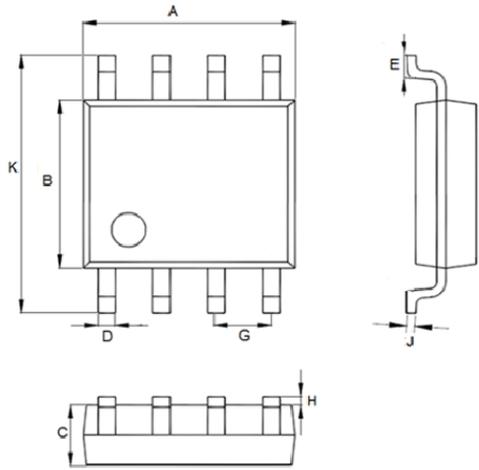


## P+N-Channel Enhancement Mode MOSFET

Primary characteristics				
Symbol	Parameter	Value		Unit
		N-ch.	P-ch.	
$I_D$	Continuous drain current ( $T_C=25^\circ\text{C}$ )	9.7	9.2	A
$V_{DSS}$	Drain source voltage	40	40	V
$R_{DS(ON)}$	Static drain-source ON resistance	27	70	mΩ MAX

### Features

- **SOP-8** case for easy automatic insertion
- Pb-free and **RoHS** compliant
- Reliable and rugged
- Molding compound: UL Flammability Classification Rating 94V-0
- Terminals: matte tin-plated leads; solderability-per MIL-STD-202, Method 208

Case dimensions										
										
<b>SOP-8</b>										
Unit		A	B	C	D	E	G	H	J	K
mm	MIN	4.8	3.8	1.3	0.3	0.4	1.17	0.1	0.1	5.8
	MAX	5.2	4.2	1.5	0.5	1.0	1.37	0.3	0.3	6.2

### Applications

- Portable equipment application
- Synchronous rectification
- Motor control

Maximum ratings ( $T_A = 25^\circ\text{C}$ unless otherwise noted)					
Characteristic	Symbol	Value		Unit	
		N-channel	P-channel		
Drain-source voltage	$V_{DSS}$	40	40	V	
Gate-source voltage	$V_{GSS}$	$\pm 20$	$\pm 20$	V	
Continuous drain current ( $T_C=25^\circ\text{C}$ )	$T_C=25^\circ\text{C}$	$I_D$	9.7	9.2	A
	$T_C=100^\circ\text{C}$		6.2	5.8	
Pulsed drain current <sup>1)</sup>	$I_{DM}$		39	36.8	A
Power Dissipation	$P_D$		3.4	7.8	W
Single pulse avalanche energy <sup>2)</sup>	$E_{AS}$		18	20	mJ
Thermal resistance junction-to-air	$R_{\theta JA}$		37	16	$^\circ\text{C/W}$
Operating junction temperature range	$T_J, T_{STG}$		-55 ~ 150		$^\circ\text{C}$

