



**THE DATASHEET OF  
IPD60R1K4C6ATMA1**



# MOSFET

Metal Oxide Semiconductor Field Effect Transistor

## CoolMOS™ C6 600V

600V CoolMOS™ C6 Power Transistor  
IPD60R1K4C6

## Data Sheet

Rev. 2.3  
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 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

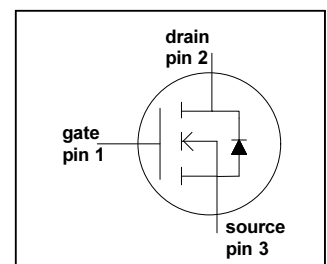
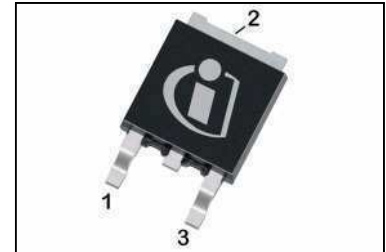
- Extremely low losses due to very low FOM  $R_{DS(on)} \cdot Q_g$  and  $E_{oss}$
- Very high commutation ruggedness
- Easy to use/drive
- Fully qualified according to JEDEC for Industrial Applications
- Halogen free mold compound, Pb-free plating

### 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
$R_{DS(on),max}$	1.4	$\Omega$
$Q_{g,typ}$	9.4	nC
$I_{D,pulse}$	8	A
$E_{oss} @ 400V$	1	$\mu J$
Body diode $di/dt$	500	A/ $\mu s$

Type / Ordering Code	Package	Marking	Related Links
IPD60R1K4C6	PG-TO252	6R1K4C6	<a href="#">IFX C6 Product Brief</a> <a href="#">IFX C6 Portfolio</a> <a href="#">IFX CoolMOS Webpage</a> <a href="#">IFX Design tools</a>

## Table of Contents

1	Description .....	2
	Table of Contents .....	3
2	Maximum Ratings .....	4
3	Thermal characteristics .....	5
4	Electrical characteristics .....	6
5	Electrical characteristics diagrams .....	8
6	Test circuits .....	12
7	Package outlines .....	13
8	Revision History .....	14

## 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>	$I_D$	-	-	3.2	A	$T_C = 25\text{ °C}$
				2.0		$T_C = 100\text{ °C}$
Pulsed drain current <sup>2)</sup>	$I_{D,pulse}$	-	-	8	A	$T_C = 25\text{ °C}$
Avalanche energy, single pulse	$E_{AS}$	-	-	26	mJ	$I_D = 0.6\text{ A}, V_{DD} = 50\text{ V}$ (see table 17)
Avalanche energy, repetitive	$E_{AR}$	-	-	0.09		$I_D = 0.6\text{ A}, V_{DD} = 50\text{ V}$
Avalanche current, repetitive	$I_{AR}$	-	-	0.6	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	$P_{tot}$	-	-	28.4	W	$T_C = 25\text{ °C}$
Operating and storage temperature	$T_j, T_{stg}$	-55	-	150	°C	
Continuous diode forward current	$I_S$	-	-	2.8	A	$T_C = 25\text{ °C}$
Diode pulse current <sup>2)</sup>	$I_{S,pulse}$	-	-	8	A	$T_C = 25\text{ °C}$
Reverse diode dv/dt <sup>3)</sup>	dv/dt	-	-	15	V/ns	$V_{DS} = 0 \dots 480\text{ V}, I_{SD} \leq I_D,$ $T_j = 25\text{ °C}$
Maximum diode commutation speed <sup>3)</sup>	di/dt			500	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**

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Thermal resistance, junction - case	$R_{thJC}$	-	-	4.4	°C/W	
Thermal resistance, junction - ambient	$R_{thJA}$	-	-	62		SMD version, device on PCB, minimal footprint
			35			SMD version, device on PCB, 6cm <sup>2</sup> cooling area <sup>1)</sup>
Soldering temperature, wave- & reflowsoldering allowed	$T_{sold}$	-	-	260	°C	reflow MSL1

1) Device on 40mm\*40mm\*1.5 epoxy PCB FR4 with 6cm<sup>2</sup> (one layer, 70µm thick) copper area for drain connection. PCB is vertical without air stream cooling

