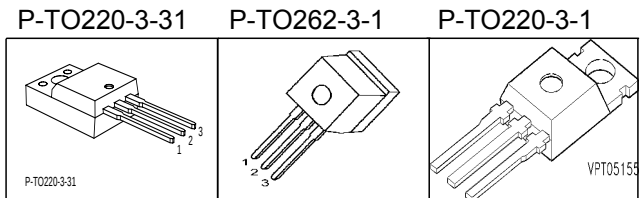


Cool MOS™ Power Transistor

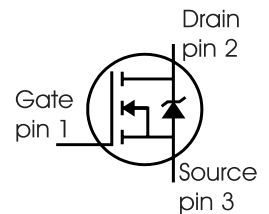
Feature

- New revolutionary high voltage technology
- Ultra low gate charge
- Periodic avalanche rated
- Extreme dv/dt rated
- Ultra low effective capacitances
- Improved transconductance
- P-TO-220-3-31: Fully isolated package (2500 VAC; 1 minute)

$V_{DS} @ T_{jmax}$	650	V
$R_{DS(on)}$	0.28	Ω
I_D	15	A



Type	Package	Ordering Code	Marking
SPP15N60C3	P-TO220-3-1	Q67040-S4600	15N60C3
SPI15N60C3	P-TO262-3-1	Q67040-S4601	15N60C3
SPA15N60C3	P-TO220-3-31	Q67040-S4603	15N60C3



Maximum Ratings

Parameter	Symbol	Value		Unit
		SPP_I	SPA	
Continuous drain current $T_C = 25^\circ\text{C}$ $T_C = 100^\circ\text{C}$	I_D	15 9.4	15 ¹⁾ 9.4 ¹⁾	A
Pulsed drain current, t_p limited by T_{jmax}	$I_{D \text{ puls}}$	45	45	A
Avalanche energy, single pulse $I_D=7.5\text{A}$, $V_{DD}=50\text{V}$	E_{AS}	460	460	mJ
Avalanche energy, repetitive t_{AR} limited by T_{jmax} ²⁾ $I_D=15\text{A}$, $V_{DD}=50\text{V}$	E_{AR}	0.8	0.8	
Avalanche current, repetitive t_{AR} limited by T_{jmax}	I_{AR}	15	15	A
Gate source voltage static	V_{GS}	± 20	± 20	V
Gate source voltage AC ($f > 1\text{Hz}$)	V_{GS}	± 30	± 30	
Power dissipation, $T_C = 25^\circ\text{C}$	P_{tot}	156	34	W
Operating and storage temperature	T_j, T_{stg}	-55...+150		$^\circ\text{C}$

Maximum Ratings

Parameter	Symbol	Value	Unit
Drain Source voltage slope $V_{DS} = 480 \text{ V}$, $I_D = 15 \text{ A}$, $T_j = 125^\circ\text{C}$	dv/dt	50	V/ns

Thermal Characteristics

Parameter	Symbol	Values			Unit
		min.	typ.	max.	
Thermal resistance, junction - case	R_{thJC}	-	-	0.8	K/W
Thermal resistance, junction - case, FullPAK	$R_{thJC \text{ FP}}$	-	-	3.7	
Thermal resistance, junction - ambient, leaded	R_{thJA}	-	-	62	
Thermal resistance, junction - ambient, FullPAK	$R_{thJA \text{ FP}}$	-	-	80	
Soldering temperature, 1.6 mm (0.063 in.) from case for 10s ³⁾	T_{sold}	-	-	260	$^\circ\text{C}$

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

Parameter	Symbol	Conditions	Values			Unit
			min.	typ.	max.	
Drain-source breakdown voltage	$V_{(BR)DSS}$	$V_{GS}=0\text{V}$, $I_D=0.25\text{mA}$	600	-	-	V
Drain-Source avalanche breakdown voltage	$V_{(BR)DS}$	$V_{GS}=0\text{V}$, $I_D=15\text{A}$	-	700	-	
Gate threshold voltage	$V_{GS(th)}$	$I_D=675\mu\text{A}$, $V_{GS}=V_{DS}$	2.1	3	3.9	
Zero gate voltage drain current	I_{DSS}	$V_{DS}=600\text{V}$, $V_{GS}=0\text{V}$, $T_j=25^\circ\text{C}$ $T_j=150^\circ\text{C}$	- -	0.1 -	1 100	μA
Gate-source leakage current	I_{GSS}	$V_{GS}=30\text{V}$, $V_{DS}=0\text{V}$	-	-	100	
Drain-source on-state resistance	$R_{DS(on)}$	$V_{GS}=10\text{V}$, $I_D=9.4\text{A}$ $T_j=25^\circ\text{C}$ $T_j=150^\circ\text{C}$	- -	0.25 0.68	0.28 -	Ω
Gate input resistance	R_G	$f=1\text{MHz}$, open drain	-	1.23	-	

Electrical Characteristics

Parameter	Symbol	Conditions	Values			Unit
			min.	typ.	max.	
Transconductance	g_{fs}	$V_{DS} \geq 2 \cdot I_D \cdot R_{DS(on)max}$, $I_D = 9.4A$	-	11.9	-	S
Input capacitance	C_{iss}	$V_{GS} = 0V$, $V_{DS} = 25V$, $f = 1MHz$	-	1660	-	pF
Output capacitance	C_{oss}		-	540	-	
Reverse transfer capacitance	C_{rss}		-	40	-	
Effective output capacitance, ⁴⁾ energy related	$C_{o(er)}$	$V_{GS} = 0V$, $V_{DS} = 0V$ to $480V$	-	80	-	
Effective output capacitance, ⁵⁾ time related	$C_{o(tr)}$		-	127	-	
Turn-on delay time	$t_{d(on)}$	$V_{DD} = 480V$, $V_{GS} = 0/10V$, $I_D = 15A$, $R_G = 4.3\Omega$	-	10	-	ns
Rise time	t_r		-	5	-	
Turn-off delay time	$t_{d(off)}$		-	50	80	
Fall time	t_f		-	5	10	

Gate Charge Characteristics

Gate to source charge	Q_{gs}	$V_{DD} = 480V$, $I_D = 15A$	-	7	-	nC
Gate to drain charge	Q_{gd}		-	29	-	
Gate charge total	Q_g	$V_{DD} = 480V$, $I_D = 15A$, $V_{GS} = 0$ to $10V$	-	63	-	
Gate plateau voltage	$V_{(plateau)}$	$V_{DD} = 480V$, $I_D = 15A$	-	5	-	V

¹Limited only by maximum temperature

²Repetitive avalanche causes additional power losses that can be calculated as $P_{AV} = E_{AR} \cdot f$.