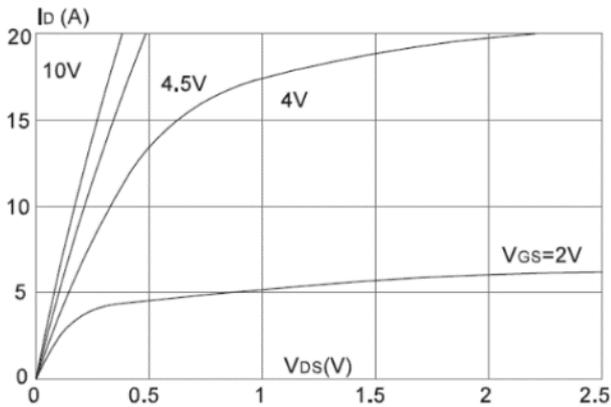
N-channel						
Electrical characteristics (T <sub>A</sub> = 25°C)						
Characteristic	Test condition	Symbol	Value			Unit
			Min.	Typ.	Max.	
Drain-source breakdown voltage	V <sub>GS</sub> =0V, I <sub>D</sub> =250μA	V <sub>DSS</sub>	40	-	-	V
Zero gate voltage drain current	V <sub>DS</sub> =40V, V <sub>GS</sub> =0V	I <sub>DSS</sub>	-	-	1.0	μA
Gate body leakage current	V <sub>GS</sub> =±20V, V <sub>DS</sub> =0V	I <sub>GSS</sub>	-	-	±100	nA
Gate threshold voltage <sup>3)</sup>	V <sub>DS</sub> =V <sub>GS</sub> , I <sub>D</sub> =250μA	V <sub>GS(TH)</sub>	1.0	-	2.5	V
Drain-source on-state resistance <sup>3)</sup>	V <sub>GS</sub> =10V, I <sub>D</sub> =4.0A	R <sub>DS(ON)</sub>	-	-	21	mΩ
	V <sub>GS</sub> =4.5V, I <sub>D</sub> =3.0A		-	-	27	
Dynamic electrical characteristics						
Characteristic	Test condition	Symbol	Value			Unit
			Min.	Typ.	Max.	
Input capacitance	V <sub>DS</sub> =20V V <sub>GS</sub> =0V f=1.0MHz	C <sub>ISS</sub>	-	882	-	pF
Output capacitance		C <sub>OSS</sub>	-	77.6	-	
Reverse transfer capacitance		C <sub>RSS</sub>	-	61.7	-	
Turn ON delay time	V <sub>DD</sub> =20V V <sub>GS</sub> =10V I <sub>D</sub> =8.0A R <sub>G</sub> =3.0Ω R <sub>L</sub> =1.0Ω	t <sub>d(ON)</sub>	-	10	-	ns
Turn ON rise time		t <sub>r</sub>	-	12	-	
Turn OFF delay time		t <sub>d(OFF)</sub>	-	32	-	
Turn OFF fall time		t <sub>f</sub>	-	8.0	-	
Switching characteristics <sup>3), 4)</sup>						
Characteristic	Test condition	Symbol	Value			Unit
			Min.	Typ.	Max.	
Total gate-charge	V <sub>DD</sub> =20V V <sub>GS</sub> =10V I <sub>D</sub> =5.0A	Q <sub>G</sub>	-	10	-	nC
Gate to source charge		Q <sub>GS</sub>	-	1.7	-	
Gate to drain (Miller) charge		Q <sub>GD</sub>	-	2.0	-	
Source-drain diode characteristics						
Characteristic	Test condition	Symbol	Value			Unit
			Min.	Typ.	Max.	
Diode forward voltage	I <sub>SD</sub> =8.0A, V <sub>GS</sub> =0V	V <sub>SD</sub>	-	-	1.2	V
Reverse recovery time	I <sub>S</sub> =8.0A, V <sub>GS</sub> =0V, di/dt=100A/μs	t <sub>rr</sub>	-	17	-	ns
Reverse recovery charge		Q <sub>rr</sub>	-	10	-	nC
Notes:						
1) Repetitive rating: pulse width limited by maximum junction temperature						
2) EAS condition: T <sub>J</sub> =25°C, V <sub>DD</sub> =20V, V <sub>G</sub> =10V, L=0.5mH, R <sub>G</sub> =25Ω						
3) I <sub>SD</sub> ≤I <sub>MAX</sub> , di/dt=100A/μs, V <sub>DD</sub> ≤BV <sub>DSS</sub> , starting T <sub>J</sub> =25°C						
4) Pulse test: pulse width ≤300μs, duty cycle ≤2%						

