

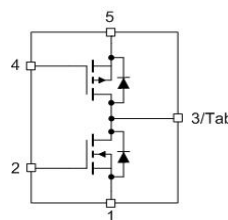
OptiMOS[®] -T PN Half Bridge

Features

- Dual p- and n-channel MOSFET
- Automotive AEC Q101 qualified
- Green package (RoHS compliant)
- Ultra low $R_{DS(on)}$
- 150 °C operating temperature

Product Summary

	P	N	
V_{DS}	-30	55	V
$R_{DS(on),max}$	13	12	m Ω
I_D	-40	40	A

PG-TO220-5-13


Type	Package	Marking
BTS7904S	PG-TO220-5-13	7904S

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

Parameter	Symbol	Conditions	Value		Unit
			P	N	
Continuous drain current ¹⁾	I_D	$T_C=25\text{ °C}$	-40	40	A
		$T_C=100\text{ °C}$	-40	40	
Pulsed drain current ²⁾	$I_{D,pulse}$	$T_C=25\text{ °C}$	-160	160	
Avalanche energy, single pulse ²⁾	E_{AS}	$I_D=\pm 20\text{ A}$	350	200	mJ
Avalanche current, single pulse	I_{AS}		-40	40	A
Gate source voltage	V_{GS}		-16 / +5	+16 / -16 ³⁾	V
Power dissipation ²⁾	P_{tot}	$T_C=25\text{ °C}$	96	69	W
Operating and storage temperature	T_j, T_{stg}		-55 ... 150		°C
IEC climatic category; DIN IEC 68-1			55/150/56		

Parameter	Symbol	Conditions	Values			Unit
			min.	typ.	max.	

Thermal characteristics

Thermal resistance, junction - case	P	R_{thJC}		-	-	1.3	K/W
	N			-	-	1.8	
SMD version, device on PCB ⁵⁾		R_{thJA}	minimal footprint	-	-	62	
			6 cm ² cooling area ⁴⁾	-	-	45	

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

Drain-source breakdown voltage	P	$V_{(BR)DSS}$	$V_{GS}=0\text{ V}, I_D=-1\text{ mA}$	-30	-	-	V
	N		$V_{GS}=0\text{ V}, I_D=1\text{ mA}$	55	-	-	
Gate threshold voltage	P	$V_{GS(th)}$	$V_{DS}=V_{GS}, I_D=-70\text{ }\mu\text{A}$	-1	-1.5	-2.1	
	N		$V_{DS}=V_{GS}, I_D=40\text{ }\mu\text{A}$	1.2	1.7	2.2	
Zero gate voltage drain current	P	I_{DSS}	$V_{DS}=-18\text{ V}, V_{GS}=0\text{ V}, T_j=25\text{ }^\circ\text{C}$	-	-0.01	-1	μA
			$V_{DS}=-18\text{ V}, V_{GS}=0\text{ V}, T_j=125\text{ }^\circ\text{C}$	-	-1	-100	
	N		$V_{DS}=18\text{ V}, V_{GS}=0\text{ V}, T_j=25\text{ }^\circ\text{C}$	-	0.01	1	
			$V_{DS}=18\text{ V}, V_{GS}=0\text{ V}, T_j=125\text{ }^\circ\text{C}$	-	1	100	
Gate-source leakage current	P	I_{GSS}	$V_{GS}=-16\text{ V}, V_{DS}=0\text{ V}$	-	-10	-100	nA
	N		$V_{GS}=16\text{ V}, V_{DS}=0\text{ V}$	-	1	100	
Drain-source on-state resistance	P	$R_{DS(on)}$	$V_{GS}=-10\text{ V}, I_D=-20\text{ A}$	-	7.2	13	m Ω
	N		$V_{GS}=10\text{ V}, I_D=20\text{ A}$	-	9.7	12	
	P		$V_{GS}=-4.5\text{ V}, I_D=-12.5\text{ A}$	-	17.5	21	
	N		$V_{GS}=4.5\text{ V}, I_D=20\text{ A}$	-	16.8	20.5	

Parameter	Symbol	Conditions	Values			Unit
			min.	typ.	max.	

Dynamic characteristics

Input capacitance	P	C_{iss}	$V_{GS}=0\text{ V}, V_{DS}=\pm 25\text{ V}, f=1\text{ MHz}$ $V_{DD}=15\text{ V}, V_{GS}=10\text{ V}$ N: $I_D=30\text{ A}, R_G=2\ \Omega$ P: $I_D=-30\text{ A}, R_G=2\ \Omega$	-	3900	5200	pF
	N			-	4600	6100	
Output capacitance	P	C_{oss}		-	1000	1300	
	N			-	570	760	
Reverse transfer capacitance	P	C_{rss}		-	850	1300	
	N			-	550	820	
Turn-on delay time	P	$t_{d(on)}$		-	22	-	ns
	N			-	15	-	
Rise time	P	t_r		-	94	-	
	N			-	77	-	
Turn-off delay time	P	$t_{d(off)}$	-	104	-		
	N		-	31	-		
Fall time	P	t_f	-	150	-		
	N		-	8	-		

