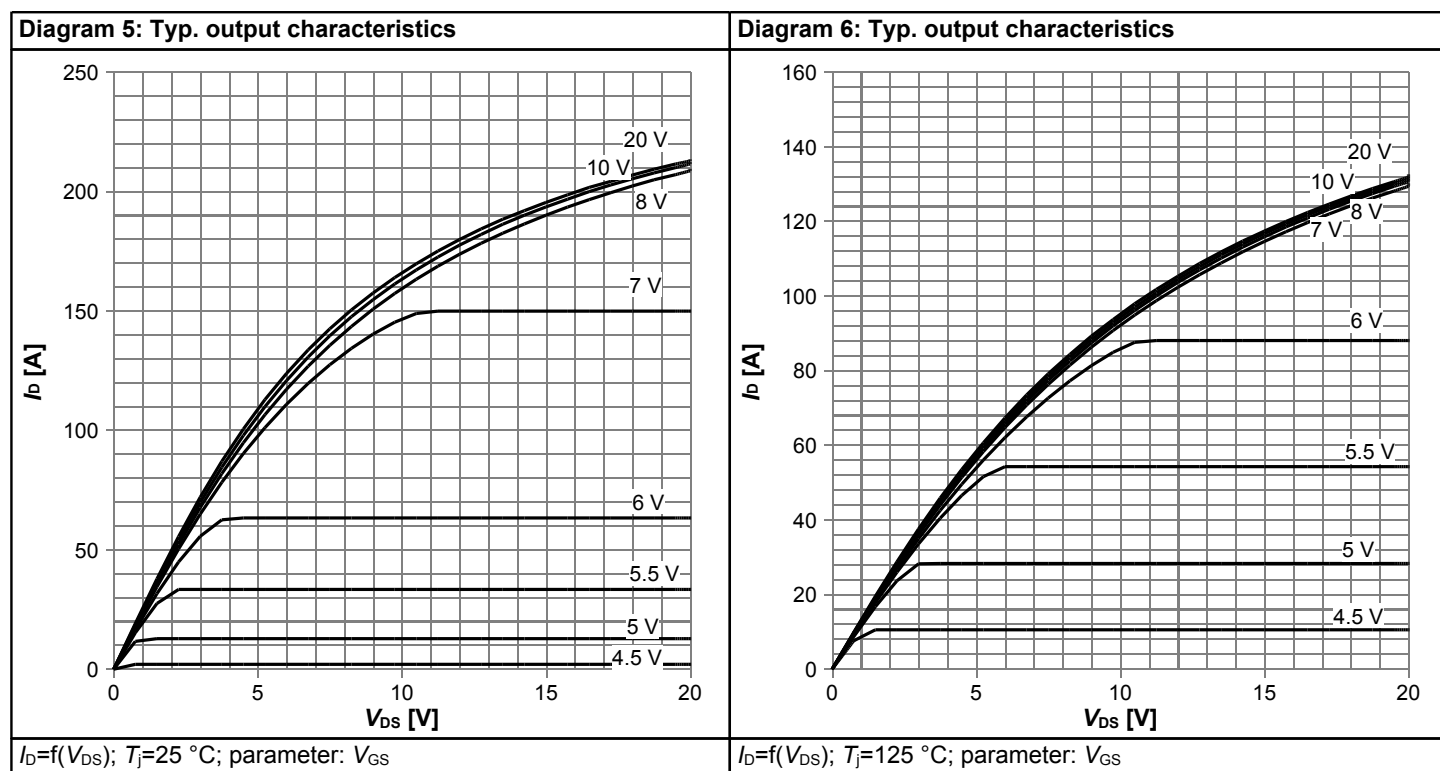


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