P-channel						
Electrical characteristics (T <sub>A</sub> = 25°C)						
Characteristic	Test condition	Symbol	Value			Unit
			Min.	Typ.	Max.	
Drain-source breakdown voltage	V <sub>GS</sub> =0V, I <sub>D</sub> =250μA	V <sub>DSS</sub>	40	-	-	V
Zero gate voltage drain current	V <sub>DS</sub> =40V, V <sub>GS</sub> =0V	I <sub>DSS</sub>	-	-	1.0	μA
Gate body leakage current	V <sub>GS</sub> =±20V, V <sub>DS</sub> =0V	I <sub>GSS</sub>	-	-	±100	nA
Gate threshold voltage <sup>3)</sup>	V <sub>DS</sub> =V <sub>GS</sub> , I <sub>D</sub> =250μA	V <sub>GS(TH)</sub>	1.0	-	2.5	V
Drain-source on-state resistance <sup>3)</sup>	V <sub>GS</sub> =10V, I <sub>D</sub> =5.0A	R <sub>DS(ON)</sub>	-	-	55	mΩ
	V <sub>GS</sub> =4.5V, I <sub>D</sub> =4.0A		-	-	70	
Dynamic electrical characteristics						
Characteristic	Test condition	Symbol	Value			Unit
			Min.	Typ.	Max.	
Input capacitance	V <sub>DS</sub> =20V V <sub>GS</sub> =0V f=1.0MHz	C <sub>ISS</sub>	-	931	-	pF
Output capacitance		C <sub>OSS</sub>	-	96	-	
Reverse transfer capacitance		C <sub>RSS</sub>	-	72	-	
Turn ON delay time	V <sub>DD</sub> =20V V <sub>GS</sub> =10V I <sub>D</sub> =5.0A R <sub>G</sub> =2.5Ω	t <sub>d(ON)</sub>	-	7.2	-	ns
Turn ON rise time		t <sub>r</sub>	-	14	-	
Turn OFF delay time		t <sub>d(OFF)</sub>	-	21	-	
Turn OFF fall time		t <sub>f</sub>	-	8.1	-	
Switching characteristics <sup>3), 4)</sup>						
Characteristic	Test condition	Symbol	Value			Unit
			Min.	Typ.	Max.	
Total gate-charge	V <sub>DD</sub> =20V V <sub>GS</sub> =10V I <sub>D</sub> =3.0A	Q <sub>G</sub>	-	18	-	nC
Gate to source charge		Q <sub>GS</sub>	-	3.2	-	
Gate to drain (Miller) charge		Q <sub>GD</sub>	-	3.8	-	
Source-drain diode characteristics						
Characteristic	Test condition	Symbol	Value			Unit
			Min.	Typ.	Max.	
Diode forward voltage	I <sub>SD</sub> =5.0A, V <sub>GS</sub> =0V	V <sub>SD</sub>	-	-	1.2	V
Reverse recovery time	I <sub>S</sub> =5.0A, V <sub>GS</sub> =0V, di/dt=100A/μs	t <sub>rr</sub>	-	26	-	ns
Reverse recovery charge		Q <sub>rr</sub>	-	18	-	nC
Notes:						
1) Repetitive rating: pulse width limited by maximum junction temperature						
2) E <sub>AS</sub> condition: T <sub>J</sub> =25°C, V <sub>DD</sub> =20V, V <sub>G</sub> =10V, L=0.5mH, R <sub>G</sub> =25Ω						
3) I <sub>SD</sub> ≤I <sub>MAX</sub> , di/dt=100A/μs, V <sub>DD</sub> ≤BV <sub>DSS</sub> , starting T <sub>J</sub> =25°C						
4) Pulse test: pulse width ≤300μs, duty cycle ≤2%						