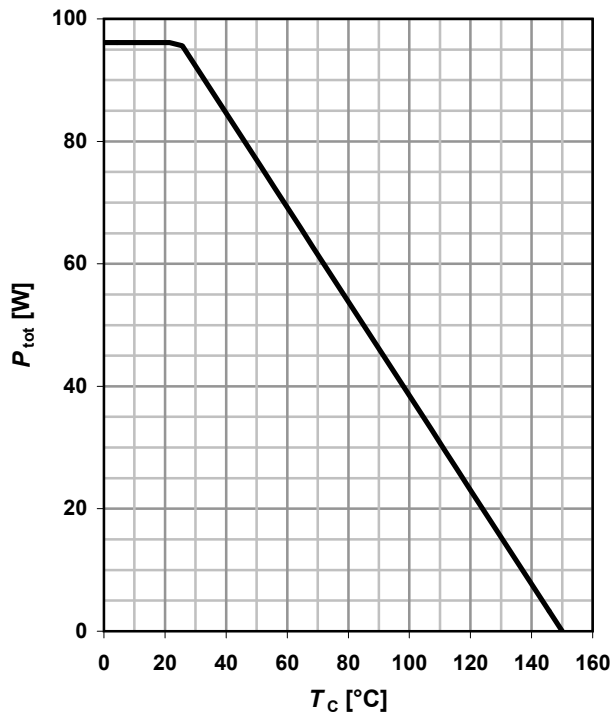
Gate Charge Characteristics²⁾

Gate to source charge	P	Q_{gs}	$V_{DD}=-24\text{ V}, I_D=-40\text{ A}, V_{GS}=0\text{ to }-10\text{ V}$	-	-12	-16	nC
Gate to drain charge		Q_{gd}		-	-30	-45	
Switching charge		Q_g		-	-80	-121	
Gate plateau voltage		$V_{plateau}$		-	-3.0	-	
Gate to source charge	N	Q_{gs}	$V_{DD}=44\text{ V}, I_D=40\text{ A}, V_{GS}=0\text{ to }10\text{ V}$	-	20	27	
Gate to drain charge		Q_{gd}		-	32	48	
Gate charge		Q_g		-	82	123	
Gate plateau voltage		$V_{plateau}$			4.2		

Parameter	Symbol	Conditions	Values			Unit	
			min.	typ.	max.		
Reverse Diode							
Diode continuous forward current ²⁾	P	I_S	$T_C=25\text{ °C}$	-	-	-40	A
	N					40	
Diode pulse current	P	$I_{S,pulse}$		-	-	-160	
	N					160	
Diode forward voltage	P	V_{SD}	$V_{GS}=0\text{ V}, I_F=-40\text{ A},$ $T_j=25\text{ °C}$	-	-1.00	-1.2	V
	N		$V_{GS}=0\text{ V}, I_F=40\text{ A},$ $T_j=25\text{ °C}$	-	0.90	1.2	
Reverse recovery time ²⁾	P	t_{rr}	$V_R=15\text{ V}, I_F=I_S,$ $di_F/dt=400\text{ A}/\mu\text{s}$	-	41	-	ns
	N			-	47	-	
Reverse recovery charge ²⁾	P	Q_{rr}		-	-40	-	nC
	N			-	50	-	

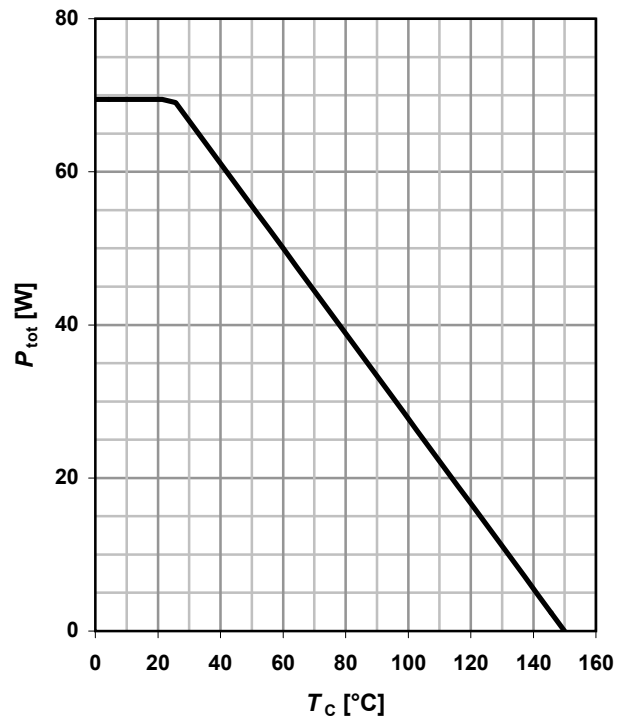
1 Power dissipation (P)

$P_{tot}=f(T_C), V_{GS} \geq 6 \text{ V}$



2 Power dissipation (N)

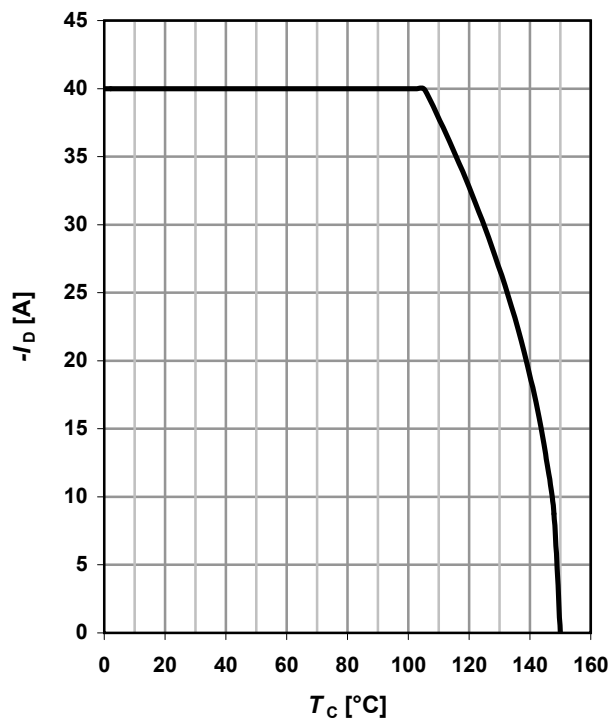
$P_{tot}=f(T_C), V_{GS} \geq 6 \text{ V}$



