

CoolMOS™ CP 600V

600V CoolMOS™ CP Power Transistor
IPD60R385CP

Data Sheet

Rev. 2.6
Final

Power Management & Multimarket

CoolMOS® Power Transistor
Features

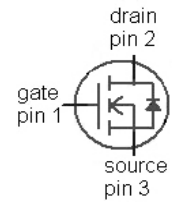
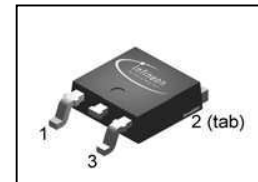
- Worldwide best $R_{ds,on}$ in TO252
- Ultra low gate charge
- Extreme dv/dt rated
- High peak current capability
- Fully qualified according to JEDEC for industrial applications
- Pb-free lead plating; RoHS compliant, available in Halogen free mold compound

Product Summary

$V_{DS} @ T_{j,max}$	650	V
$R_{DS(on),max}$	0.385	Ω
$Q_{g,typ}$	17	nC

CoolMOS CP is specially designed for:

- Hard switching SMPS topologies


PG-TO252


Type	Package	Ordering Code	Marking
IPD60R385CP	PG-TO252	SP000307381	6R385P

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

Parameter	Symbol	Conditions	Value	Unit
Continuous drain current	I_D	$T_C=25\text{ °C}$	9.0	A
		$T_C=100\text{ °C}$	5.7	
Pulsed drain current ²⁾	$I_{D,pulse}$	$T_C=25\text{ °C}$	27	
Avalanche energy, single pulse	E_{AS}	$I_D=3.4\text{ A}, V_{DD}=50\text{ V}$	227	mJ
Avalanche energy, repetitive $t_{AR}^{2),3)}$	E_{AR}	$I_D=3.4\text{ A}, V_{DD}=50\text{ V}$	0.3	
Avalanche current, repetitive $t_{AR}^{2),3)}$	I_{AR}		3	A
MOSFET dv/dt ruggedness	dv/dt	$V_{DS}=0\dots480\text{ V}$	50	V/ns
Gate source voltage	V_{GS}	static	± 20	V
		AC ($f>1\text{ Hz}$)	± 30	
Power dissipation	P_{tot}	$T_C=25\text{ °C}$	83	W
Operating and storage temperature	T_j, T_{stg}		-55 ... 150	$^{\circ}\text{C}$

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

Parameter	Symbol	Conditions	Value	Unit
Continuous diode forward current	I_S	$T_C=25\text{ }^\circ\text{C}$	5.2	A
Diode pulse current ²⁾	$I_{S,pulse}$		27	
Reverse diode dv/dt ⁴⁾	dv/dt		15	V/ns

Parameter	Symbol	Conditions	Values			Unit
			min.	typ.	max.	

Thermal characteristics

Thermal resistance, junction - case	R_{thJC}		-	-	1.5	K/W
Thermal resistance, junction - ambient	R_{thJA}	SMD version, device on PCB, minimal footprint	-	-	62	
		SMD version, device on PCB, 6 cm ² cooling area ⁵⁾	-	35	-	
Soldering temperature, reflowsoldering	T_{sold}	reflow MSL1	-	-	260	$^\circ\text{C}$

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

Drain-source breakdown voltage	$V_{(BR)DSS}$	$V_{GS}=0\text{ V}, I_D=250\text{ }\mu\text{A}$	600	-	-	V
Gate threshold voltage	$V_{GS(th)}$	$V_{DS}=V_{GS}, I_D=0.34\text{ mA}$	2.5	3	3.5	
Zero gate voltage drain current	I_{DSS}	$V_{DS}=600\text{ V}, V_{GS}=0\text{ V}, T_j=25\text{ }^\circ\text{C}$	-	-	1	μA
		$V_{DS}=600\text{ V}, V_{GS}=0\text{ V}, T_j=150\text{ }^\circ\text{C}$	-	10	-	
Gate-source leakage current	I_{GSS}	$V_{GS}=20\text{ V}, V_{DS}=0\text{ V}$	-	-	100	nA
Drain-source on-state resistance	$R_{DS(on)}$	$V_{GS}=10\text{ V}, I_D=5.2\text{ A}, T_j=25\text{ }^\circ\text{C}$	-	0.35	0.385	Ω
		$V_{GS}=10\text{ V}, I_D=5.2\text{ A}, T_j=150\text{ }^\circ\text{C}$	-	0.94	-	
Gate resistance	R_G	$f=1\text{ MHz}, \text{open drain}$	-	1.8	-	Ω