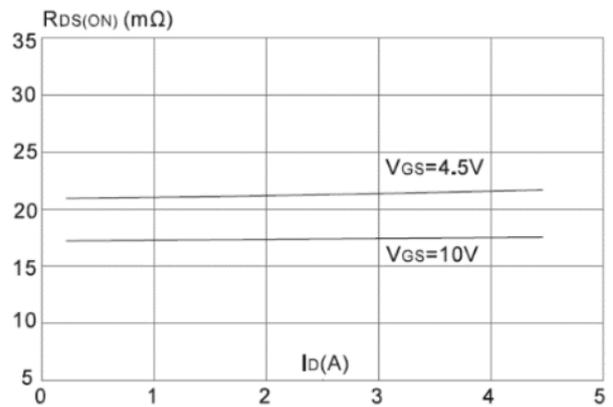
**N-channel**

**Typical characteristics**

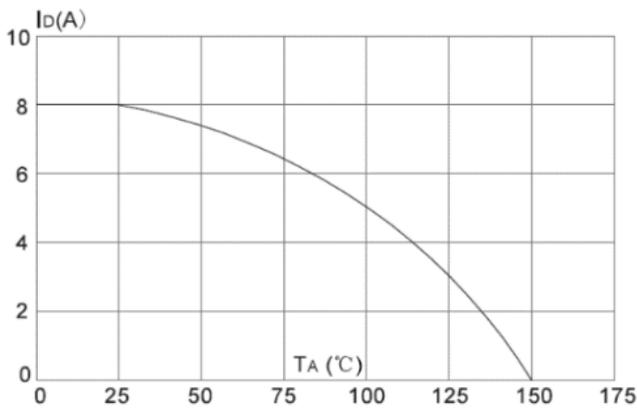
**Output characteristics**



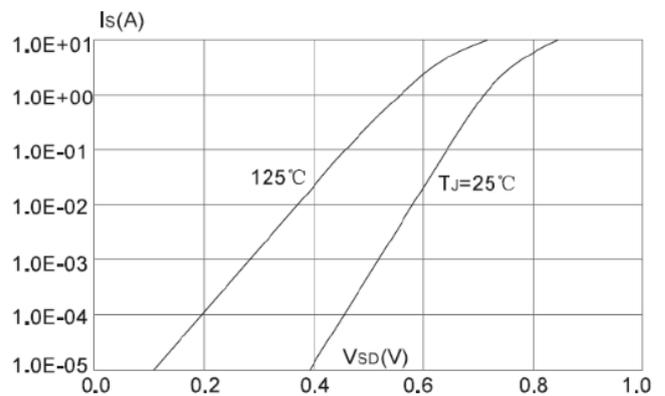
**On-resistance vs. drain current and gate voltage**



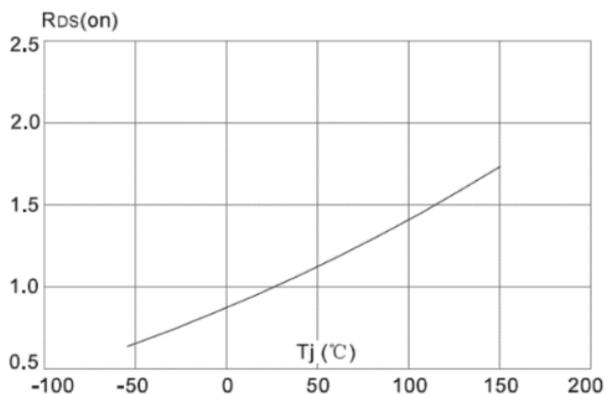
**Maximum continuous drain current vs. ambient temperature**