## 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		$V_{DS}=V_{GS}$ , $I_D=0.09\text{ mA}$
Zero gate voltage drain current	$I_{DSS}$	-	-	1	$\mu\text{A}$	$V_{DS}=600\text{ V}$ , $V_{GS}=0\text{ V}$ , $T_J=25\text{ °C}$
		-	10	-		$V_{DS}=600\text{ V}$ , $V_{GS}=0\text{ V}$ , $T_J=150\text{ °C}$
Gate-source leakage current	$I_{GSS}$	-	-	100	nA	$V_{GS}=20\text{ V}$ , $V_{DS}=0\text{ V}$
Drain-source on-state resistance	$R_{DS(on)}$	-	1.26	1.4	$\Omega$	$V_{GS}=10\text{ V}$ , $I_D=1.1\text{ A}$ , $T_J=25\text{ °C}$
		-	3.28	-		$V_{GS}=10\text{ V}$ , $I_D=1.1\text{ A}$ , $T_J=150\text{ °C}$
Gate resistance	$R_G$	-	14	-	$\Omega$	$f=1\text{ MHz}$ , open drain

**Table 5 Dynamic characteristics**

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Input capacitance	$C_{iss}$	-	200	-	pF	$V_{GS}=0\text{ V}$ , $V_{DS}=100\text{ V}$ , $f=1\text{ MHz}$
Output capacitance	$C_{oss}$	-	16	-		
Effective output capacitance, energy related <sup>1)</sup>	$C_{o(er)}$	-	11	-		
Effective output capacitance, time related <sup>2)</sup>	$C_{o(tr)}$	-	41.3	-		
Turn-on delay time	$t_{d(on)}$	-	8	-	ns	$V_{DD}=400\text{ V}$ , $V_{GS}=10\text{ V}$ , $I_D=1.4\text{ A}$ , $R_G=12.2\ \Omega$ (see table 16)
Rise time	$t_r$	-	7	-		
Turn-off delay time	$t_{d(off)}$	-	40	-		
Fall time	$t_f$	-	20	-		

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	$Q_{gs}$	-	1.1	-	nC	$V_{DD}=480\text{ V}$ , $I_D=1.4\text{ A}$ , $V_{GS}=0\text{ to }10\text{ V}$
Gate to drain charge	$Q_{gd}$	-	5	-		
Gate charge total	$Q_g$	-	9.4	-		
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	$V_{GS}=0\text{ V}$ , $I_F=1.4\text{ A}$ , $T_j=25\text{ °C}$
Reverse recovery time	$t_{rr}$	-	230	-	ns	$V_R=400\text{ V}$ , $I_F=1.4\text{ A}$ , $di_F/dt=100\text{ A}/\mu\text{s}$ (see table 18)
Reverse recovery charge	$Q_{rr}$	-	1.1	-	$\mu\text{C}$	
Peak reverse recovery current	$I_{rrm}$	-	9.8	-	A	