Parameter	Symbol	Conditions	Values			Unit
			min.	typ.	max.	
Dynamic characteristics						
Input capacitance	C_{iss}	$V_{GS}=0\text{ V}, V_{DS}=100\text{ V},$ $f=1\text{ MHz}$	-	790	-	pF
Output capacitance	C_{oss}		-	38	-	
Effective output capacitance, energy related ⁶⁾	$C_{o(er)}$	$V_{GS}=0\text{ V}, V_{DS}=0\text{ V}$ to 480 V	-	36	-	
Effective output capacitance, time related ⁷⁾	$C_{o(tr)}$		-	96	-	
Turn-on delay time	$t_{d(on)}$	$V_{DD}=400\text{ V},$ $V_{GS}=10\text{ V}, I_D=5.2\text{ A},$ $R_G=3.3\ \Omega$	-	10	-	ns
Rise time	t_r		-	5	-	
Turn-off delay time	$t_{d(off)}$		-	40	-	
Fall time	t_f		-	5	-	

0

Gate Charge Characteristics

Gate to source charge	Q_{gs}	$V_{DD}=400\text{ V}, I_D=5.2\text{ A},$ $V_{GS}=0\text{ to }10\text{ V}$	-	4	-	nC
Gate charge at threshold	$Q_{g(th)}$		-	4.6	6.2	
Gate to drain charge	Q_{gd}		-	6	-	
Switching charge	Q_{sw}		-	12	17	
Gate charge total	Q_g		-	17	22	
Gate plateau voltage	$V_{plateau}$		-	5.0	-	V

Reverse Diode

Diode forward voltage	V_{SD}	$V_{GS}=0\text{ V}, I_F=5.2\text{ A},$ $T_j=25\text{ }^\circ\text{C}$	-	0.9	1.2	V
Reverse recovery time	t_{rr}	$V_R=400\text{ V}, I_F=I_S,$ $di_F/dt=100\text{ A}/\mu\text{s}$	-	260	-	ns
Reverse recovery charge	Q_{rr}		-	3.1	-	μC
Peak reverse recovery current	I_{rrm}		-	24	-	A

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

³⁾ Repetitive avalanche causes additional power losses that can be calculated as $P_{AV}=E_{AR} \cdot f$.

⁴⁾ $I_{SD} \leq I_D$, $di/dt \leq 400\text{ A}/\mu\text{s}$, $V_{DClink}=400\text{ V}$, $V_{peak} < V_{(BR)DSS}$, $T_j < T_{j,max}$, identical low side and high side switch

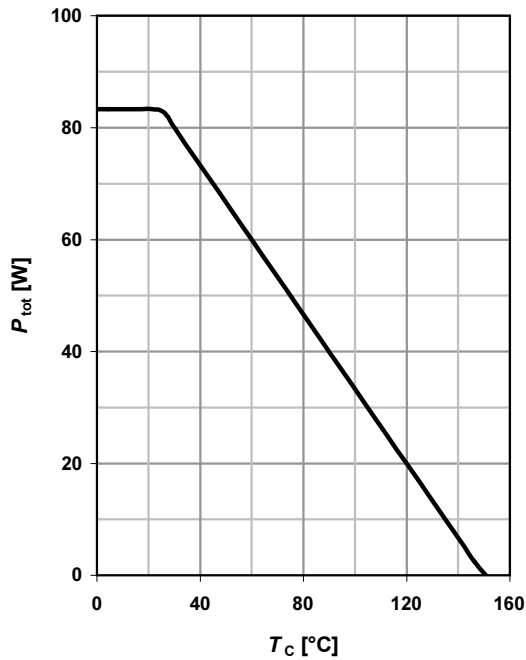
⁵⁾ Device on 40mm*40mm*1.5mm epoxy PCB FR4 with 6cm² (one layer, 70 μm thick) copper area for drain connection. PCB is without blown air.