3 Drain current (P)

$I_D=f(T_C)$

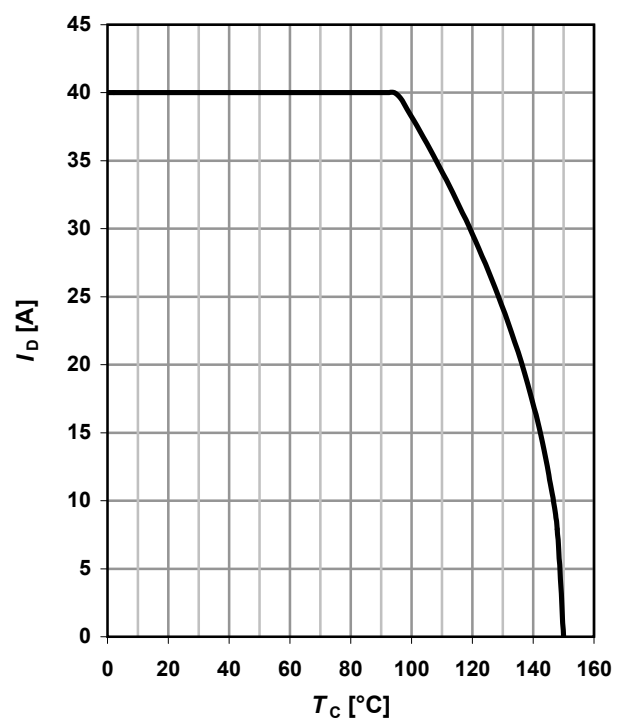
parameter: $V_{GS} \geq 6 \text{ V}$



4 Drain current (N)

$I_D=f(T_C)$

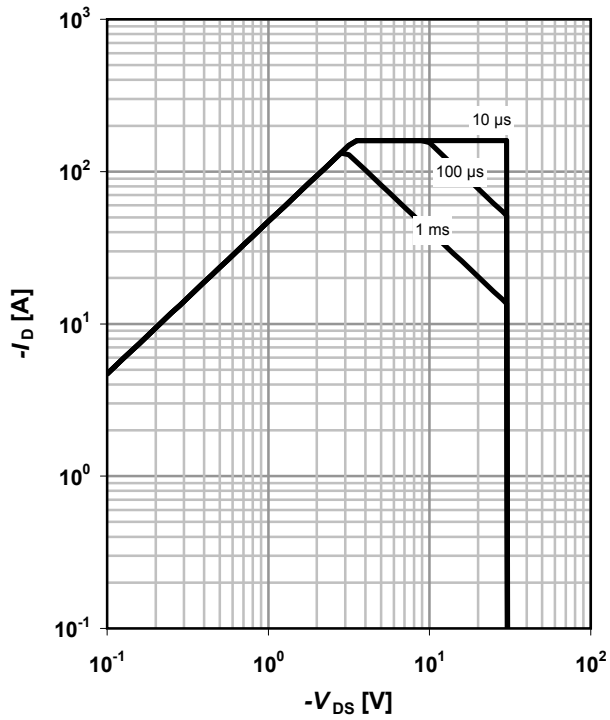
parameter: $V_{GS} \geq 6 \text{ V}$



5 Safe operating area (P)

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

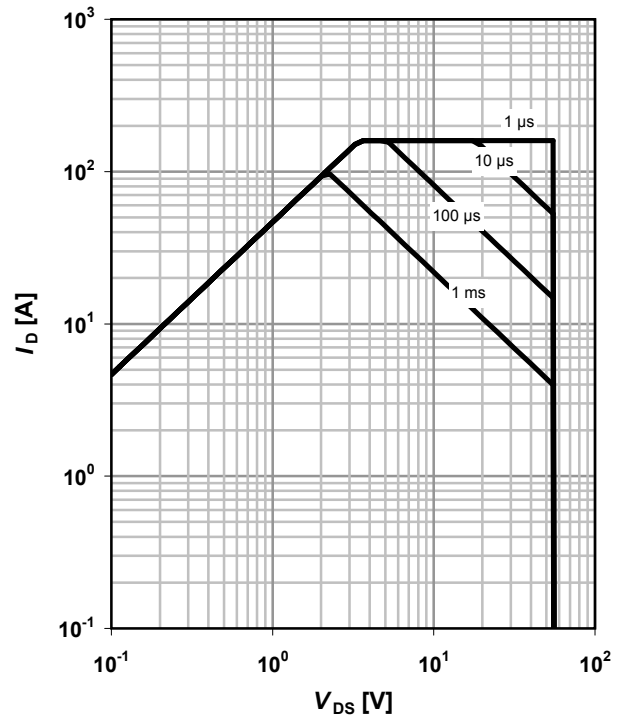
parameter: t_p



6 Safe operating area (N)

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

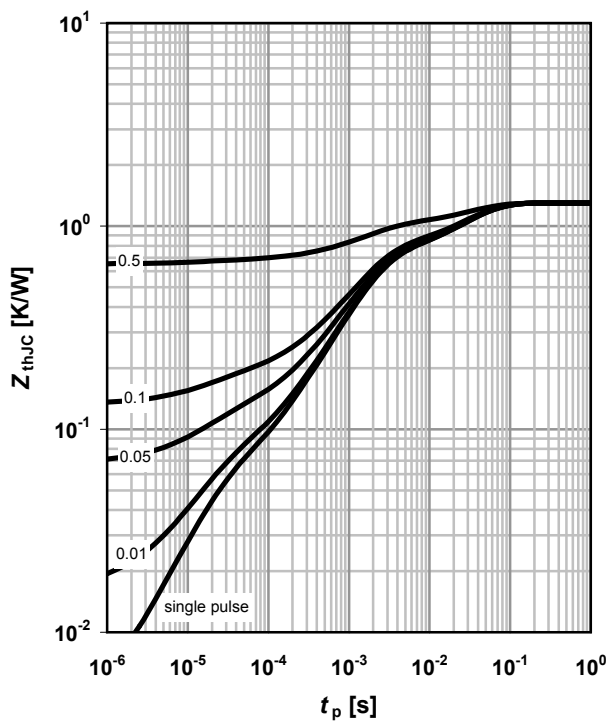
parameter: t_p



7 Max. transient thermal impedance (P)

$Z_{thJC}=f(t_p)$