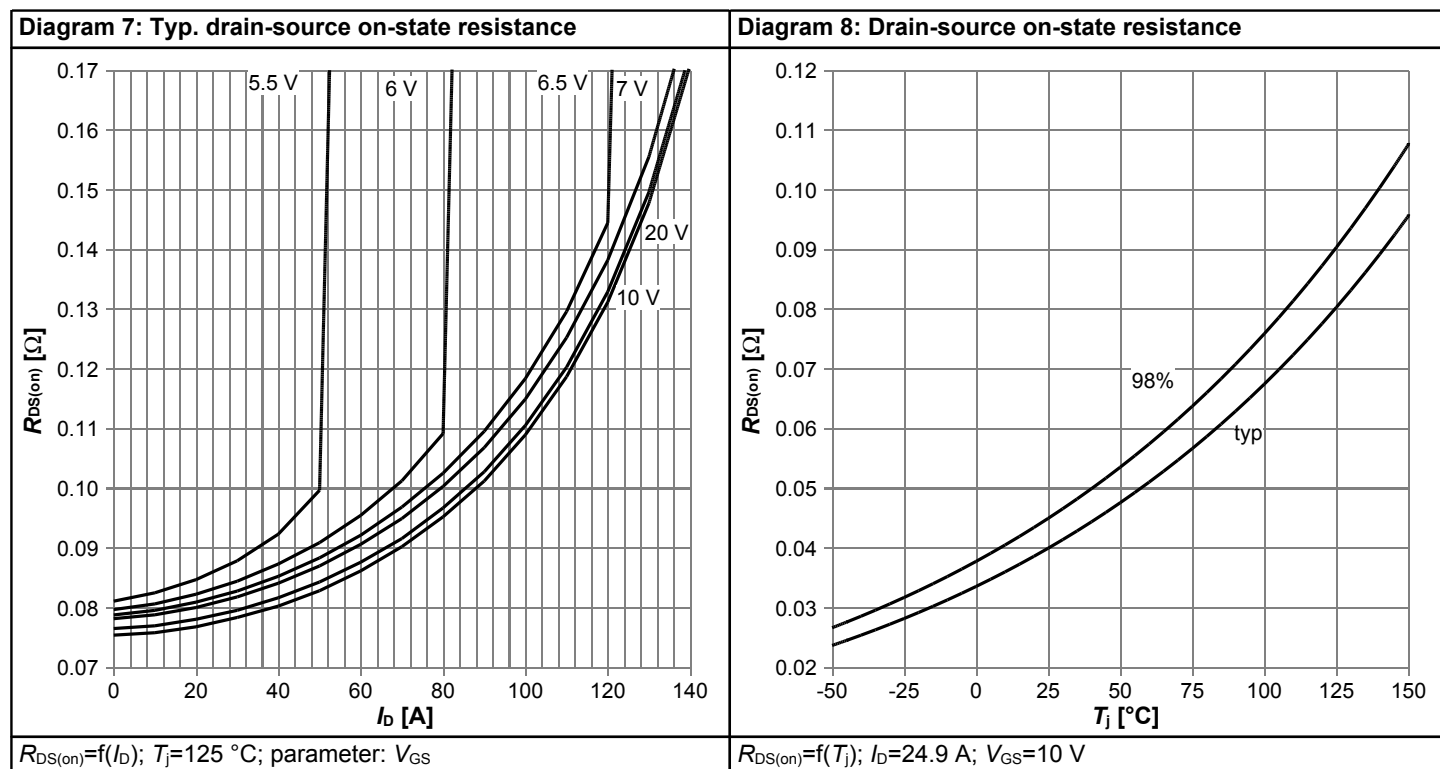