³Soldering temperature for TO-263: 220°C, reflow

⁴ $C_{o(er)}$ is a fixed capacitance that gives the same stored energy as C_{oss} while V_{DS} is rising from 0 to 80% V_{DSS} .

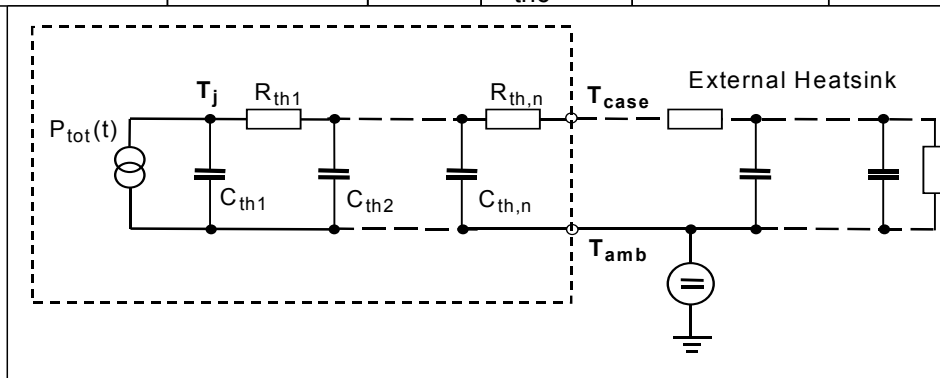
⁵ $C_{o(tr)}$ is a fixed capacitance that gives the same charging time as C_{oss} while V_{DS} is rising from 0 to 80% V_{DSS} .

Electrical Characteristics

Parameter	Symbol	Conditions	Values			Unit
			min.	typ.	max.	
Inverse diode continuous forward current	I_S	$T_C=25^\circ\text{C}$	-	-	15	A
Inverse diode direct current, pulsed	I_{SM}		-	-	45	
Inverse diode forward voltage	V_{SD}	$V_{GS}=0\text{V}, I_F=I_S$	-	1	1.2	V
Reverse recovery time	t_{rr}	$V_R=480\text{V}, I_F=I_S, di_F/dt=100\text{A}/\mu\text{s}$	-	460	-	ns
Reverse recovery charge	Q_{rr}		-	27	-	μC
Peak reverse recovery current	I_{rrm}		-	55	-	A
Peak rate of fall of reverse recovery current	di_{rr}/dt	$T_j=25^\circ\text{C}$	-	1300	-	$\text{A}/\mu\text{s}$

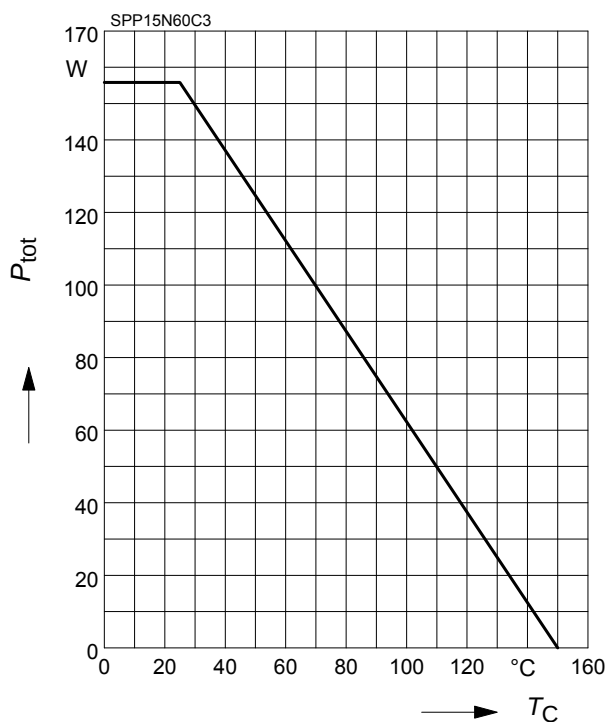
Typical Transient Thermal Characteristics

Symbol	Value		Unit	Symbol	Value		Unit
	SPP_B	SPA			SPP_B	SPA	
R_{th1}	0.012	0.012	K/W	C_{th1}	0.0002495	0.0002495	Ws/K
R_{th2}	0.023	0.023		C_{th2}	0.0009406	0.0009406	
R_{th3}	0.043	0.043		C_{th3}	0.001298	0.001298	
R_{th4}	0.156	0.176		C_{th4}	0.00362	0.00362	
R_{th5}	0.178	0.371		C_{th5}	0.009046	0.008025	
R_{th6}	0.072	2.522		C_{th6}	0.412	0.412	