5 Electrical characteristics diagrams

Table 8

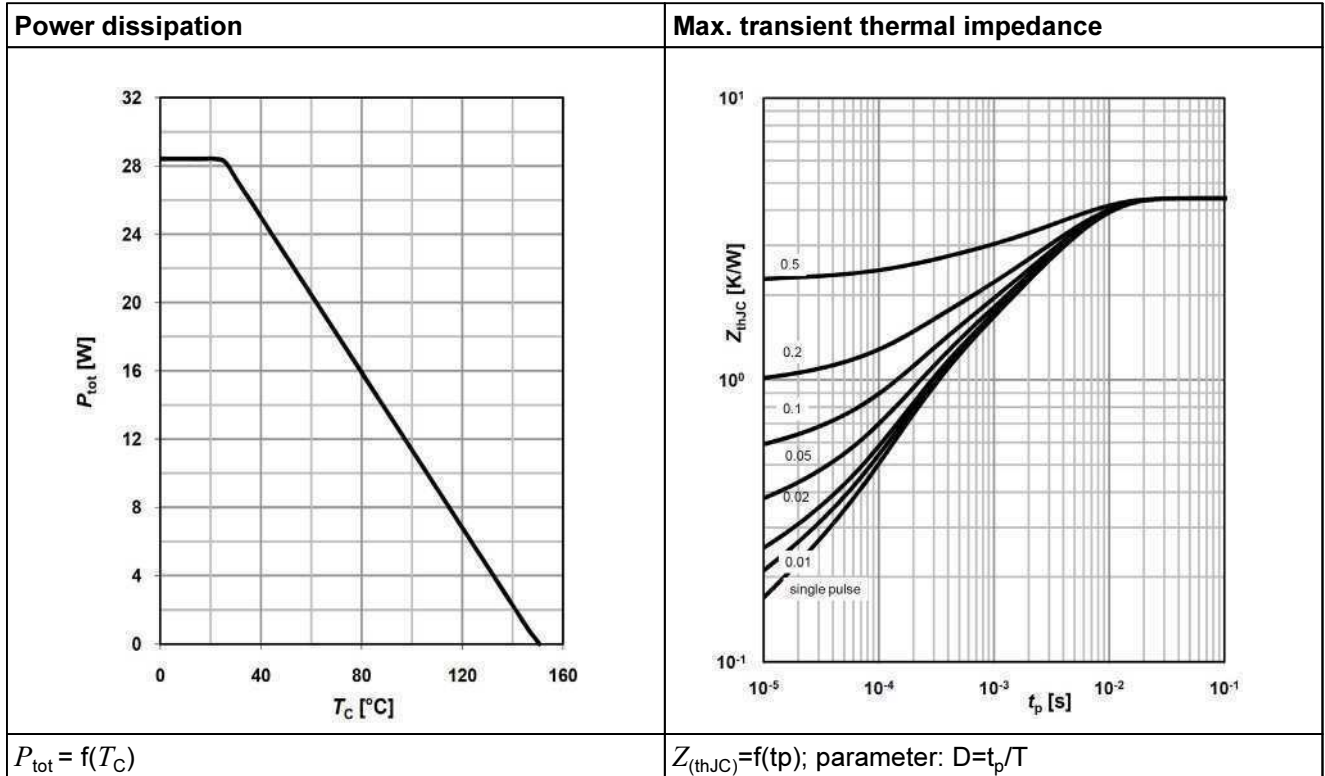