⁶⁾ $C_{o(er)}$ is a fixed capacitance that gives the same stored energy as C_{oss} while V_{DS} is rising from 0 to 80% V_{DSS} .

⁷⁾ $C_{o(tr)}$ is a fixed capacitance that gives the same charging time as C_{oss} while V_{DS} is rising from 0 to 80% V_{DSS} .

1 Power dissipation

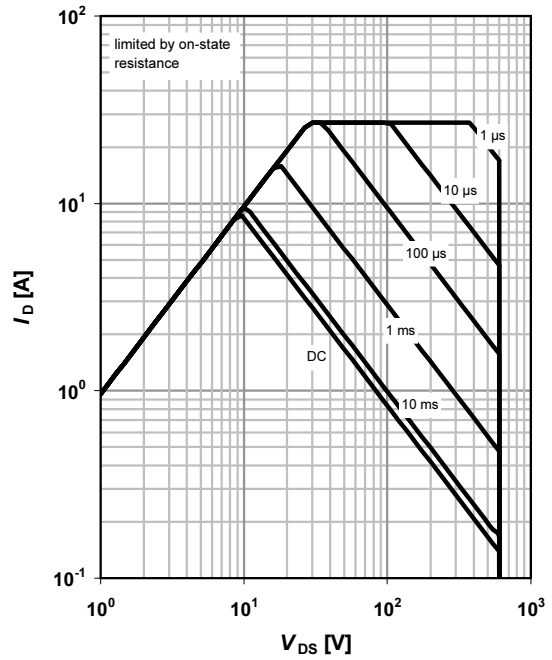
$P_{tot}=f(T_C)$



2 Safe operating area

$I_D=f(V_{DS}); T_C=25\text{ }^\circ\text{C}; D=0$