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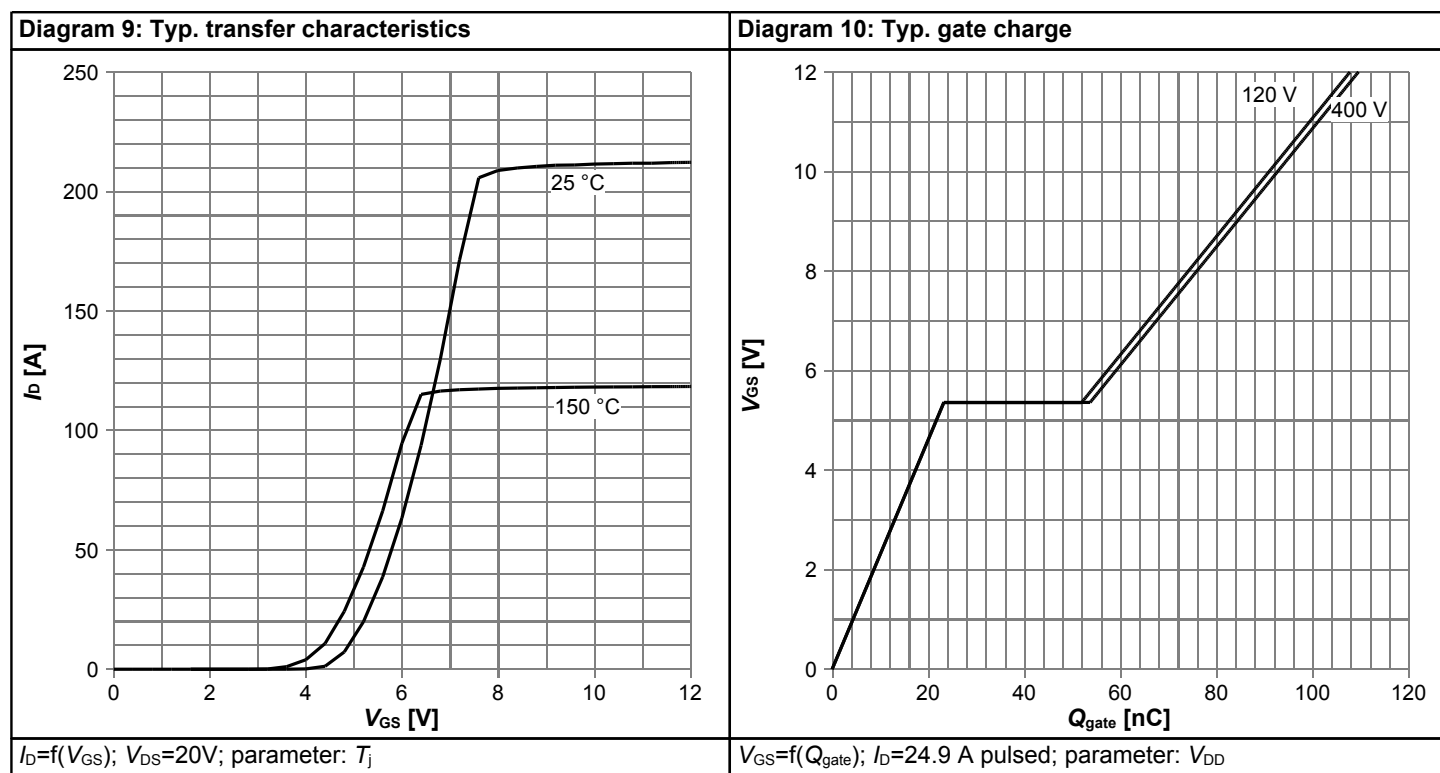