Table 9

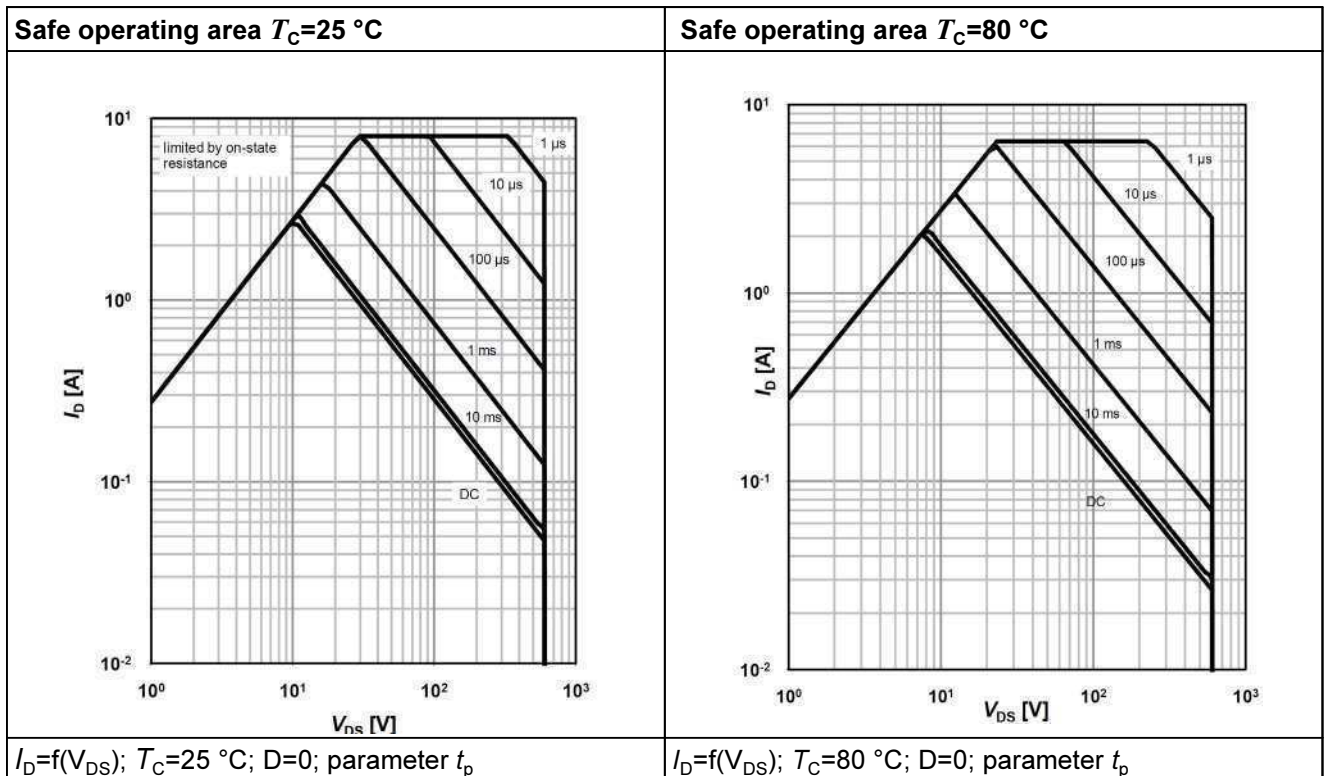


Table 10

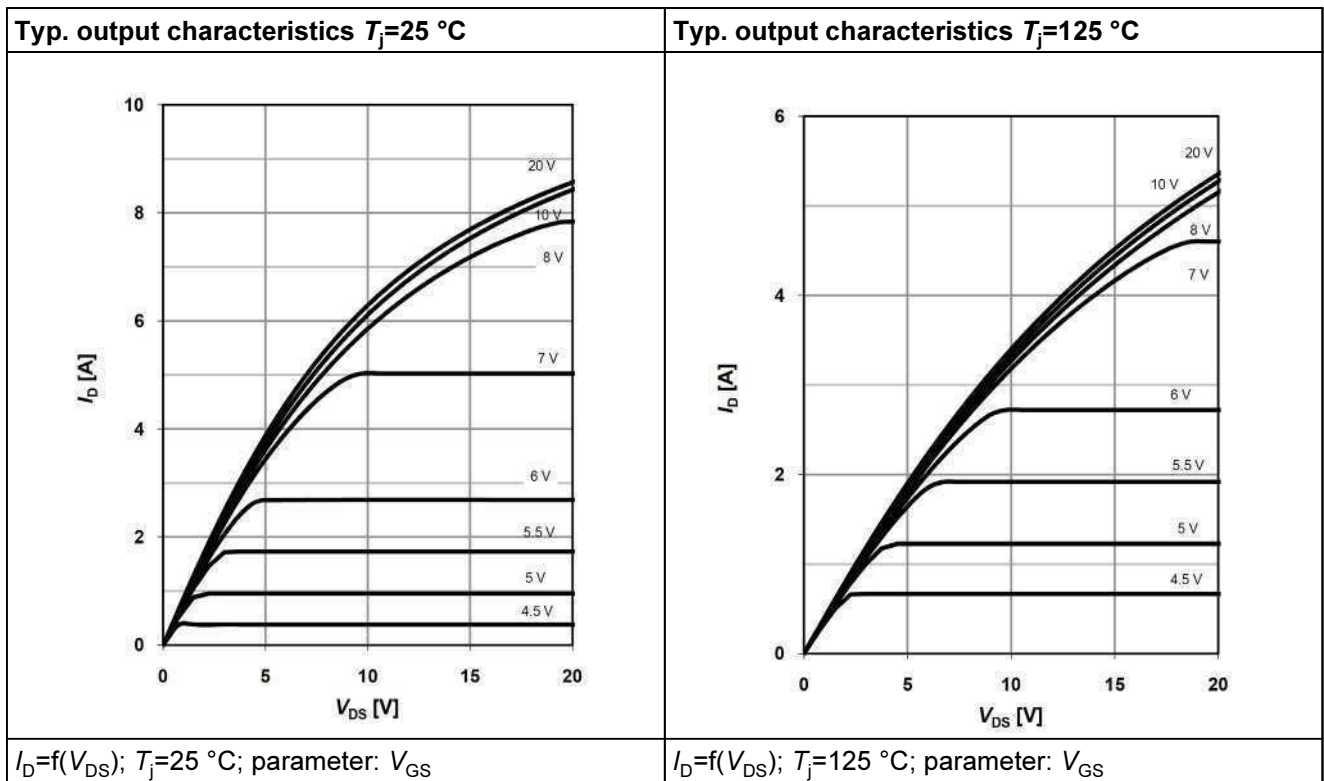