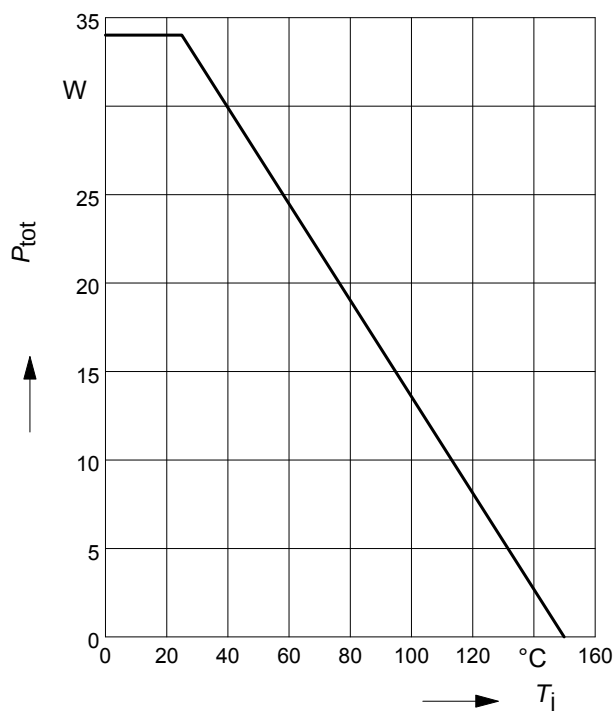
1 Power dissipation

$$P_{\text{tot}} = f(T_C)$$



2 Power dissipation FullPAK

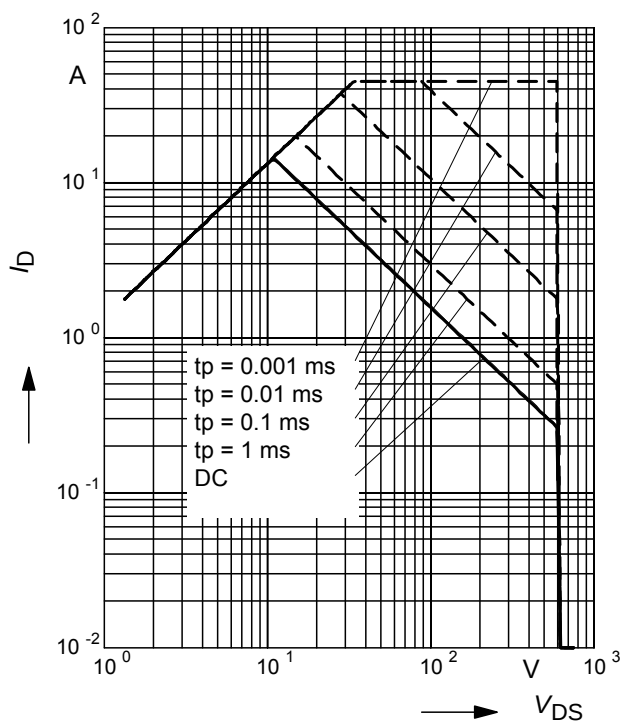
$$P_{\text{tot}} = f(T_C)$$



3 Safe operating area

$$I_D = f(V_{DS})$$

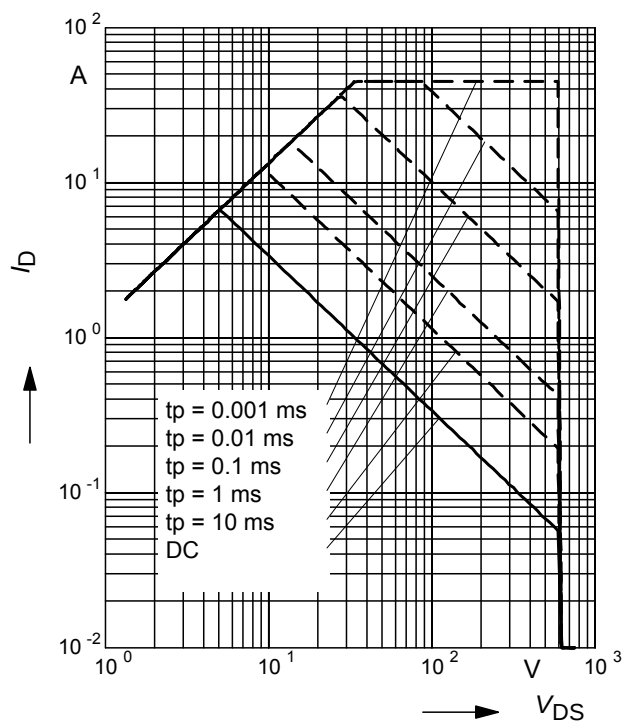
parameter : $D = 0$, $T_C = 25^\circ\text{C}$



4 Safe operating area FullPAK

$$I_D = f(V_{DS})$$

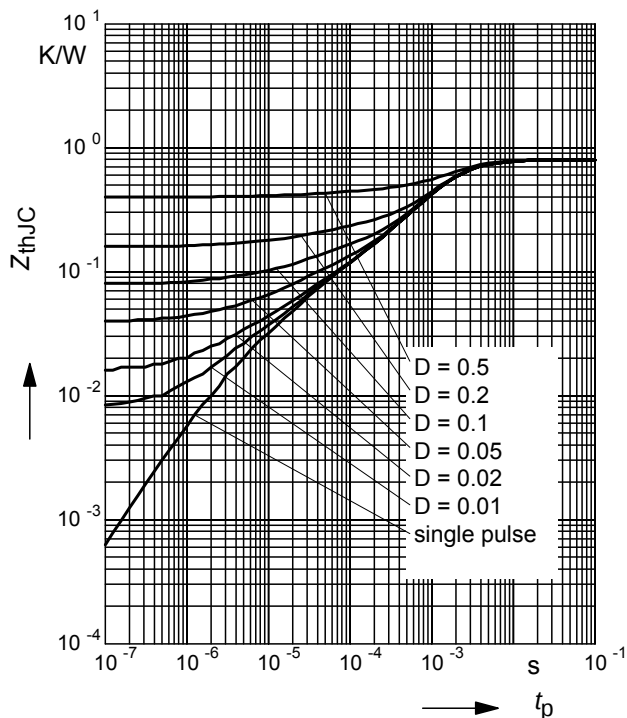
parameter: $D = 0$, $T_C = 25^\circ\text{C}$