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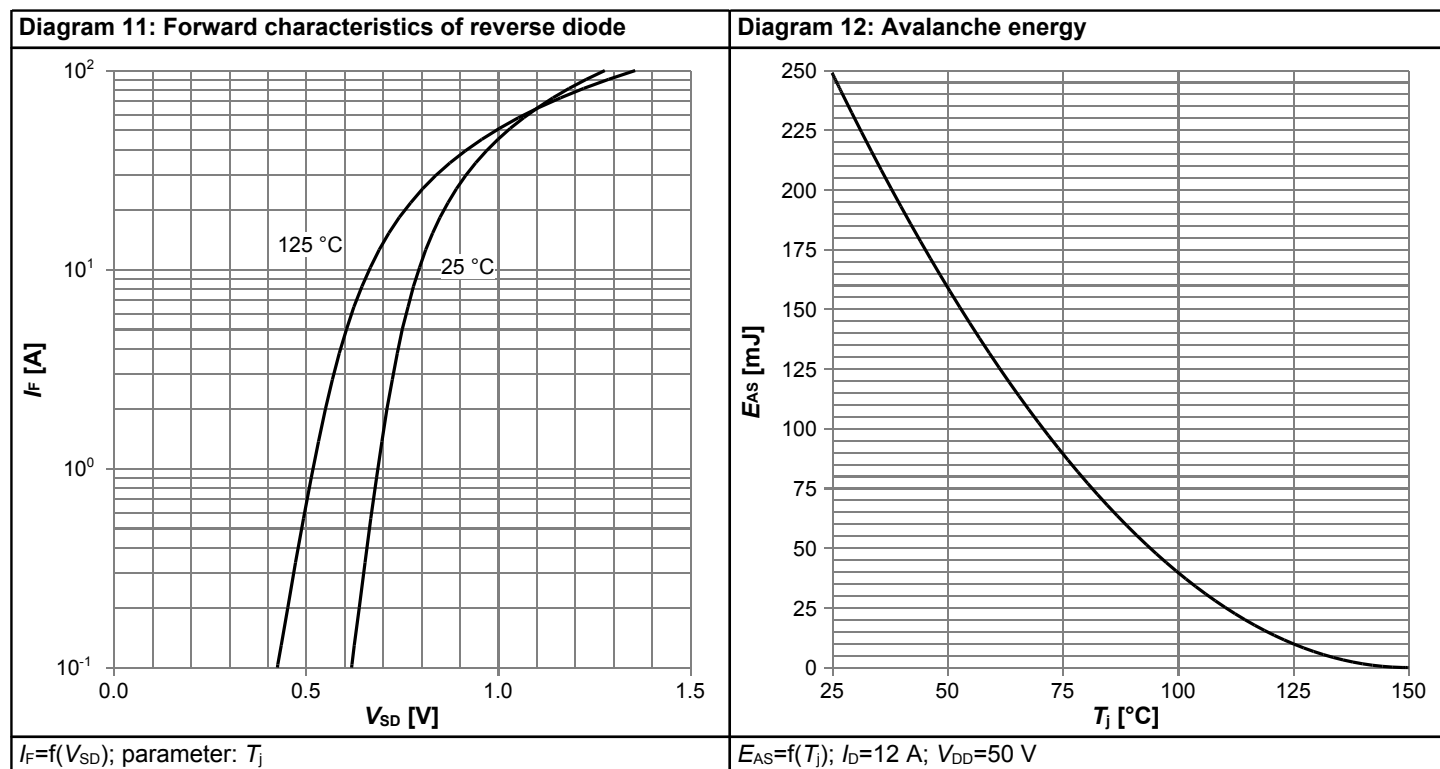