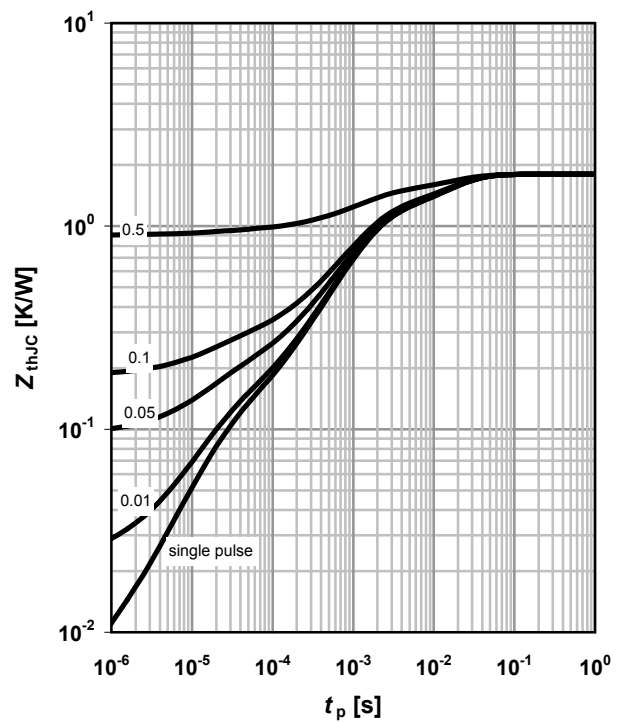
parameter: $D=t_p/T$



8 Max. transient thermal impedance (N)

$Z_{thJC}=f(t_p)$

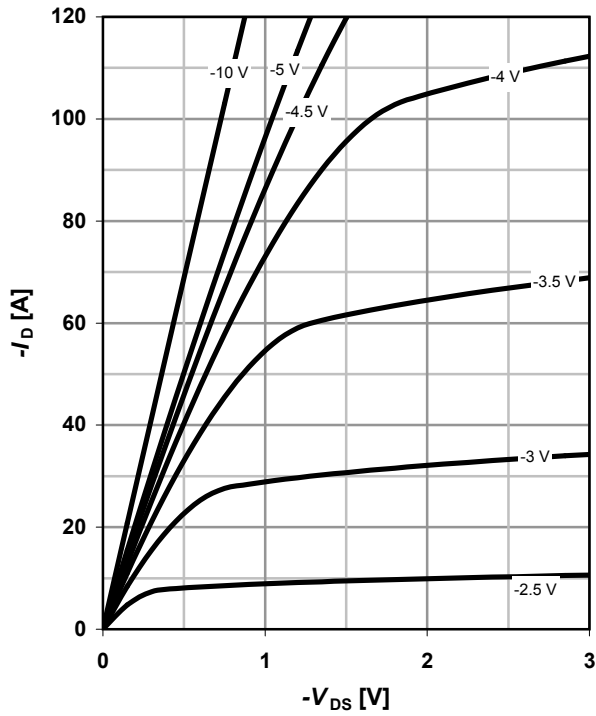
parameter: $D=t_p/T$



9 Typ. output characteristics (P)

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

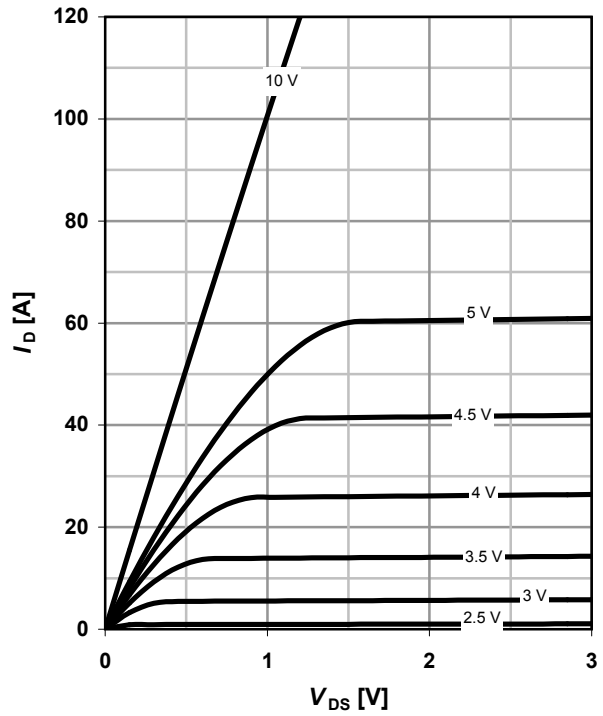
parameter: V_{GS}



10 Typ. output characteristics (N)

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

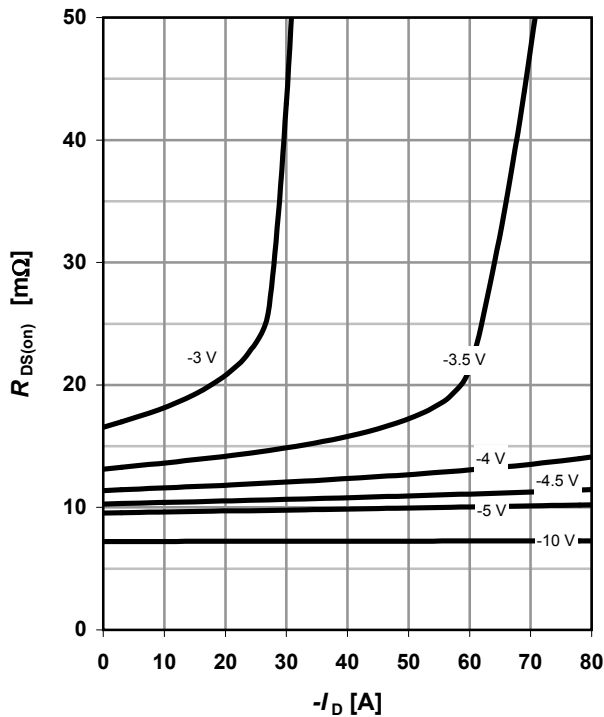
parameter: V_{GS}



11 Typ. drain-source on resistance (P)

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