5 Transient thermal impedance

$$Z_{thJC} = f(t_p)$$

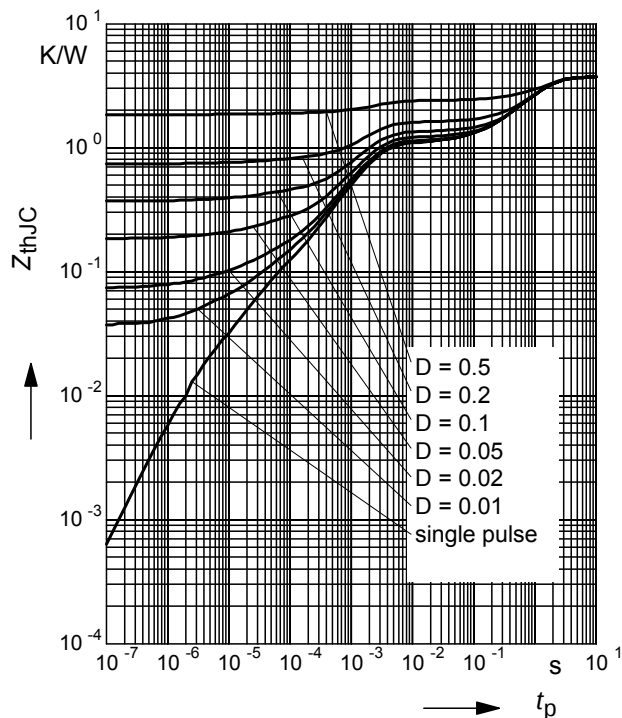
parameter: $D = t_p/T$



6 Transient thermal impedance FullPAK

$$Z_{thJC} = f(t_p)$$

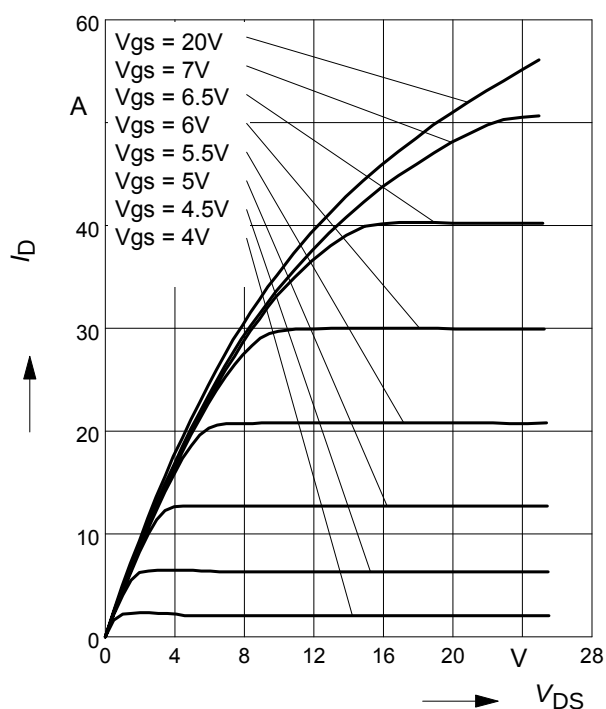
parameter: $D = t_p/t$



7 Typ. output characteristic

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

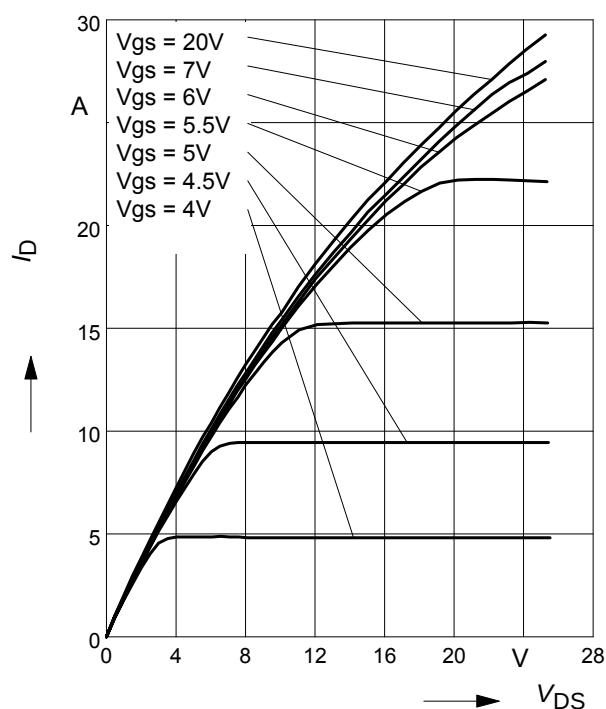
parameter: $t_p = 10 \mu\text{s}, V_{GS}$



8 Typ. output characteristic

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

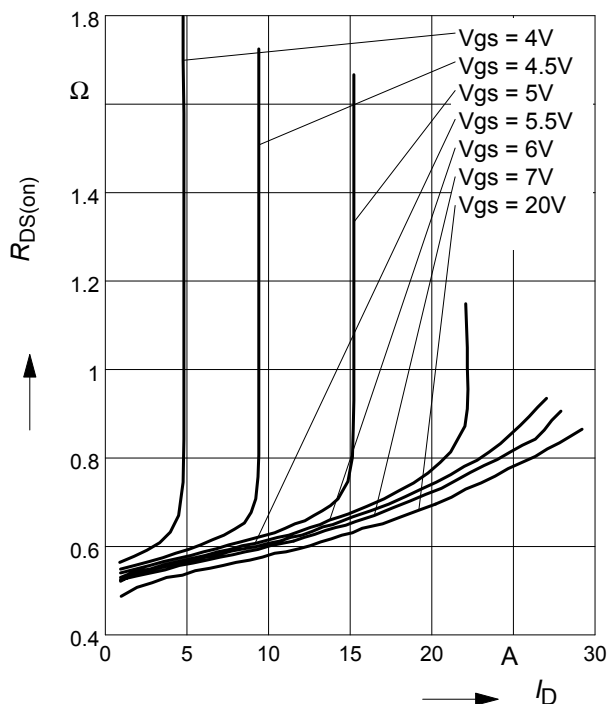
parameter: $t_p = 10 \mu\text{s}, V_{GS}$