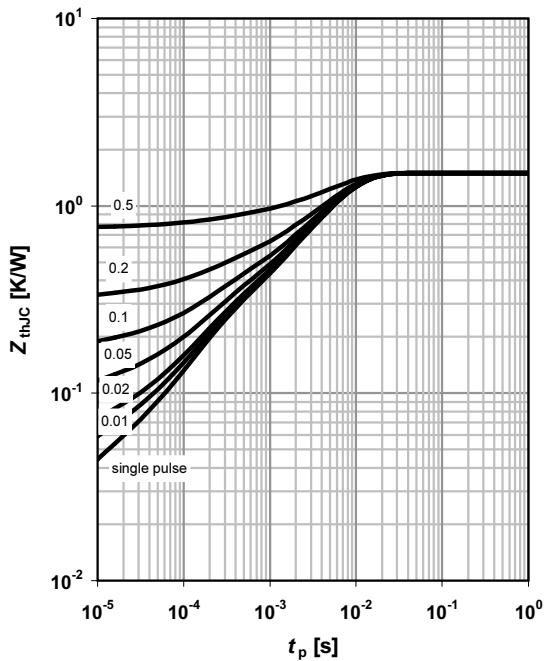
parameter: t_p



3 Max. transient thermal impedance

$Z_{thJC}=f(t_p)$

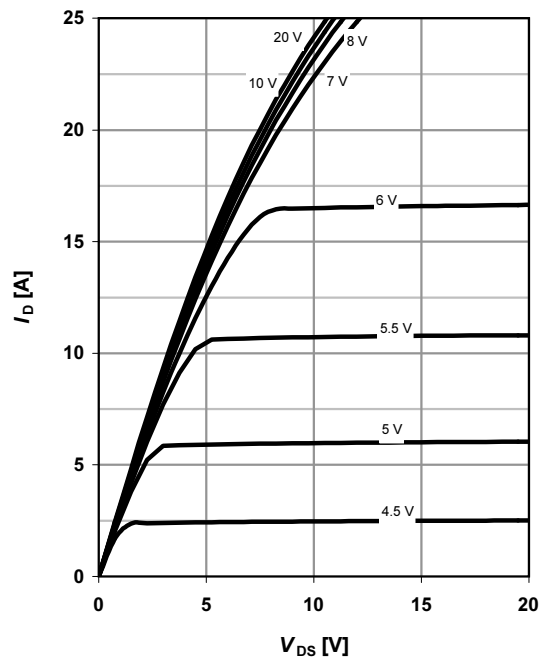
parameter: $D=t_p/T$



4 Typ. output characteristics

$I_D=f(V_{DS}); T_J=25\text{ }^\circ\text{C}$

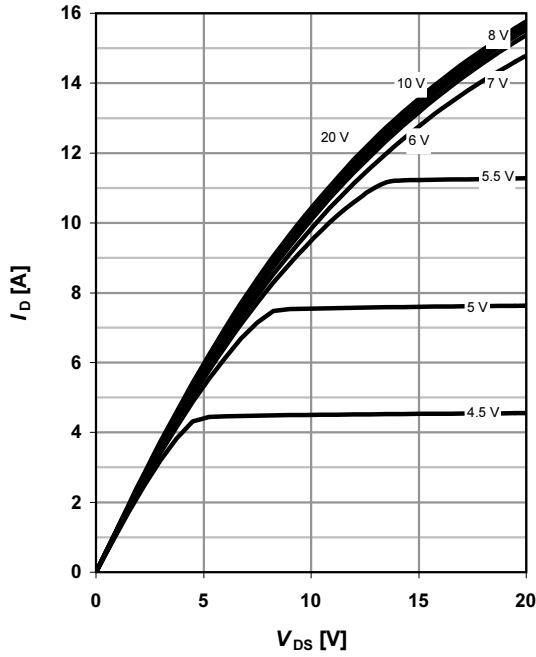
parameter: V_{GS}



5 Typ. output characteristics