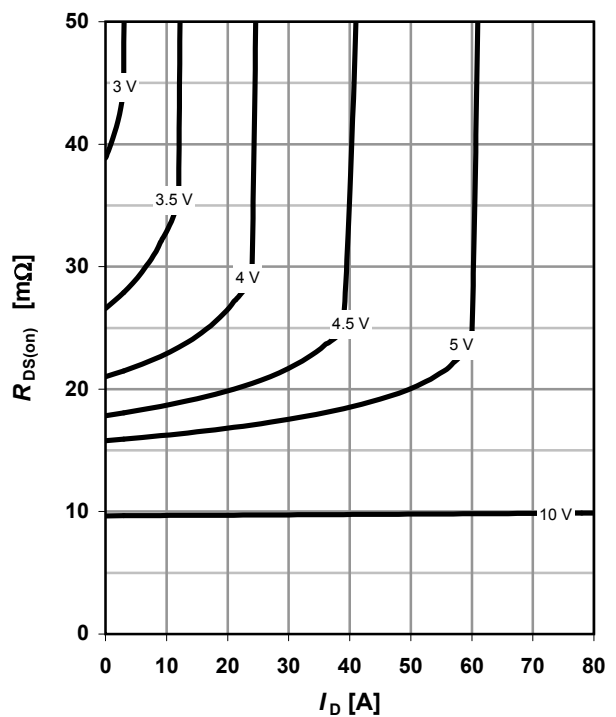
parameter: V_{GS}



12 Typ. drain-source on resistance (N)

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

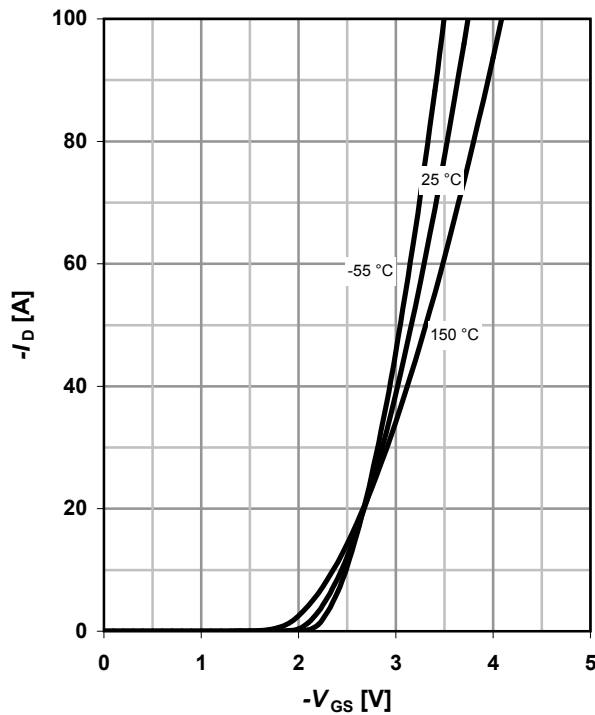
parameter: V_{GS}



13 Typ. transfer characteristics (P)

$I_D=f(V_{GS}); V_{DS}=-6\text{ V}$

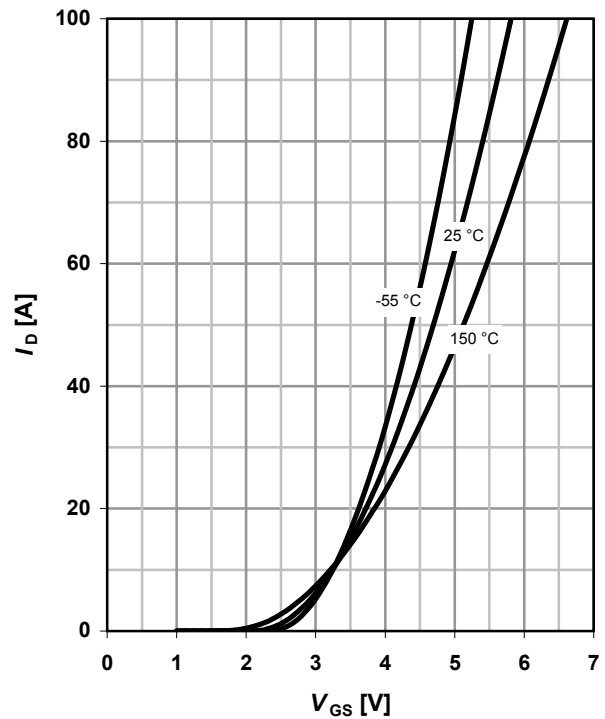
parameter: T_j



14 Typ. transfer characteristics (N)

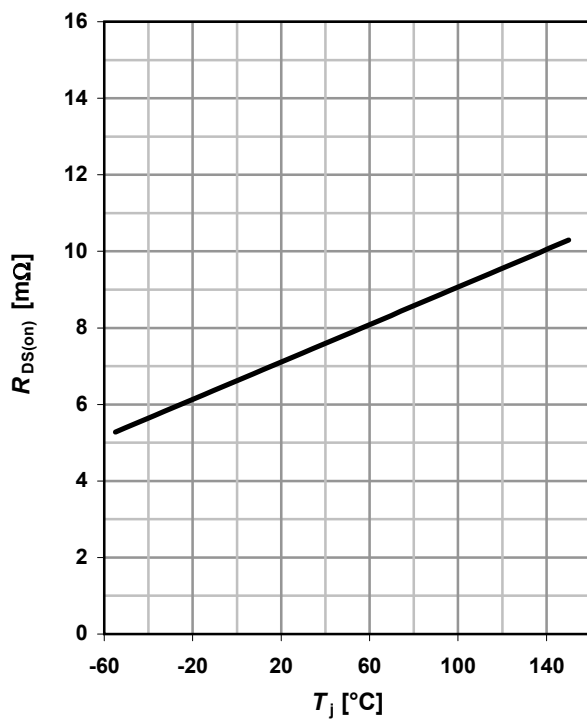
$I_D=f(V_{GS}); V_{DS}=6\text{ V}$

parameter: T_j



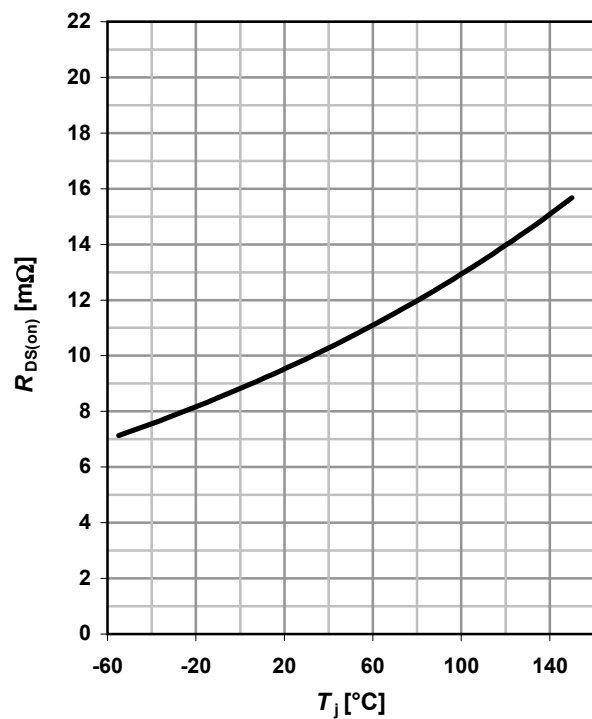
15 Drain-source on-state resistance (P)