Table 11

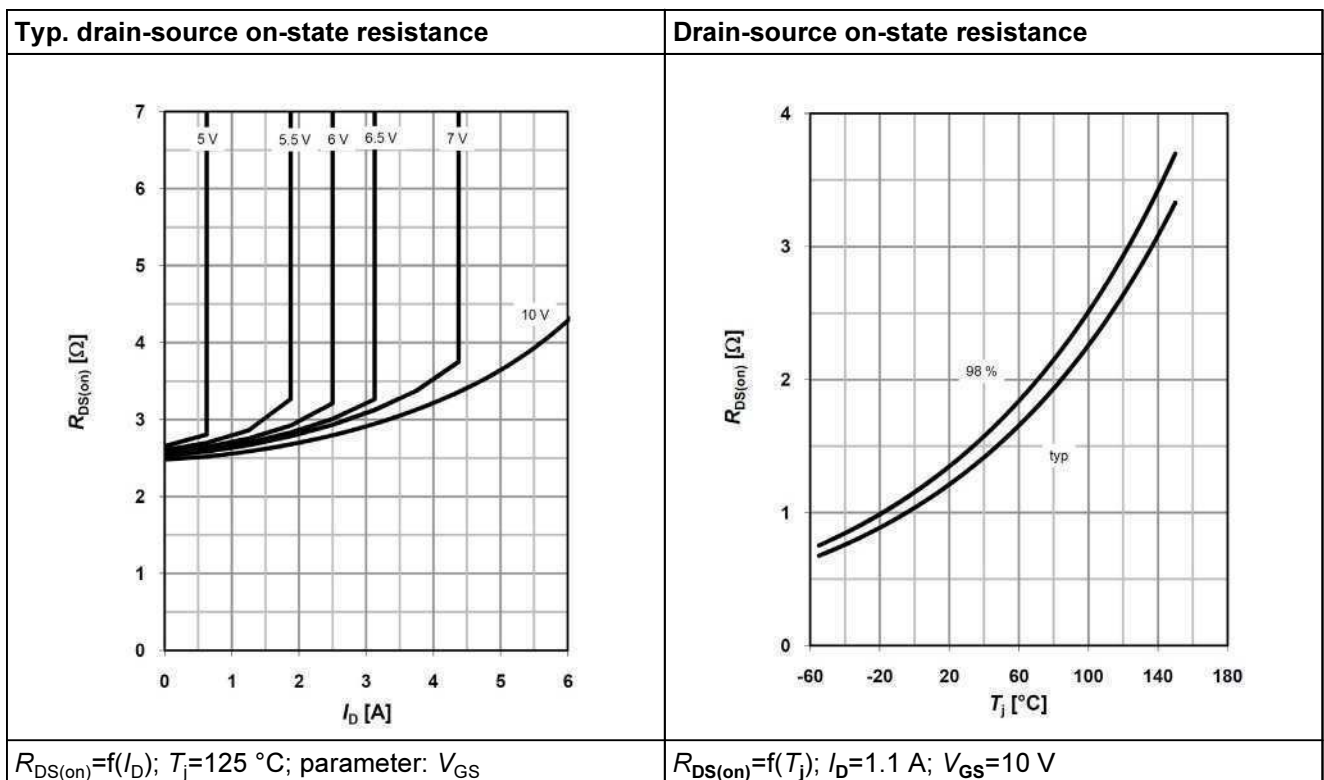


Table 12