$I_D = f(V_{DS}); T_j = 150\text{ }^\circ\text{C}$

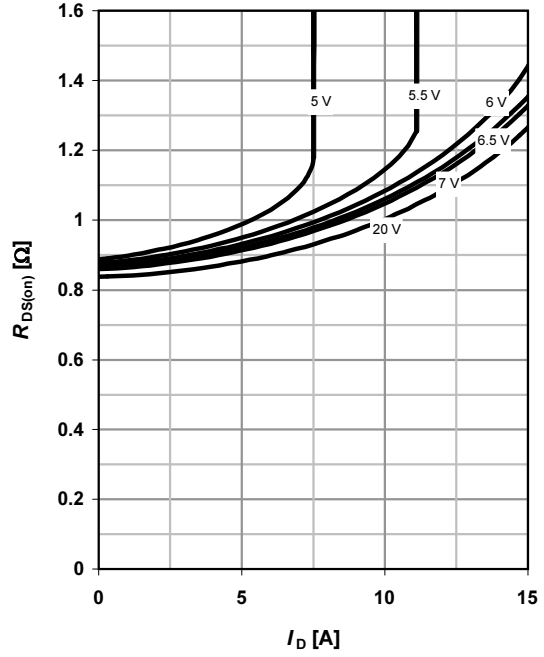
parameter: V_{GS}



6 Typ. drain-source on-state resistance

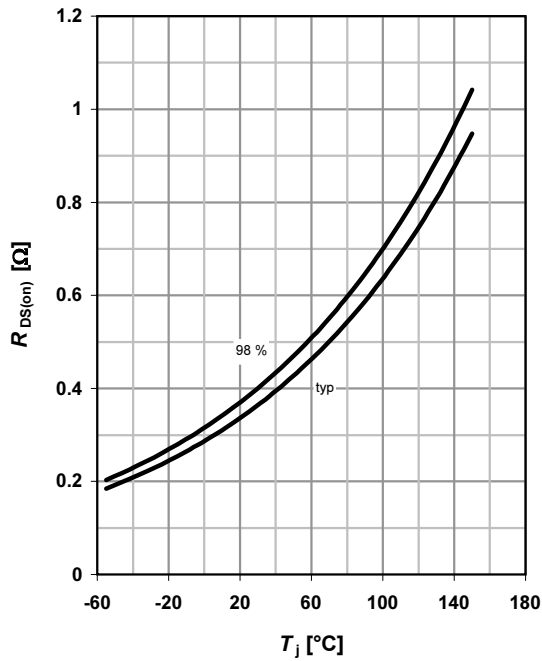
$R_{DS(on)} = f(I_D); T_j = 150\text{ }^\circ\text{C}$

parameter: V_{GS}



7 Drain-source on-state resistance

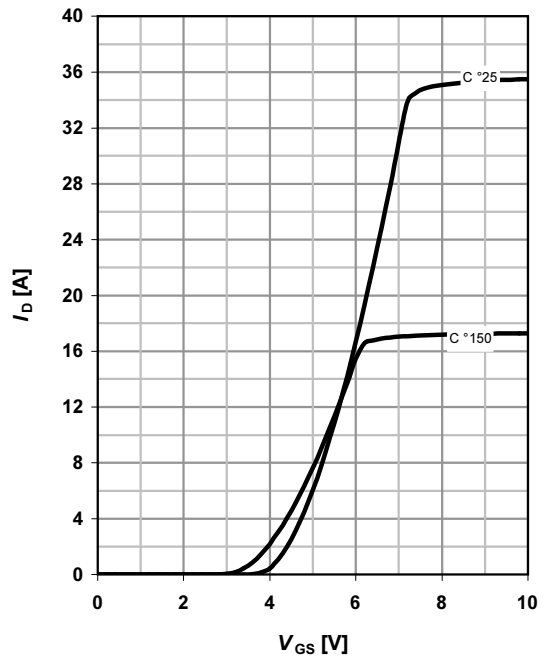
$R_{DS(on)} = f(T_j); I_D = 5.2\text{ A}; V_{GS} = 10\text{ V}$