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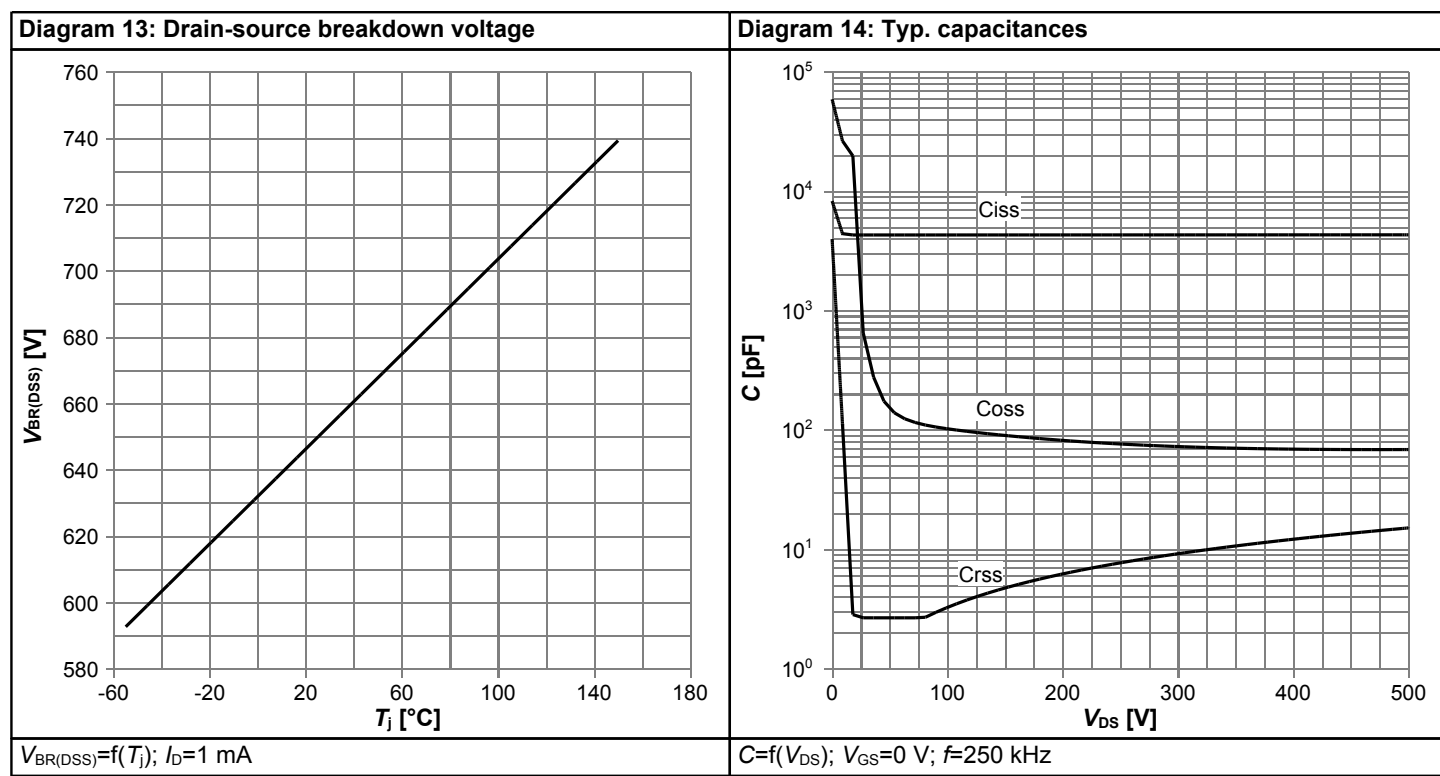
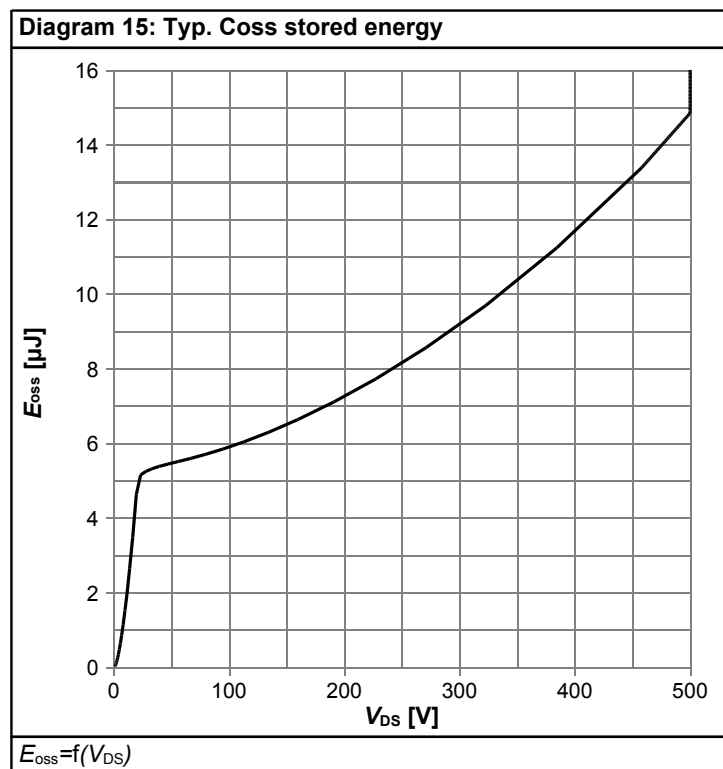