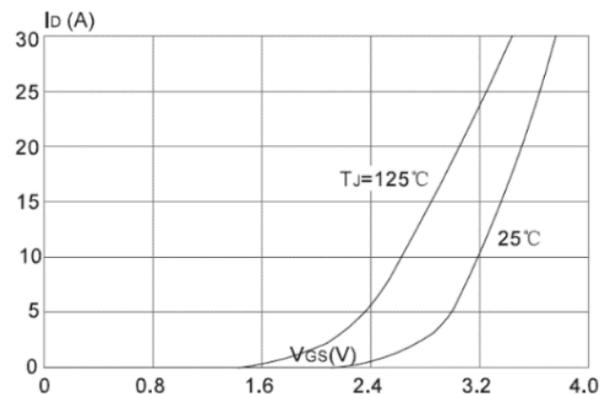
**Body-diode characteristics**

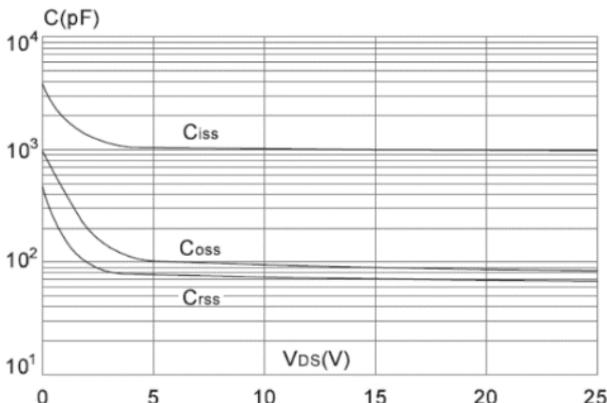
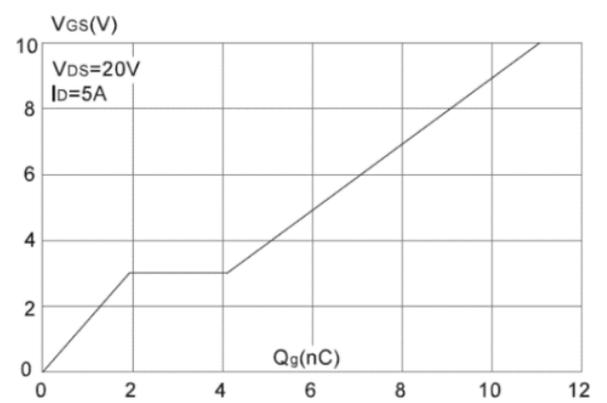
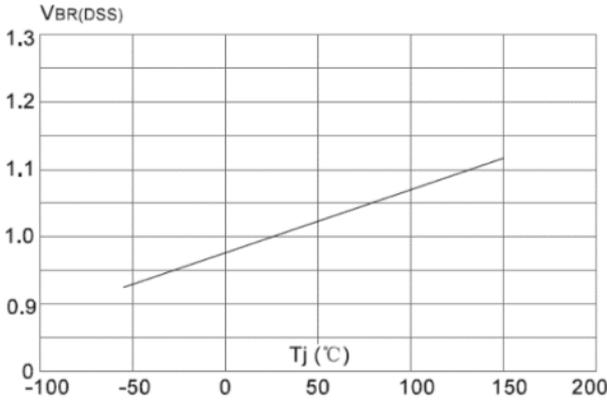
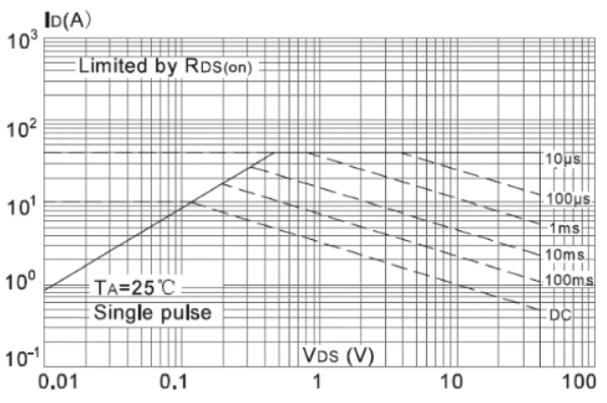