8 Typ. transfer characteristics

$I_D = f(V_{GS}); |V_{DS}| > 2|I_D|R_{DS(on)max}$

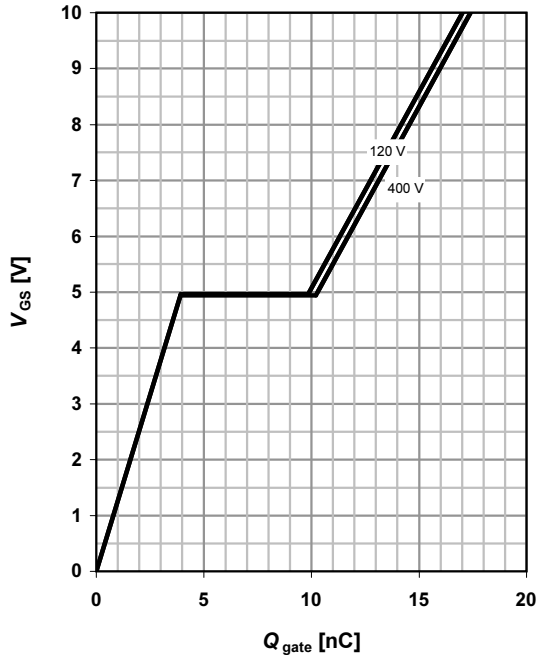
parameter: T_j



9 Typ. gate charge

$V_{GS}=f(Q_{gate}); I_D=5.2 \text{ A pulsed}$

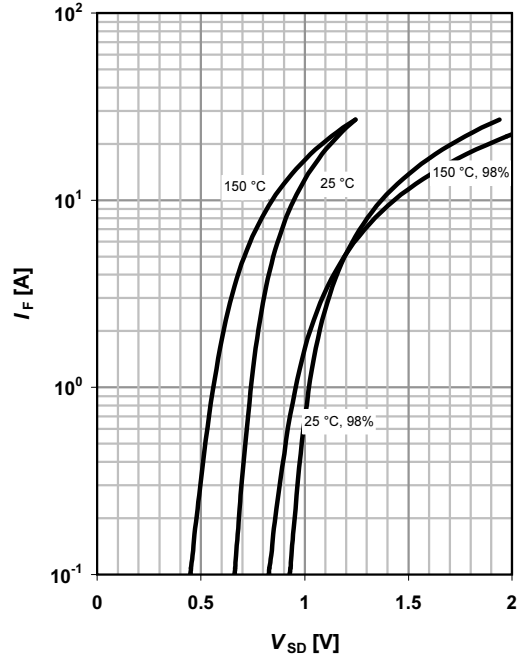
parameter: V_{DD}



10 Forward characteristics of reverse diode

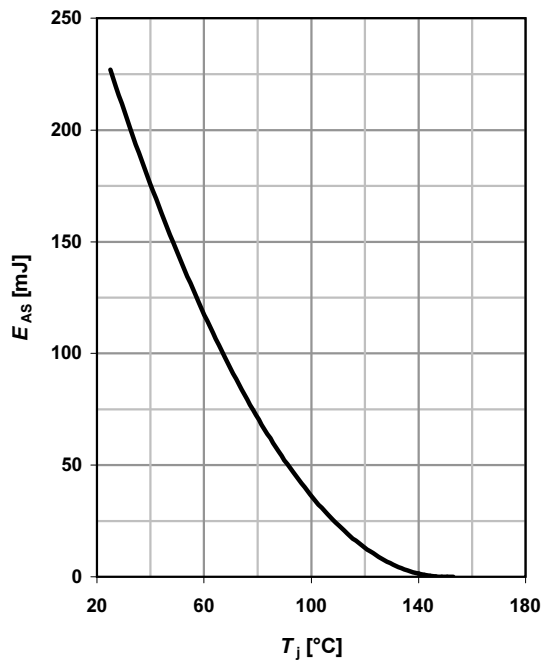
$I_F=f(V_{SD})$

parameter: T_j



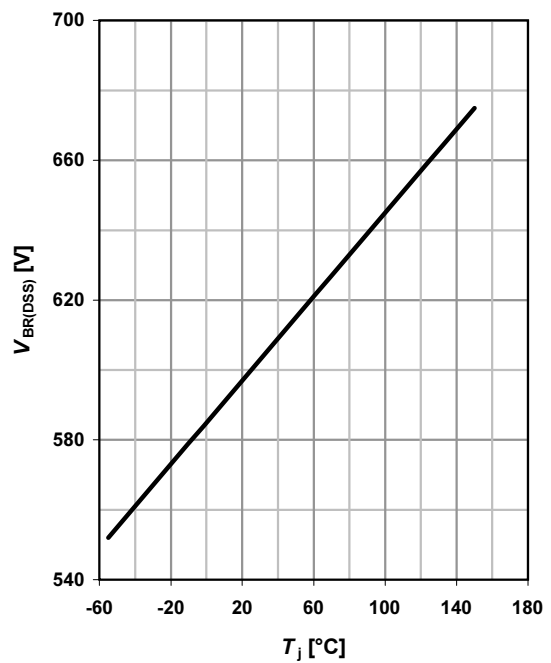
11 Avalanche energy