$R_{DS(on)}=f(T_j); I_D=-20\text{ A}; V_{GS}=-10\text{ V}$



16 Drain-source on-state resistance (N)

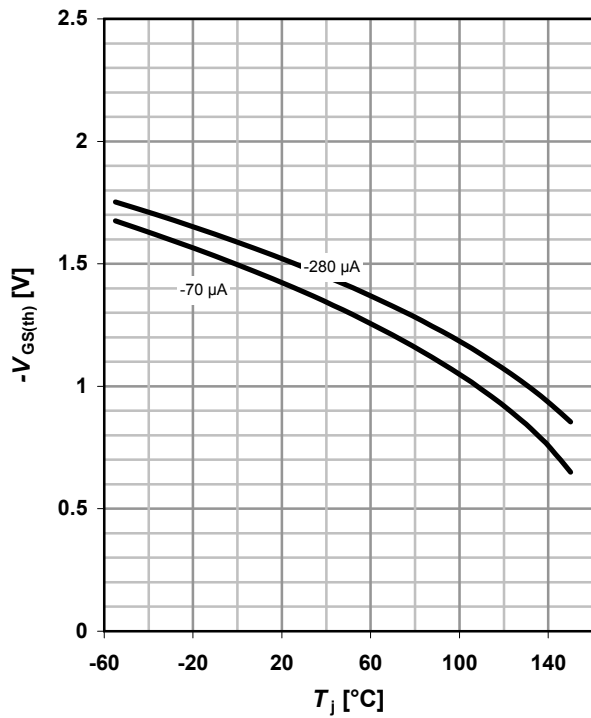
$R_{DS(on)}=f(T_j); I_D=20\text{ A}; V_{GS}=10\text{ V}$



17 Typ. gate threshold voltage (P)

$V_{GS(th)}=f(T_j); V_{GS}=V_{DS}$

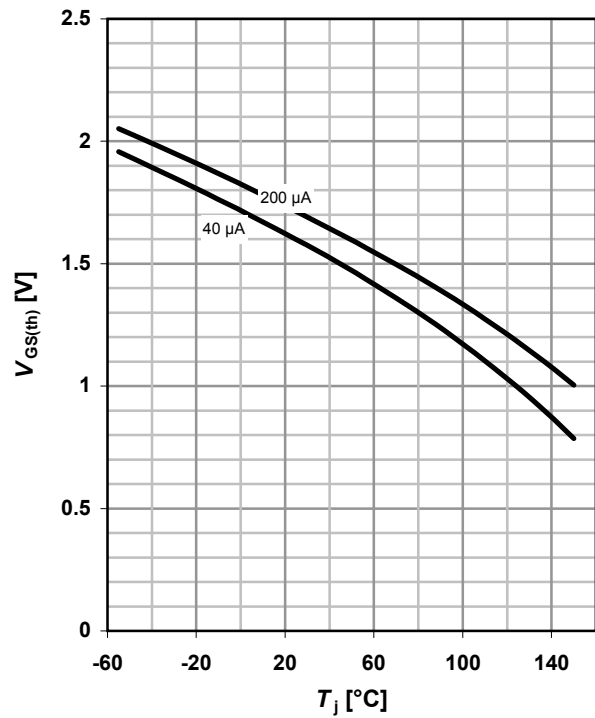
parameter: I_D



18 Typ. gate threshold voltage (N)

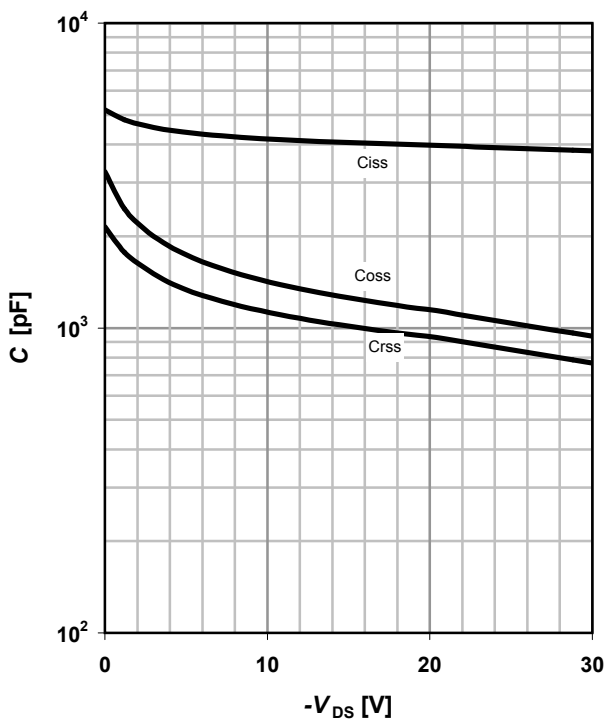
$V_{GS(th)}=f(T_j); V_{GS}=V_{DS}$

parameter: I_D



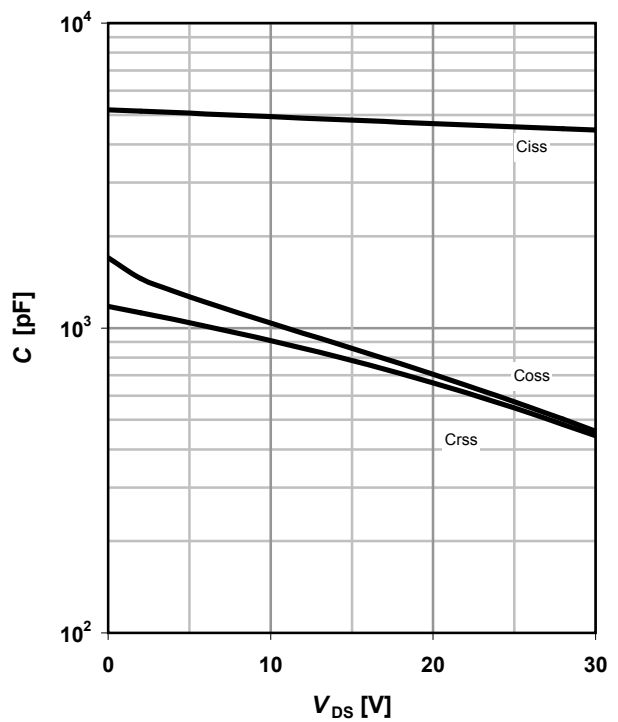
19 Typ. capacitances (P)