9 Typ. drain-source on resistance

$$R_{DS(on)} = f(I_D)$$

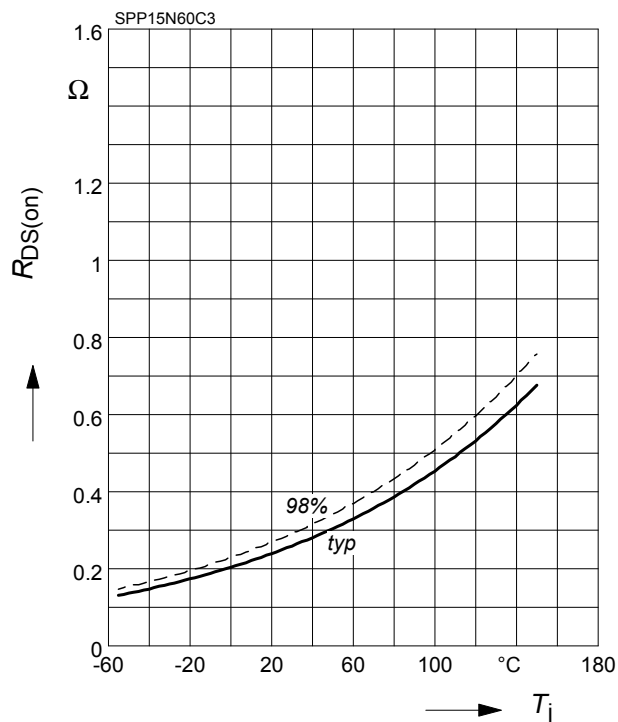
parameter: $T_j = 150^\circ\text{C}$, V_{GS}



10 Drain-source on-state resistance

$$R_{DS(on)} = f(T_j)$$

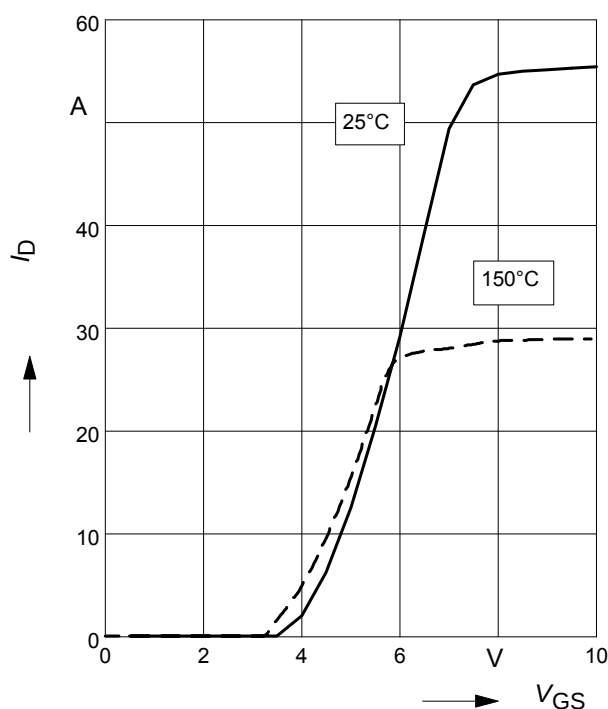
parameter: $I_D = 9.4\text{ A}$, $V_{GS} = 10\text{ V}$



11 Typ. transfer characteristics

$$I_D = f(V_{GS}); V_{DS} \geq 2 \times I_D \times R_{DS(on)max}$$

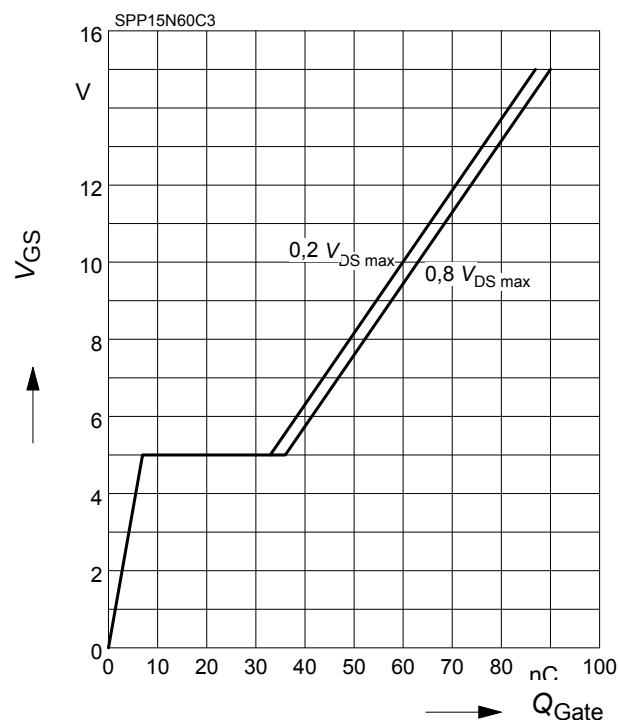
parameter: $t_p = 10\text{ }\mu\text{s}$