**ON resistance vs. junction temperature**



**Transfer characteristics**

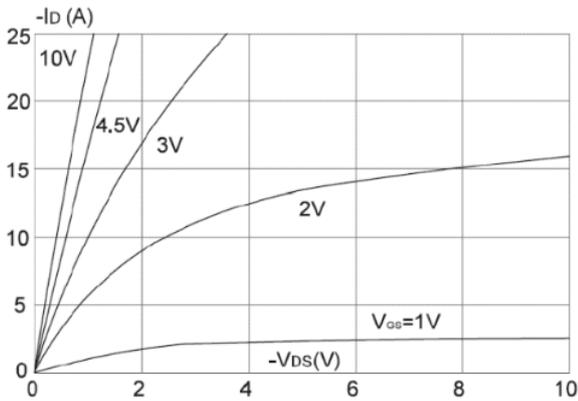


<b>N-channel</b>	
<b>Typical characteristics</b>	
<b>Capacitance characteristics</b>	<b>Gate-charge characteristics</b>
 <p>A graph showing capacitance characteristics. The y-axis is Capacitance C (pF) on a logarithmic scale from 10<sup>1</sup> to 10<sup>4</sup>. The x-axis is Drain-Source Voltage V<sub>DS</sub> (V) from 0 to 25. Three curves are shown: C<sub>iss</sub> (input capacitance), C<sub>oss</sub> (output capacitance), and C<sub>rss</sub> (reverse transfer capacitance). C<sub>iss</sub> starts at ~3000 pF at 0V and levels off at ~1000 pF. C<sub>oss</sub> starts at ~1000 pF at 0V and levels off at ~100 pF. C<sub>rss</sub> starts at ~100 pF at 0V and levels off at ~10 pF.</p>	 <p>A graph showing gate-charge characteristics. The y-axis is Gate-Source Voltage V<sub>GS</sub> (V) from 0 to 10. The x-axis is Gate Charge Q<sub>g</sub> (nC) from 0 to 12. The curve shows a linear increase from (0,0) to (2,3), a constant plateau at V<sub>GS</sub> = 3V from Q<sub>g</sub> = 2 to 4 nC, and then a linear increase to (11,10). Test conditions: V<sub>DS</sub> = 20V, I<sub>D</sub> = 5A.</p>
<b>Breakdown voltage vs. junction temperature</b>	<b>Safe operating area</b>
 <p>A graph showing breakdown voltage V<sub>BR(DSS)</sub> vs. junction temperature T<sub>J</sub> (°C). The y-axis is V<sub>BR(DSS)</sub> from 0 to 1.3. The x-axis is T<sub>J</sub> (°C) from -100 to 200. The curve shows a linear increase from ~0.93V at -50°C to ~1.12V at 150°C.</p>	 <p>A graph showing the safe operating area (SOA). The y-axis is Drain Current I<sub>D</sub> (A) on a logarithmic scale from 10<sup>-1</sup> to 10<sup>3</sup>. The x-axis is Drain-Source Voltage V<sub>DS</sub> (V) on a logarithmic scale from 0.01 to 100. The graph shows a solid line for DC operation and dashed lines for pulse widths of 10μs, 100μs, 1ms, 10ms, and 100ms. A region is labeled 'Limited by R<sub>DS(on)</sub>'. Test conditions: T<sub>A</sub> = 25°C, Single pulse.</p>

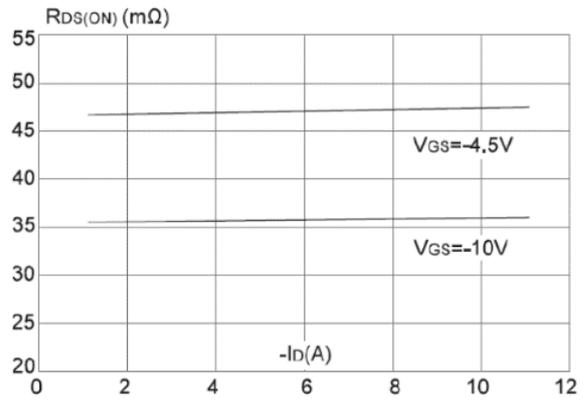
**P-channel**

**Typical characteristics**

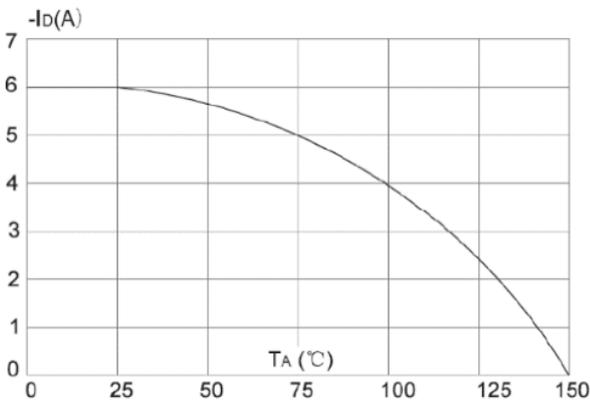
**Output characteristics**



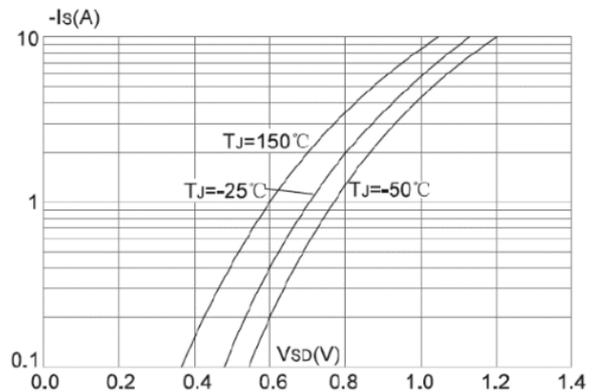
**On-resistance vs. drain current and gate voltage**