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



20 Typ. capacitances (N)

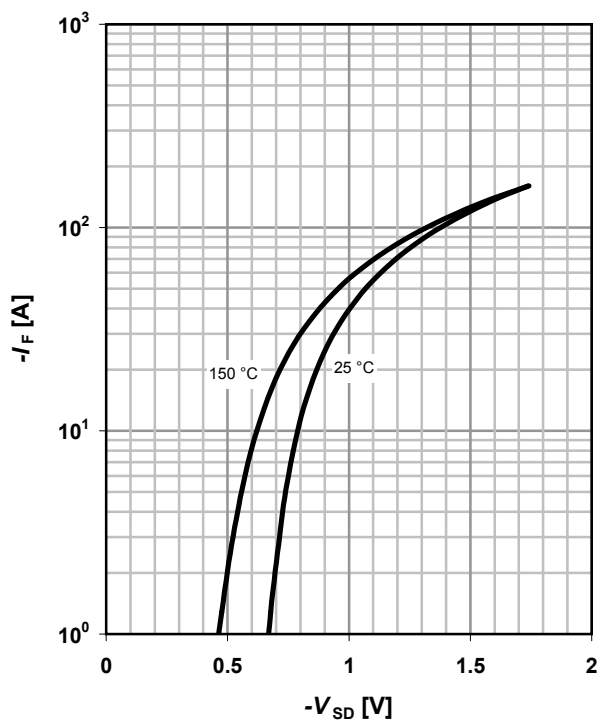
$C=f(V_{DS}); V_{GS}=0\text{ V}; f=1\text{ MHz}$