12 Typ. gate charge

$$V_{GS} = f(Q_{Gate})$$

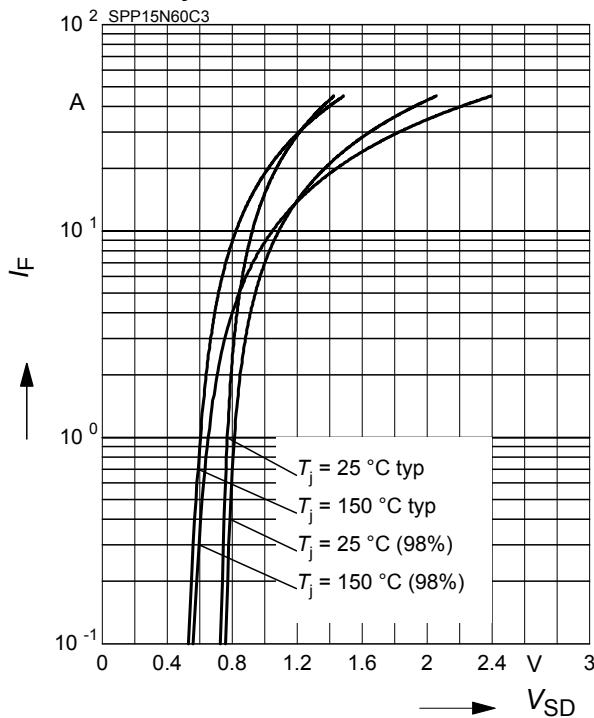
parameter: $I_D = 15\text{ A pulsed}$



13 Forward characteristics of body diode

$$I_F = f(V_{SD})$$

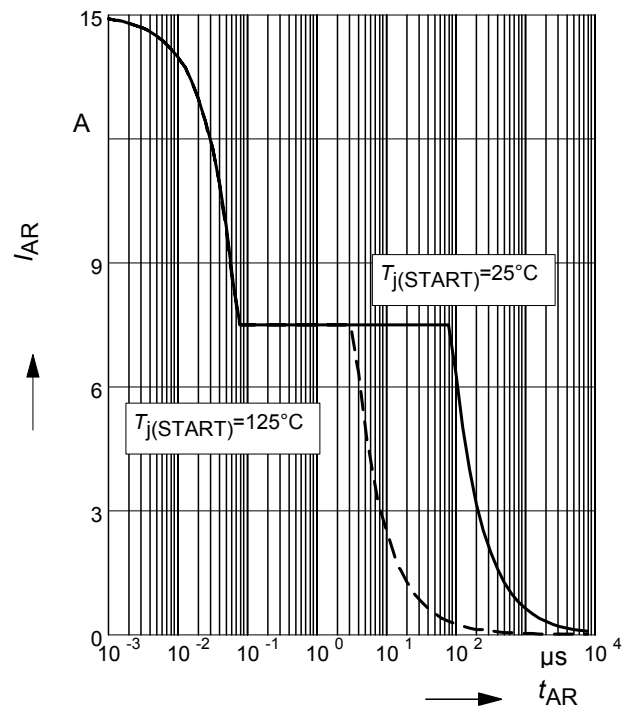
parameter: T_j , $t_p = 10 \mu s$



14 Avalanche SOA

$$I_{AR} = f(t_{AR})$$

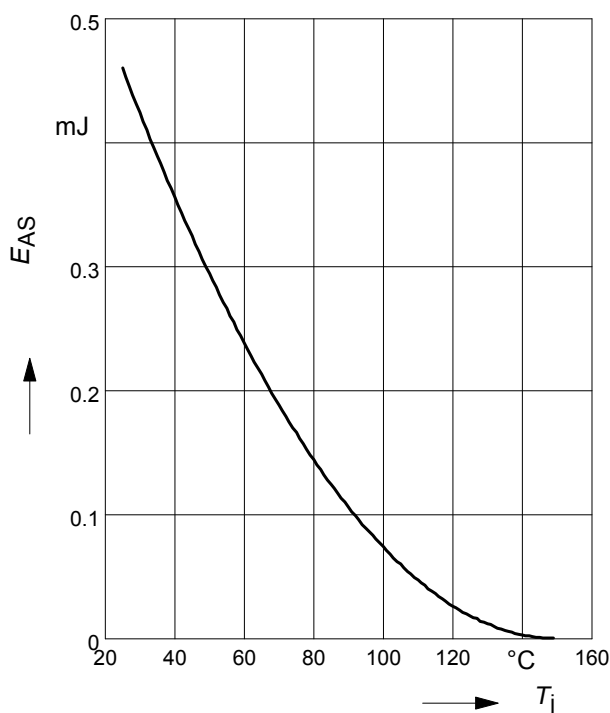
par.: $T_j \leq 150 \text{ °C}$



15 Avalanche energy

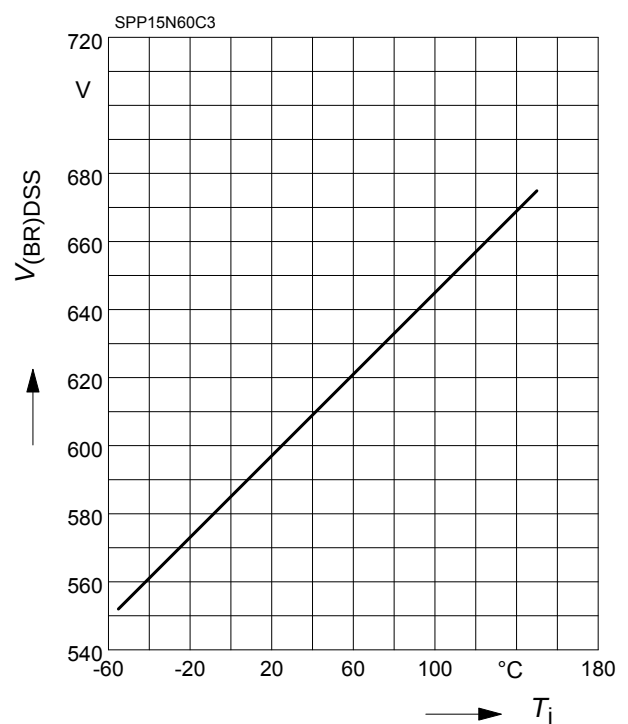
$$E_{AS} = f(T_j)$$