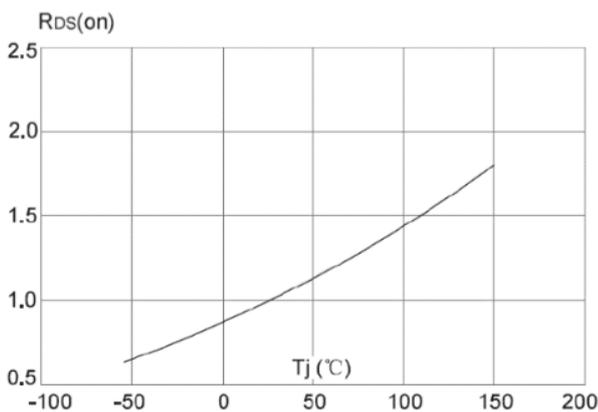
**Maximum continuous drain current vs. ambient temperature**



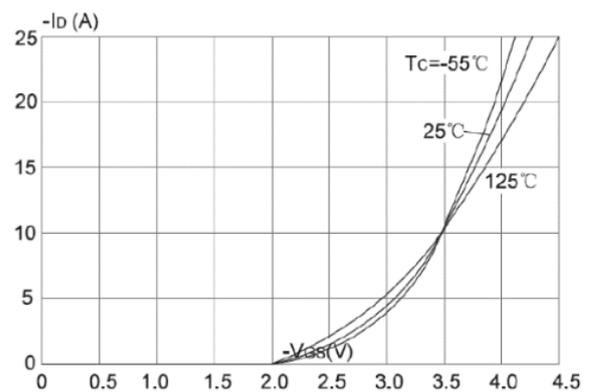
**Body-diode characteristics**

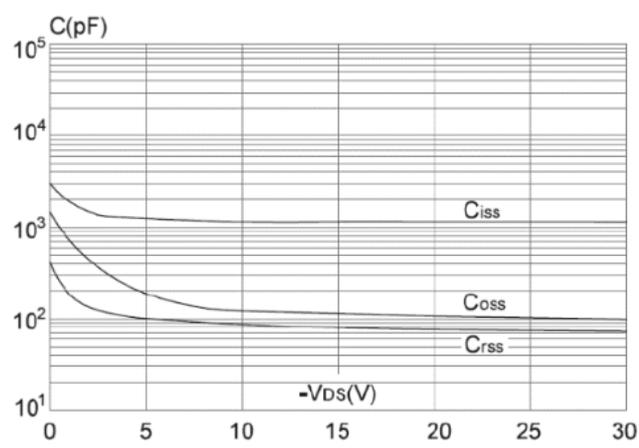
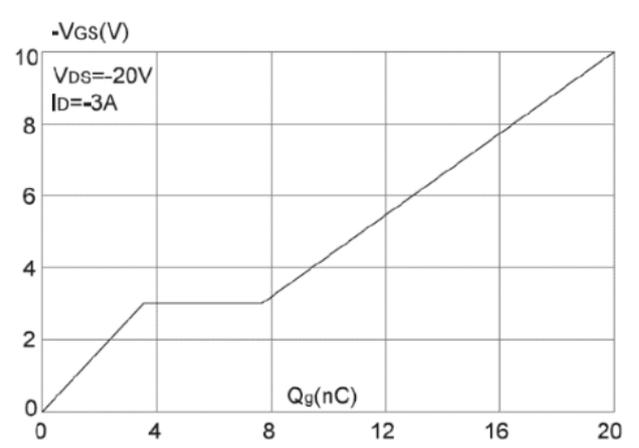
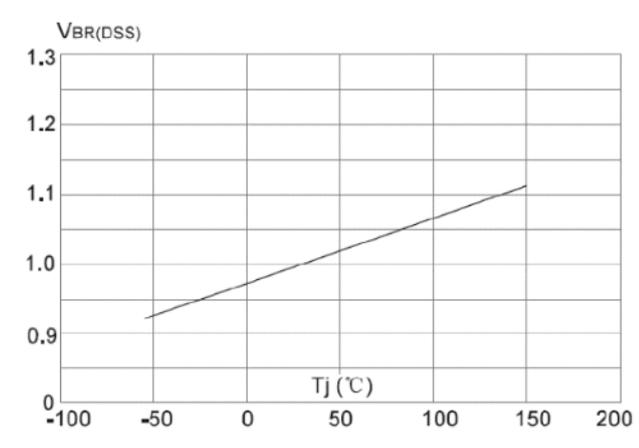
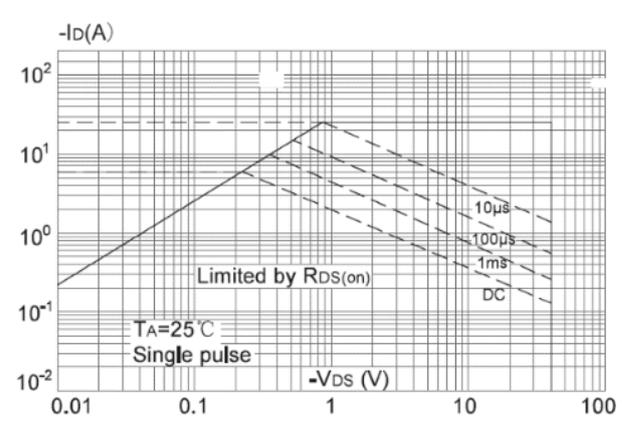