21 Forward characteristics of reverse diode (P)

$I_F=f(V_{SD})$

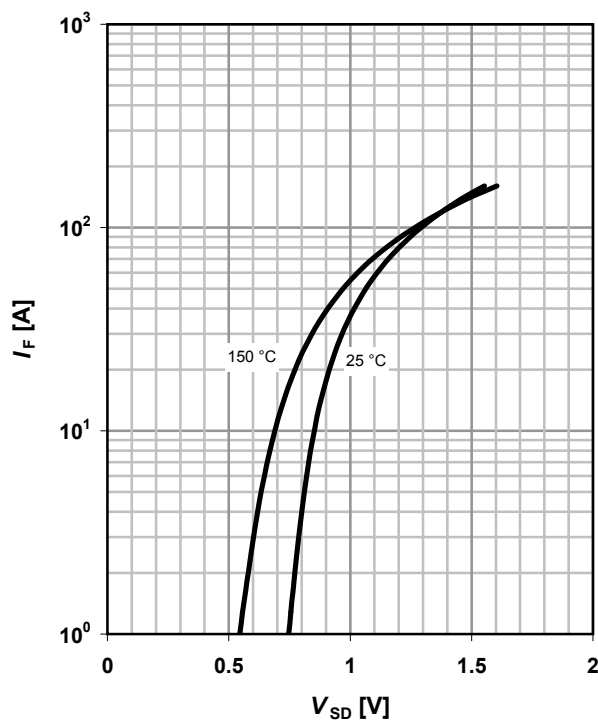
parameter: T_j



22 Forward characteristics of reverse diode (N)

$I_F=f(V_{SD})$

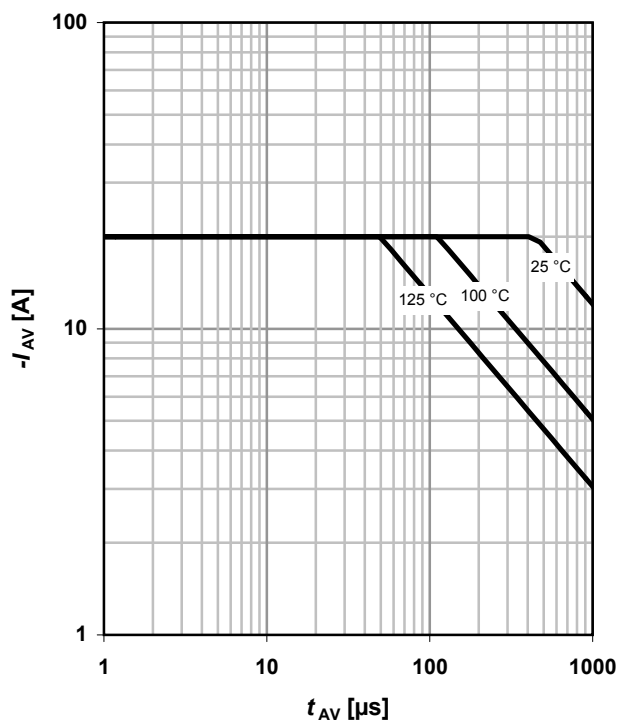
parameter: T_j



23 Avalanche characteristics (P)

$I_{AS}=f(t_{AV}); R_{GS}=25 \Omega$

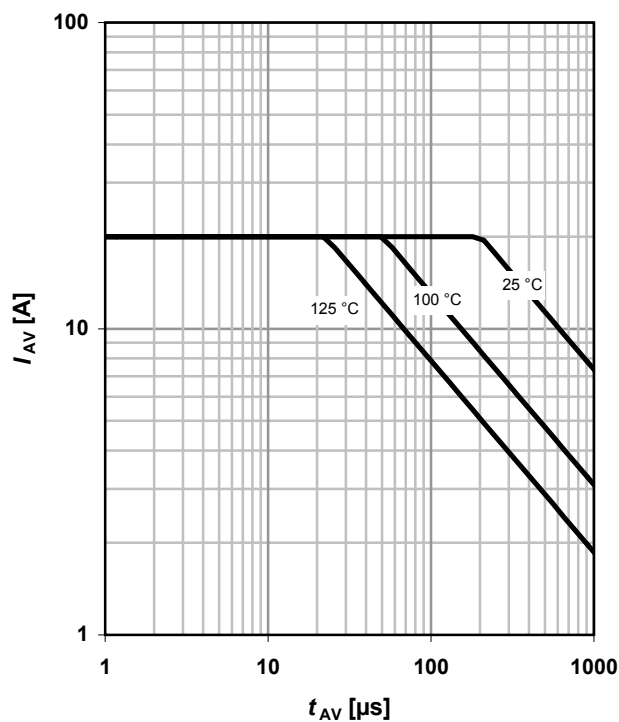
parameter: $T_{j(start)}$



24 Avalanche characteristics (N)

$I_{AS}=f(t_{AV}); R_{GS}=25 \Omega$

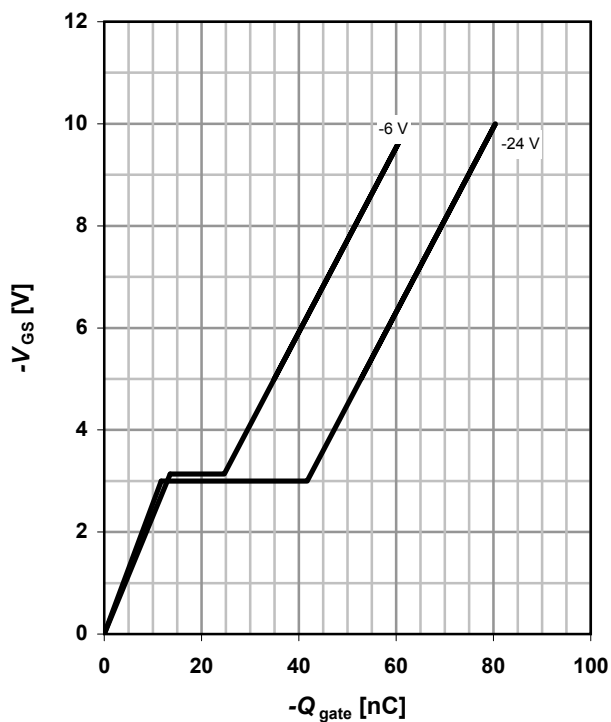
parameter: $T_{j(start)}$



25 Typ. gate charge (P)

$V_{GS}=f(Q_{gate}); I_D=-40\text{ A pulsed}$

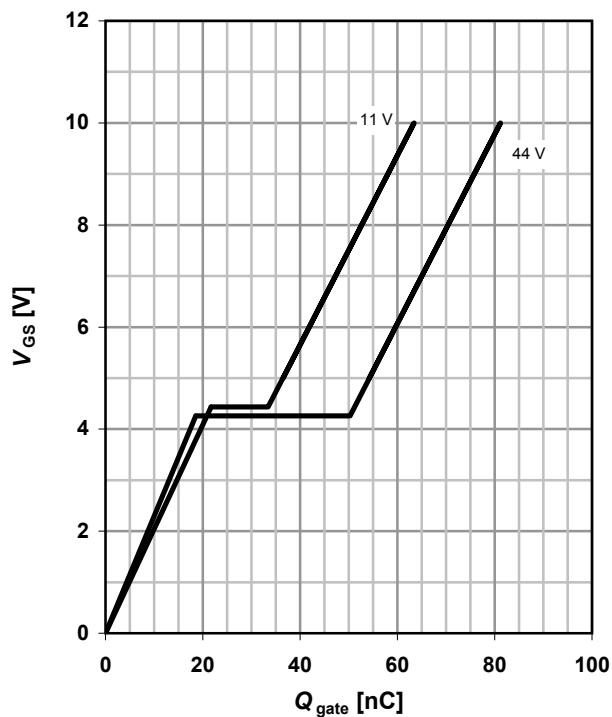
parameter: V_{DD}



26 Typ. gate charge (N)

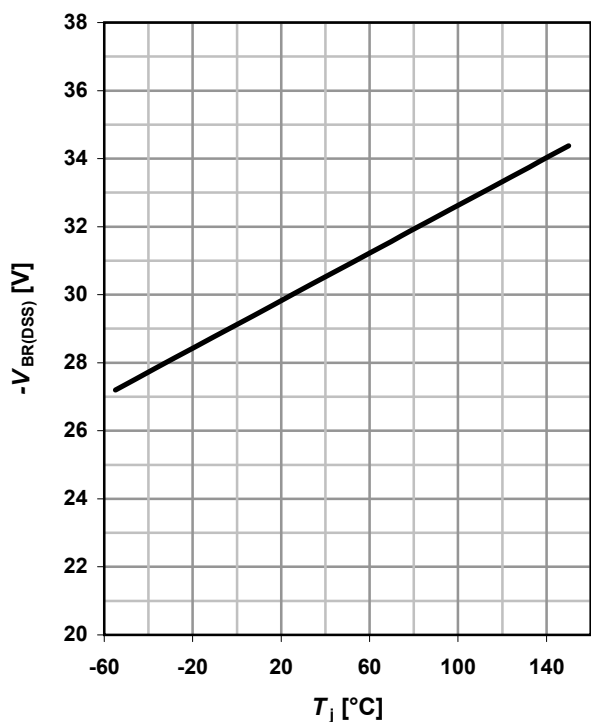
$V_{GS}=f(Q_{gate}); I_D=40\text{ A pulsed}$

parameter: V_{DD}



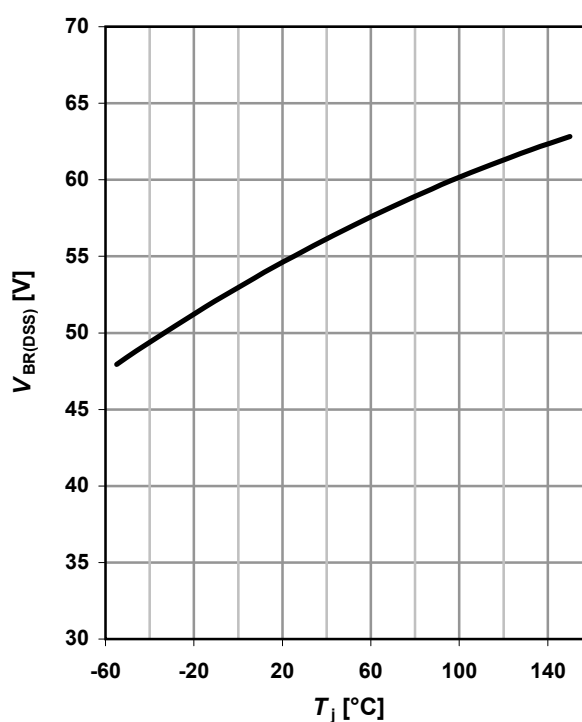
27 Drain-source breakdown voltage (P)

$V_{BR(DSS)}=f(T_j); I_D=-1\text{ mA}$



28 Drain-source breakdown voltage (N)

$V_{BR(DSS)}=f(T_j); I_D=1\text{ mA}$





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