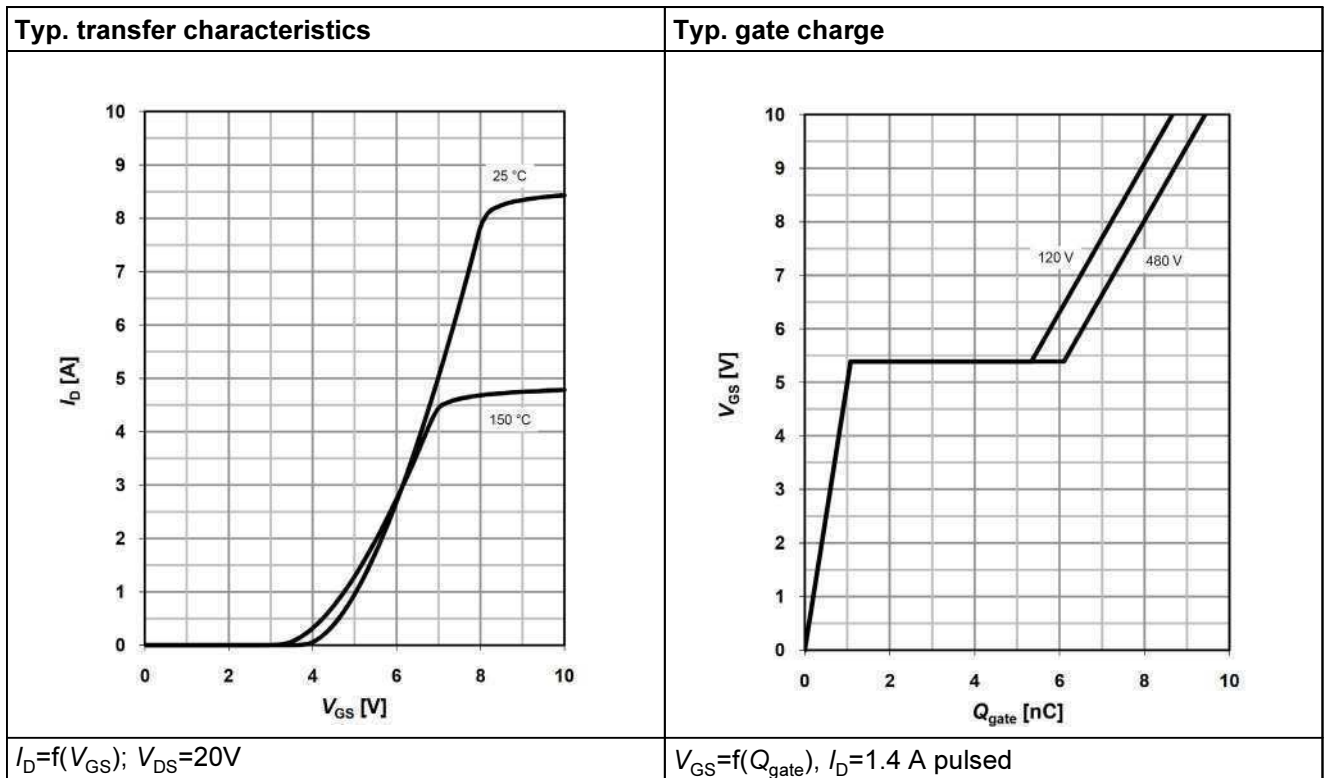


Table 13

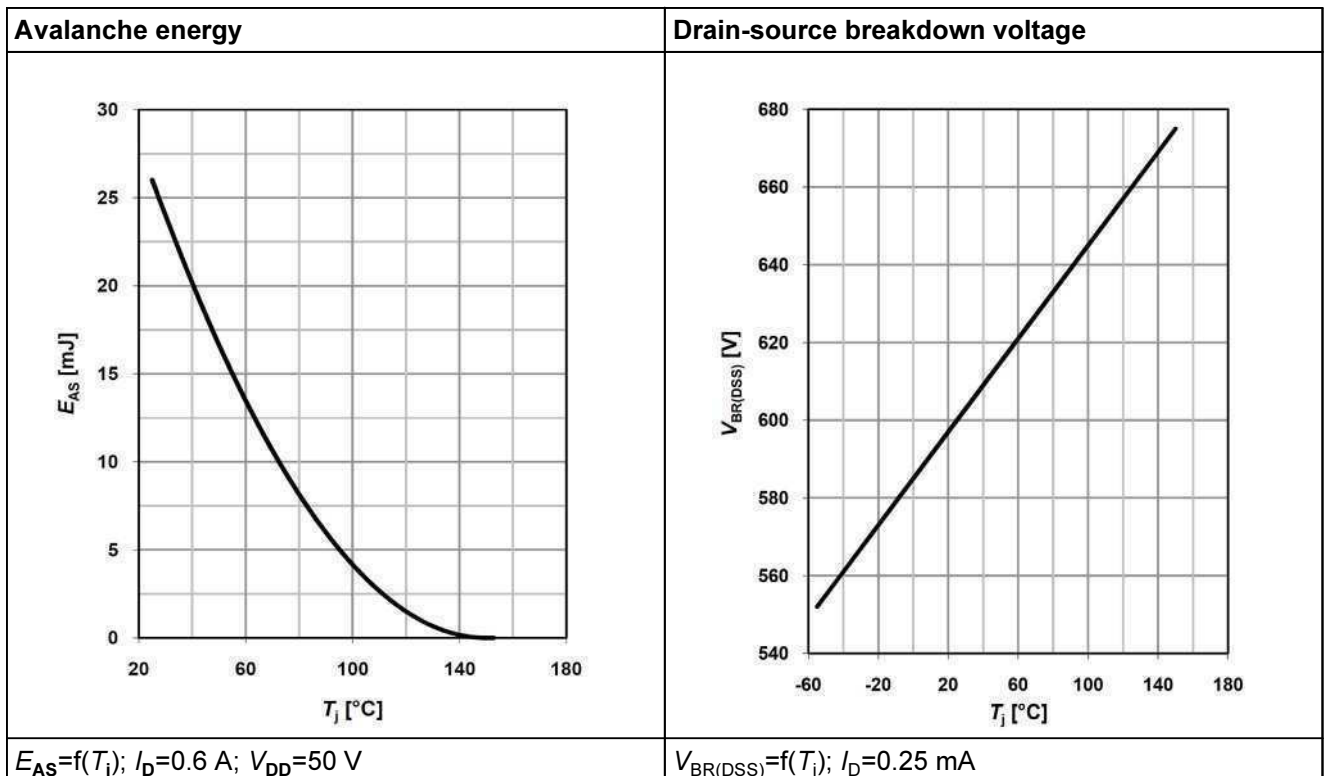