par.: $I_D = 7.5 \text{ A}$, $V_{DD} = 50 \text{ V}$



16 Drain-source breakdown voltage

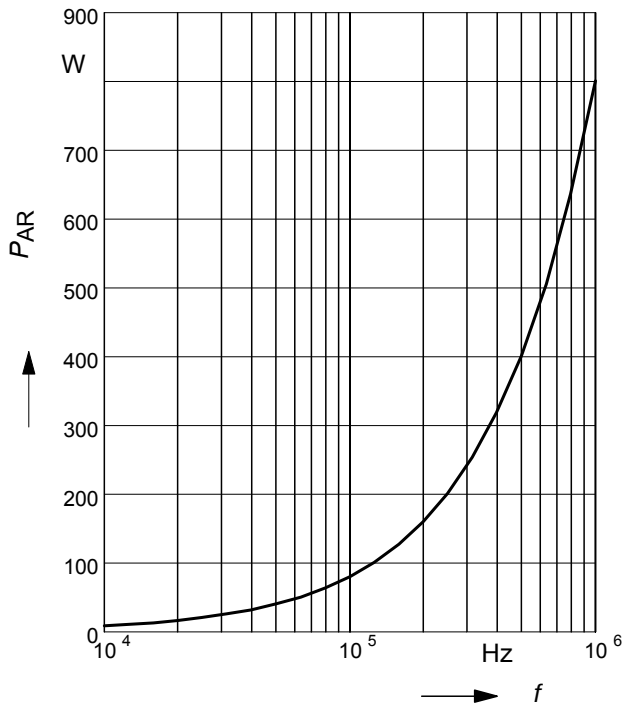
$$V_{(BR)DSS} = f(T_j)$$



17 Avalanche power losses

$$P_{AR} = f(f)$$

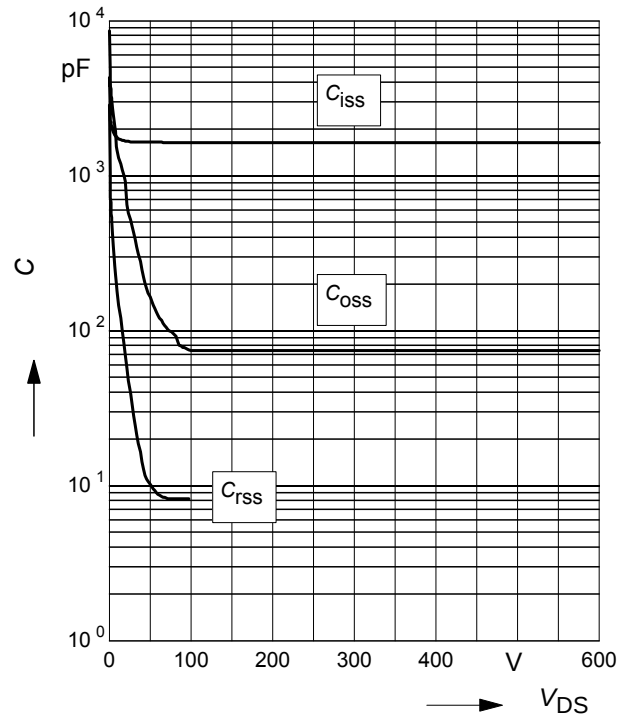
parameter: $E_{AR}=0.8\text{mJ}$



18 Typ. capacitances

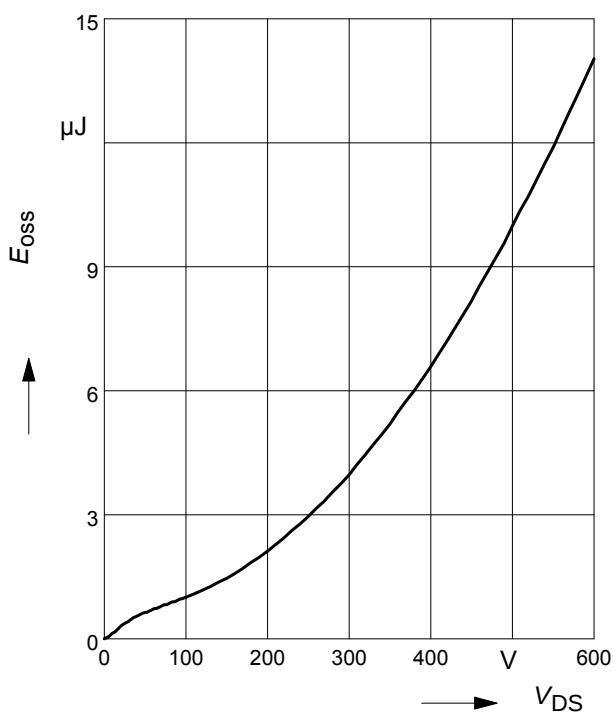
$$C = f(V_{DS})$$

parameter: $V_{GS}=0\text{V}$, $f=1\text{ MHz}$

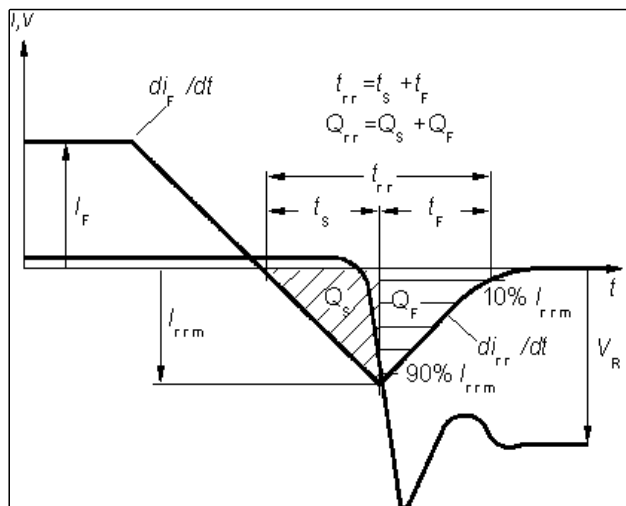


19 Typ. C_{oss} stored energy

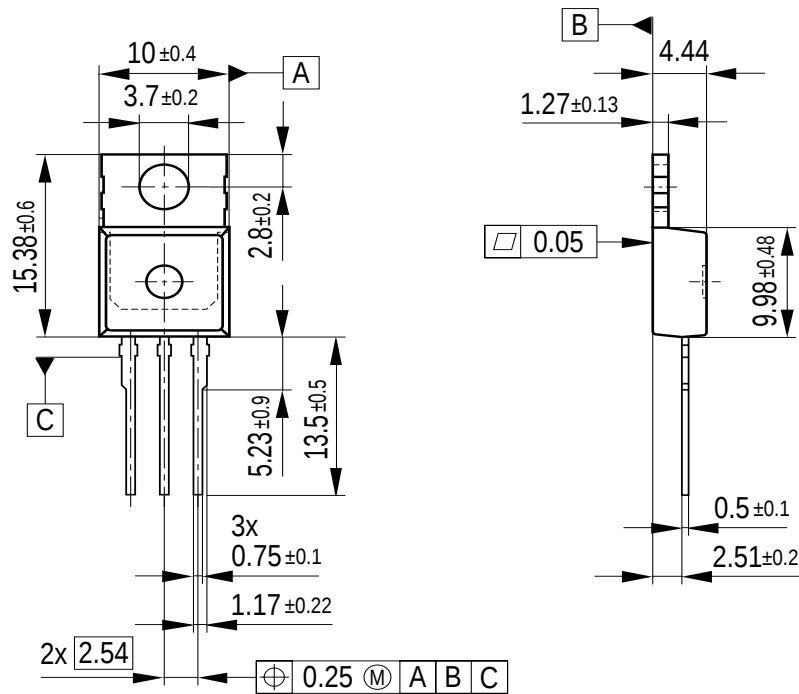