$E_{AS}=f(T_j); I_D=3.4 \text{ A}; V_{DD}=50 \text{ V}$



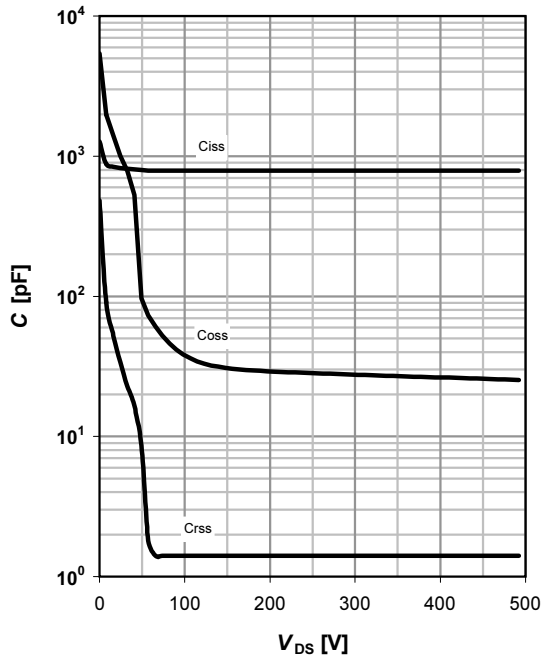
12 Drain-source breakdown voltage

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



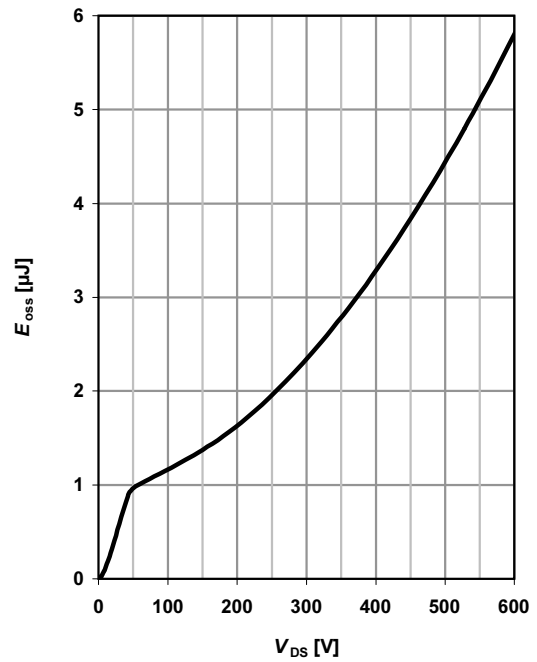
13 Typ. capacitances

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

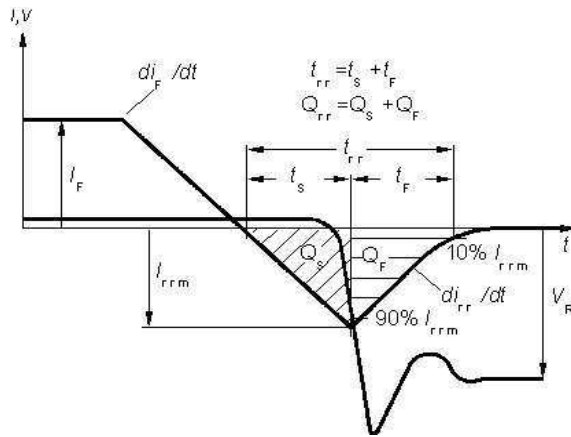


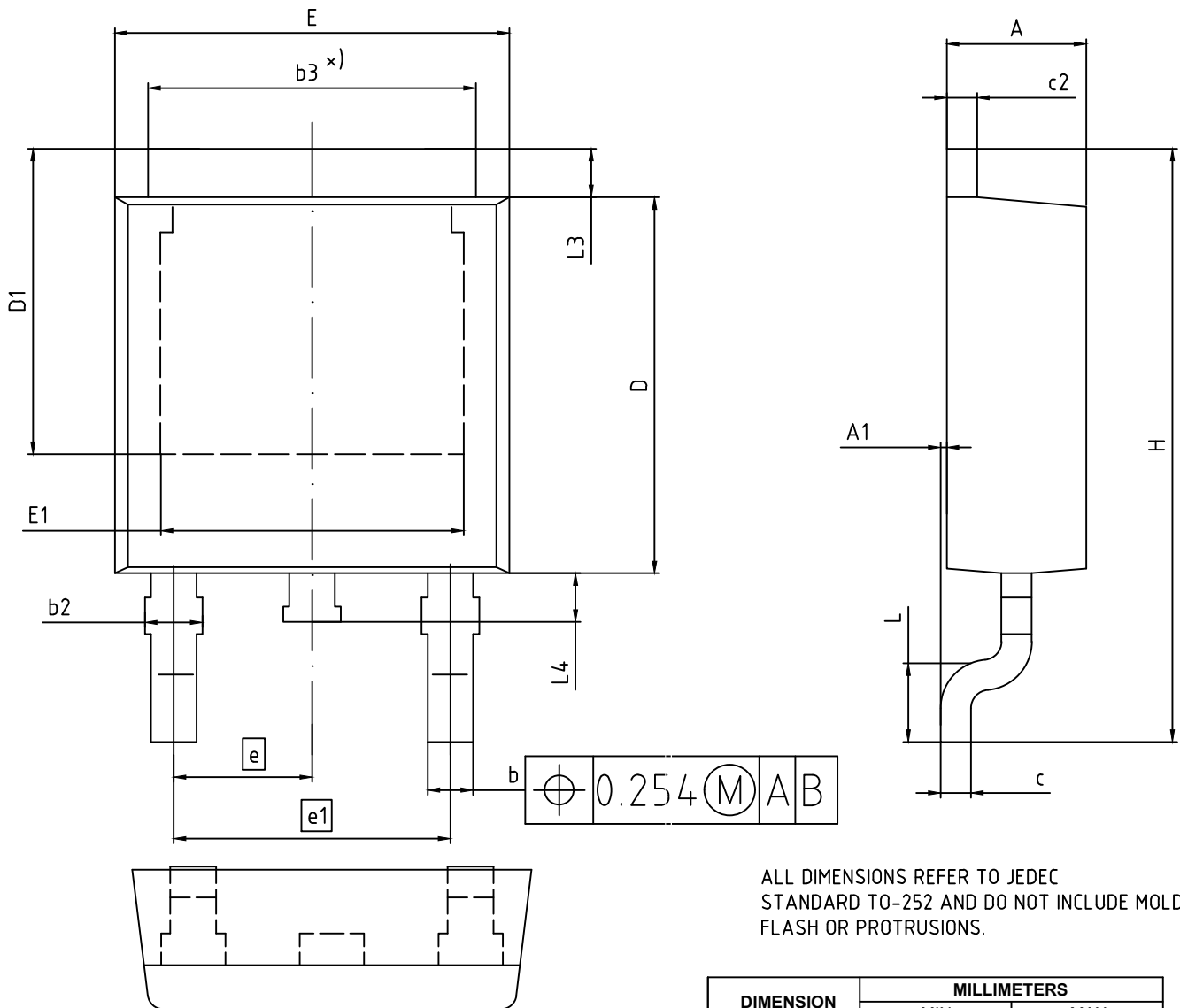
14 Typ. Coss stored energy

$E_{oss} = f(V_{DS})$



Definition of diode switching characteristics





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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Revision History

IPD60R385CP

Revision: 2020-05-27, Rev. 2.6

Previous Revision

Revision	Date	Subjects (major changes since last revision)
2.4	2015-02-03	Update soldering temperature from reflow MSL3 to MSL1
2.5	2016-06-02	Non-halogen free version discontinued (creation: 2016.06.01)
2.6	2020-05-27	Update package outline

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