Table 14

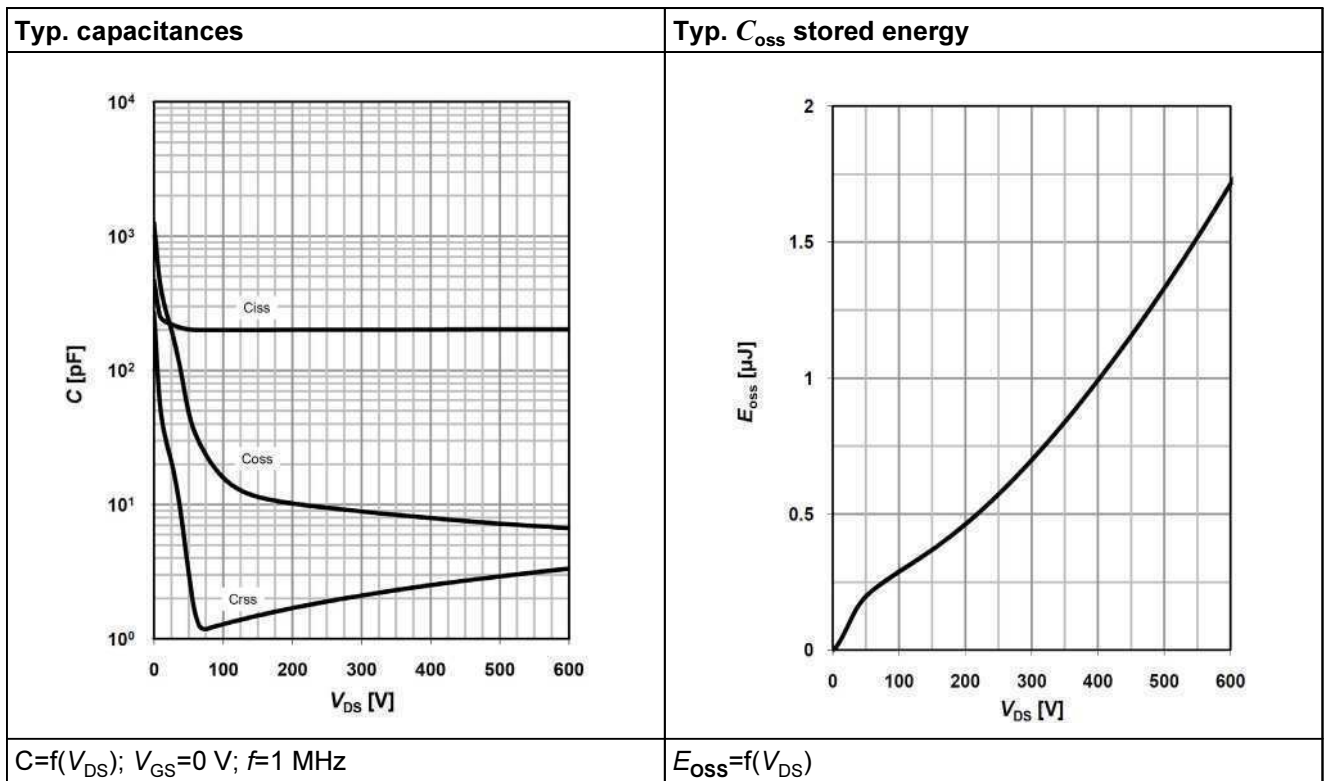
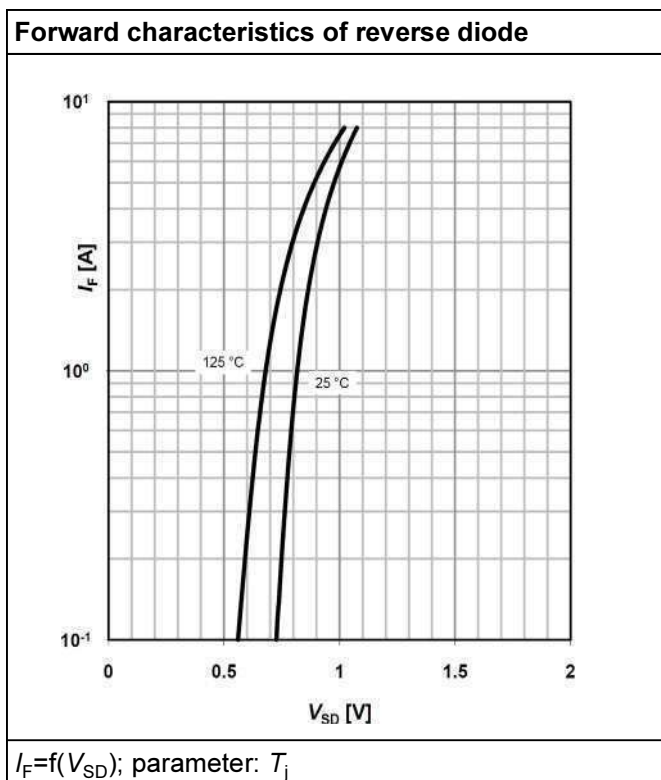