$$E_{oss}=f(V_{DS})$$



Definition of diodes switching characteristics

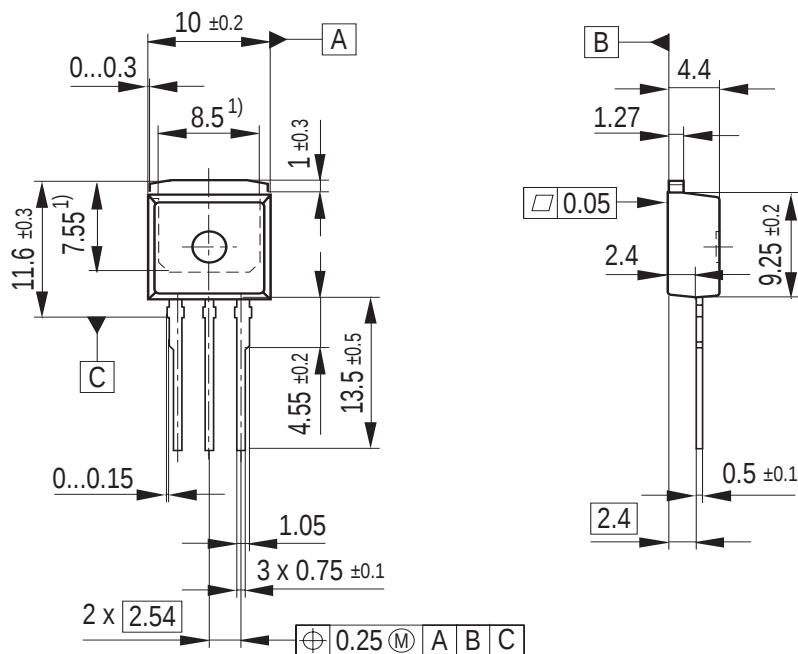


P-TO-220-3-1



All metal surfaces tin plated, except area of cut.
Metal surface min. $x=7.25$, $y=12.3$

P-TO-262-3-1 (I²-PAK)

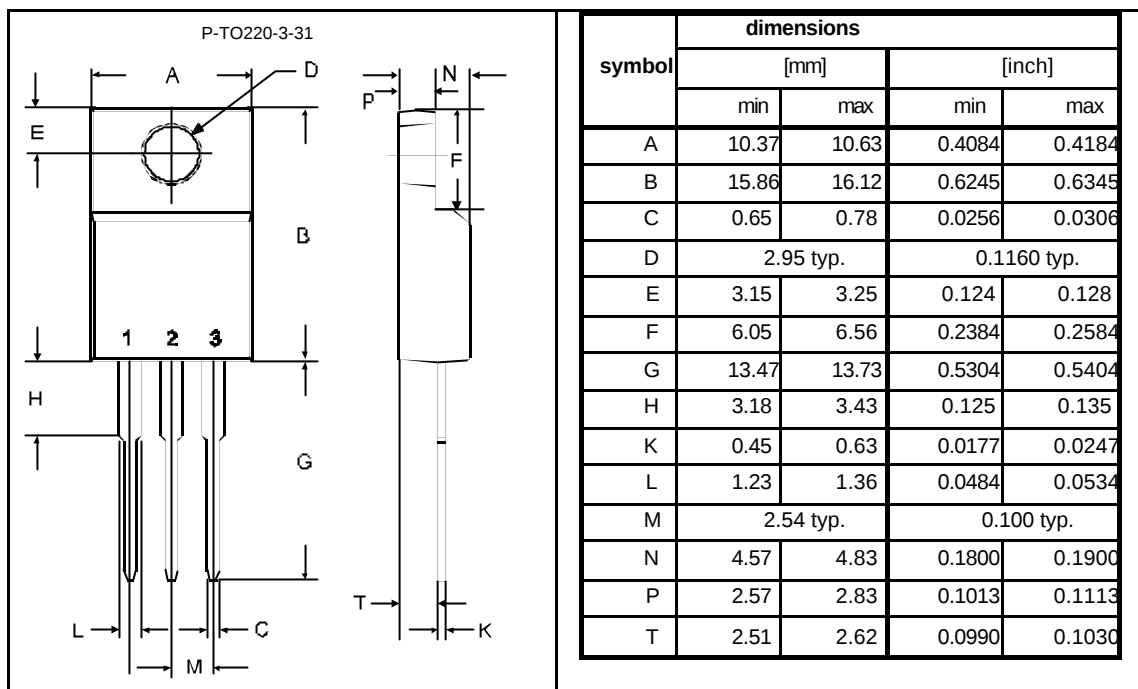


¹⁾ Typical

Metal surface min. X = 7.25, Y = 6.9

All metal surfaces tin plated, except area of cut.

P-TO-220-3-31 (FullPAK)



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