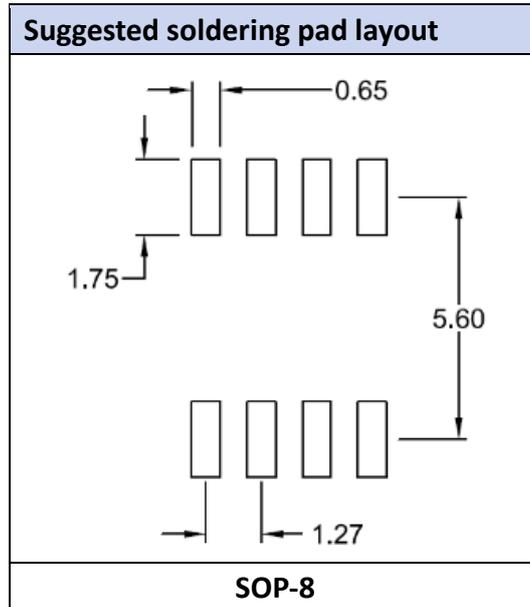
**ON resistance vs. junction temperature**



**Transfer characteristics**



P-channel	
Typical characteristics	
Capacitance characteristics	Gate-charge characteristics
 <p>Capacitance characteristics graph showing <math>C_{iss}</math>, <math>C_{oss}</math>, and <math>C_{rss}</math> (pF) versus <math>-V_{ds}</math> (V). The y-axis is logarithmic from <math>10^1</math> to <math>10^5</math>. The x-axis is linear from 0 to 30V.</p>	 <p>Gate-charge characteristics graph showing <math>-V_{gs}</math> (V) versus <math>Q_g</math> (nC). Conditions: <math>V_{ds} = -20V</math>, <math>I_d = -3A</math>. The y-axis is linear from 0 to 10V. The x-axis is linear from 0 to 20nC.</p>
Breakdown voltage vs. junction temperature	Safe operating area
 <p>Breakdown voltage vs. junction temperature graph showing <math>V_{BR(DSS)}</math> versus <math>T_j</math> (°C). The y-axis is linear from 0.9 to 1.3V. The x-axis is linear from -100 to 200°C.</p>	 <p>Safe operating area graph showing <math>-I_d</math> (A) versus <math>-V_{ds}</math> (V). The y-axis is logarithmic from <math>10^{-2}</math> to <math>10^2</math>. The x-axis is logarithmic from 0.01 to 100V. Curves are shown for 10<math>\mu</math>s, 100<math>\mu</math>s, 1ms, and DC. Limited by <math>R_{DS(on)}</math>. <math>T_A = 25^\circ C</math>, Single pulse.</p>



Ordering information			
Part Number	Package	Shipping Quantity	Dimensions
GAKSH4402-S8	SOP-8	4000 pcs / tape & reel	---

## Disclaimer

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