Table 15



## 6 Test circuits

Table 16 Switching times test circuit and waveform for inductive load

Switching times test circuit for inductive load	Switching time waveform

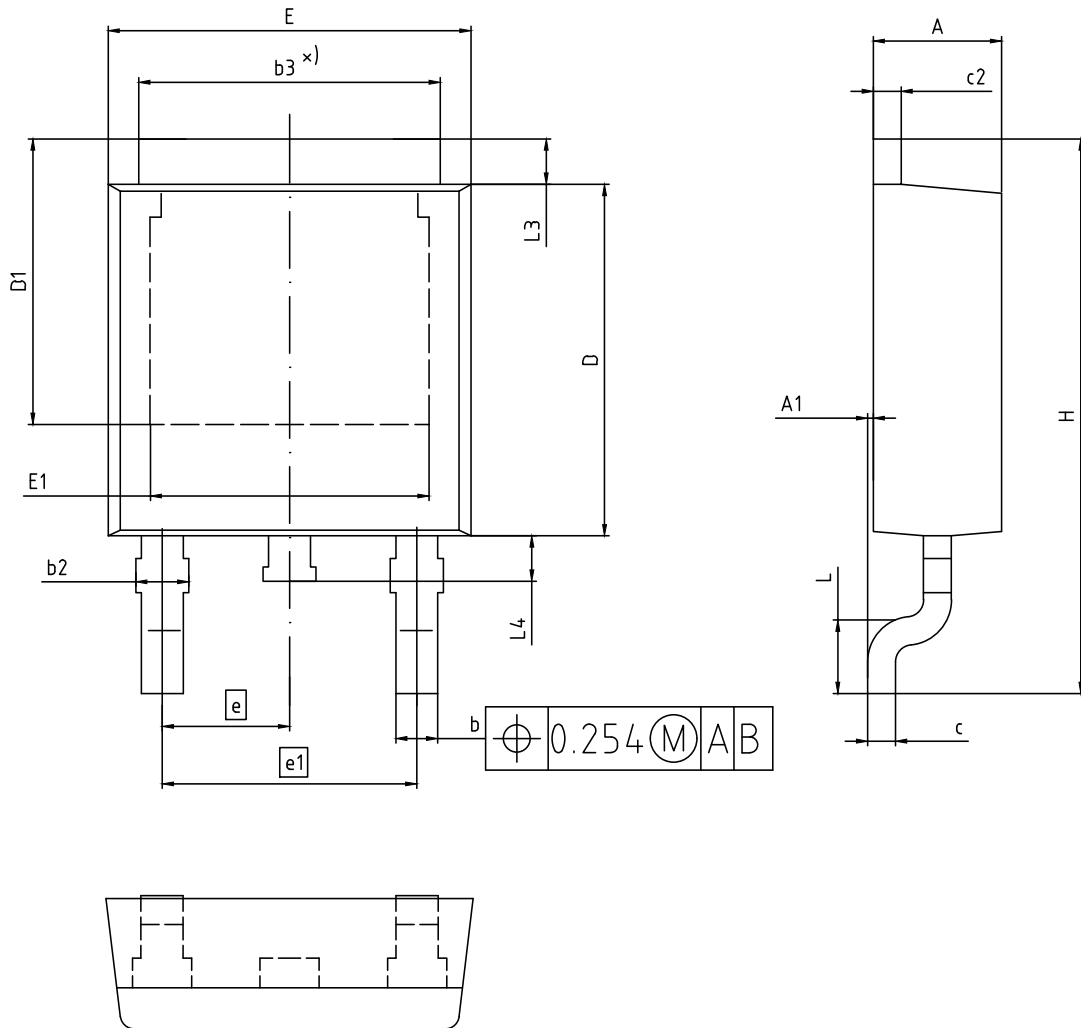
Table 17 Unclamped inductive load test circuit and waveform

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



ALL DIMENSIONS REFER TO JEDEC STANDARD TO-252 AND DO NOT INCLUDE MOLD FLASH OR PROTRUSIONS.

DIMENSION	MILLIMETERS	
	MIN.	MAX.
A	2.16	2.41
A1	0.00	0.15
b	0.64	0.89
b2	0.65	1.15
b3	4.95	5.50
c	0.46	0.61
c2	0.40	0.98
D	5.97	6.22
D1	5.02	5.84
E	6.35	6.73
E1	4.32	5.50
e	2.29	
e1	4.57	
N	3	
H	9.40	10.48
L	1.18	1.78
L3	0.89	1.27
L4	0.51	1.02

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Figure 1 Outlines TO-252, dimensions in mm

## Revision History

IPD60R1K4C6

**Revision: 2020-05-20, Rev. 2.3**

Previous Revision

Revision	Date	Subjects (major changes since last revision)
1.1	2011-06-08	Release of final data sheet
2.0	2011-06-08	Release of final data sheet
2.1	2011-09-14	-
2.2	2015-11-17	Added Halogen Free info
2.3	2020-05-20	Update of the package outlines

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