Table 15



6 Test Circuits

Table 16 Diode characteristics

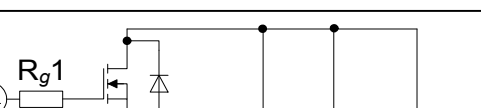
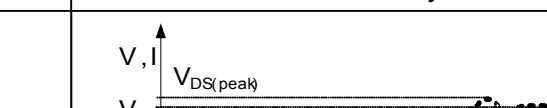
Test circuit for diode characteristics  $R_{g1} = R_{g2}$	Diode recovery waveform  $t_{rr} = t_F + t_S$ $Q_{rr} = Q_F + Q_S$
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Table 17 Switching times

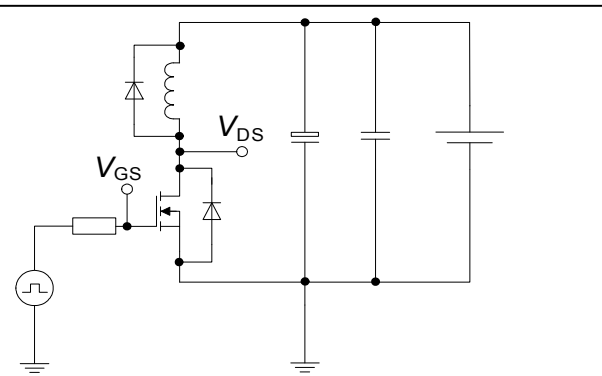
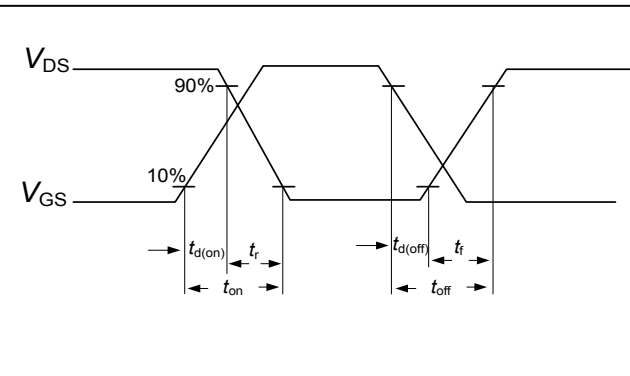
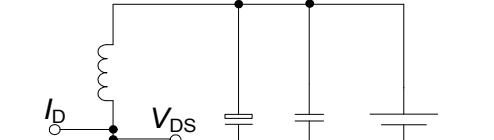
Switching times test circuit for inductive load	Switching times waveform
 The circuit diagram illustrates a switching test setup for an inductive load. A MOSFET is driven by a pulse generator connected to its gate through a resistor. The gate voltage is labeled V_{GS}. The MOSFET's drain is connected to an inductive load (represented by an inductor and a diode in parallel) and a load capacitor. The drain voltage is labeled V_{DS}. The load capacitor is connected in parallel with the inductive load. The MOSFET's source is connected to ground.	 The timing diagram shows the switching waveforms for V_{DS} (drain-source voltage) and V_{GS} (gate-source voltage). The diagram illustrates the switching transitions, including the turn-on and turn-off times, and the rise and fall times of the drain voltage. Key time intervals are marked: $t_{d(on)}$: Delay time from the start of the gate voltage rise to the 90% rise of the drain voltage. t_r: Rise time of the drain voltage from 90% to 100%. $t_{d(off)}$: Delay time from the start of the gate voltage fall to the 90% fall of the drain voltage. t_f: Fall time of the drain voltage from 90% to 10%. t_{on}: Total turn-on time, the sum of $t_{d(on)}$ and t_r. t_{off}: Total turn-off time, the sum of $t_{d(off)}$ and t_f.

Table 18 Unclamped inductive load

Unclamped inductive load test circuit	Unclamped inductive waveform
	

7 Package Outlines

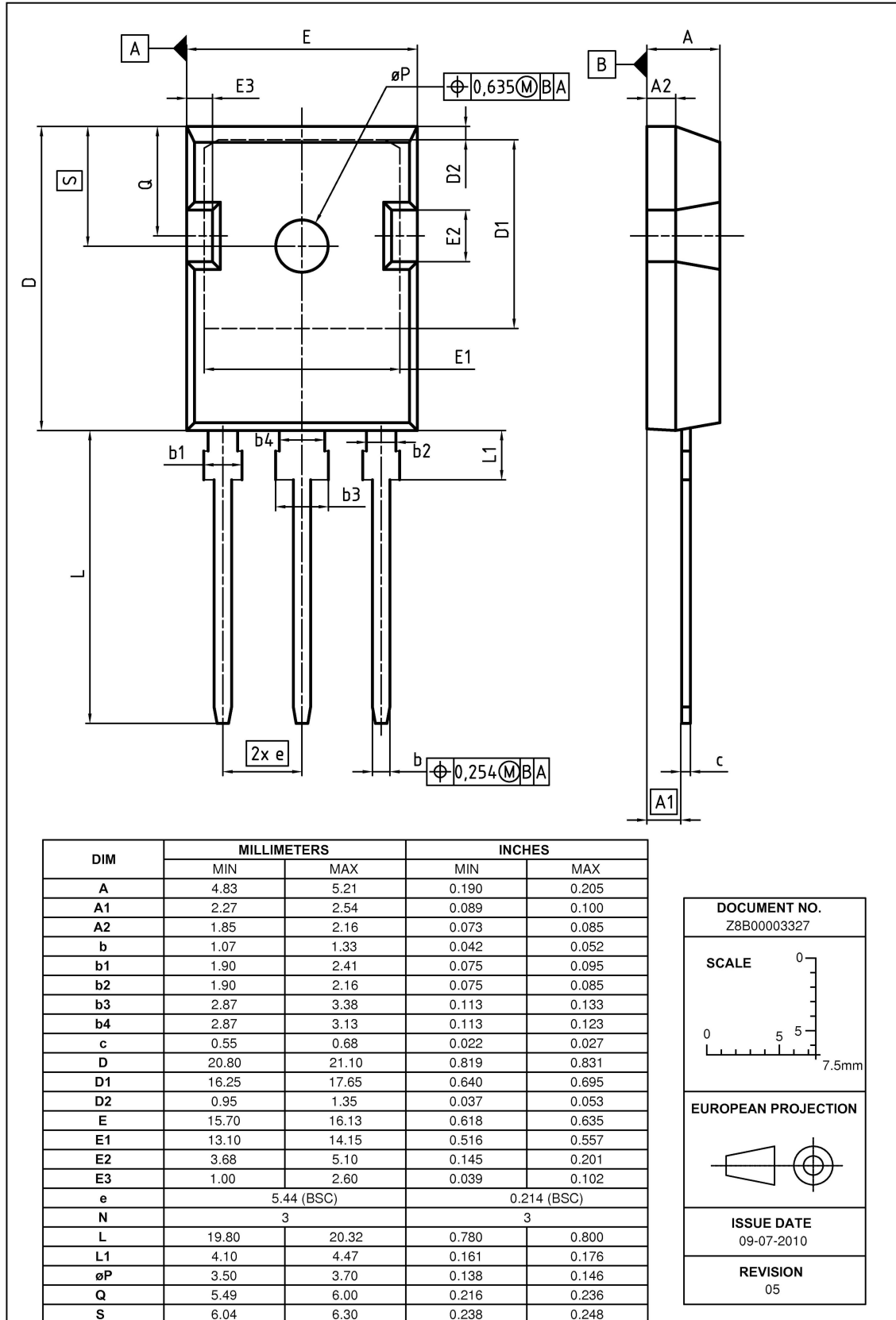


Figure 1 Outline PG-TO 247, dimensions in mm/inches

8 Appendix A

Table 19 Related Links

- IFX CoolMOS™ C7 Webpage: www.infineon.com
- IFX CoolMOS™ C7 application note: www.infineon.com
- IFX CoolMOS™ C7 simulation model: www.infineon.com
- IFX Design tools: www.infineon.com

Revision History

IPW65R045C7

Revision: 2013-04-30, Rev. 2.1

Previous Revision

Revision	Date	Subjects (major changes since last revision)
2.0	2013-04-18	Release of final version
2.1	2013-04-30	Body diode di/dt update

We Listen to Your Comments

Any information within this document that you feel is wrong, unclear or missing at all? Your feedback will help us to continuously improve the quality of this document. Please send your proposal (including a reference to this document) to:

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