S4603

N-channel SiC power MOSFET bare die

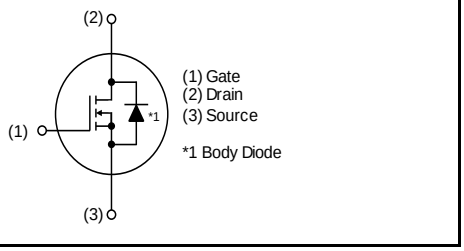
Datasheet

V_{DSS}	1200V
$R_{DS(on)}$ (Typ.)	36mΩ
I_D *1	43A

● Features

1) Low on-resistance
2) Fast switching speed
3) Fast reverse recovery
4) Easy to parallel
5) Simple to drive

●Inner circuit



● Application

- Solar inverters
- DC/DC converters
- Switch mode power supplies
- Induction heating
- Motor drives

●Absolute maximum ratings (T_{vj} = 25°C unless otherwise specified)

Parameter			Symbol	Value	Unit
Drain - source voltage			V_{DSS}	1200	V
Continuous drain and source current	$V_{GS} = V_{GS\_on}$	T_c = 25°C	I_D, I_S *1	43	A
		T_c = 100°C		30	A
Pulsed drain current	$V_{GS} = V_{GS\_on}$	T_c = 25°C	$I_{D,pulse}$ *2	84	A
Body diode pulsed forward current		V_{GS} = 0 V, T_c = 25°C	$I_{S,pulse}$ *1,*3	43	A
Body diode surge forward current			$I_{S,pulse}$ *1,*4	84	A
Gate - source voltage (DC)			V_{GSS}	-4 to +21	V
Gate - source surge voltage (t_{surge} < 300ns)			V_{GSS_surge} *5	-4 to +23	V
Recommended turn-on gate - source drive voltage			V_{GS_on} *6	+15 to +18	V
Recommended turn-off gate - source drive voltage			V_{GS_off}	0	V
Virtual junction temperature			T_{vj}	175	°C
Range of storage temperature			T_{stg}	-40 to +175	°C

●**Electrical characteristics** (T_{vj} = 25°C unless otherwise specified)

Parameter	Symbol	Conditions	Values			Unit
			Min.	Typ.	Max.	
Drain - Source breakdown voltage	$V_{(BR)DSS}$	V_{GS} = 0 V, I_D = 9.2mA T_{vj} = 25°C	1200	-	-	V
Zero Gate voltage Drain current	I_{DSS}	V_{GS} = 0 V, V_{DS} =1200V T_{vj} = 25°C T_{vj} = 150°C	- -	1 10	80 -	μA
Gate - Source leakage current	I_{GSS+}	V_{GS} = +21V , V_{DS} = 0V	-	-	100	nA
Gate - Source leakage current	I_{GSS-}	V_{GS} = -4V , V_{DS} = 0V	-	-	-100	nA
Gate threshold voltage	$V_{GS\ (th)}$ *7	V_{DS} = 10V, I_D = 11.1mA	2.8	-	4.8	V
Static Drain - Source on - state resistance	$R_{DS(on)}$ *8	V_{GS} = 18V, I_D = 21A T_{vj} = 25°C T_{vj} = 150°C	- -	36 72	45 -	mΩ
Gate input resistance	R_G	f = 1MHz, open drain	-	1	-	Ω

●**Electrical characteristics** (T_{vj} = 25°C unless otherwise specified)

Parameter	Symbol	Conditions	Values			Unit
			Min.	Typ.	Max.	
Transconductance	g_{fs} *8	V_{DS} = 10V, I_D = 21A	-	14	-	S
Input capacitance	C_{iss}	V_{GS} = 0V V_{DS} = 800V f = 1MHz	-	2335	-	pF
Output capacitance	C_{oss}		-	70	-	
Reverse transfer capacitance	C_{rss}		-	5	-	
Effective output capacitance, energy related	$C_{o(er)}$	V_{GS} = 0V V_{DS} = 0V to 800V	-	84	-	pF
Total Gate charge	Q_g *8	V_{DS} = 800V I_D = 21A V_{GS} = 18V See Fig. 1-1, 1-2.	-	91	-	nC
Gate - Source charge	Q_{gs} *8		-	20	-	
Gate - Drain charge	Q_{gd} *8		-	24	-	
Turn - on delay time	$t_{d(on)}$ *8	V_{DS} = 800V I_D = 21A V_{GS} = +18V / 0V R_G = 3.3Ω, L = 250μH E_{on} includes diode reverse recovery L_σ = 50nH, C_σ = 10pF See Fig. 2-1, 2-2, 2-3.	-	8.1	-	ns
Rise time	t_r *8		-	15	-	
Turn - off delay time	$t_{d(off)}$ *8		-	29	-	
Fall time	t_f *8		-	9.6	-	
Turn - on switching loss	E_{on} *8		-	239	-	μJ
Turn - off switching loss	E_{off} *8		-	26	-	

●**Body diode electrical characteristics** (Source-Drain) (T_{vj} = 25°C unless otherwise specified)

Parameter	Symbol	Conditions	Values			Unit
			Min.	Typ.	Max.	
Forward voltage	V_{SD} *8	V_{GS} = 0V, I_D = 21A	-	3.3	-	V
Reverse recovery time	t_{rr} *8	I_F = 21A V_R = 800V di/dt = 3700A/μs L_σ = 50nH, C_σ = 10pF See Fig. 3-1, 3-2.	-	9.2	-	ns
Reverse recovery charge	Q_{rr} *8		-	140	-	nC
Peak reverse recovery current	I_{rrm} *8		-	31	-	A

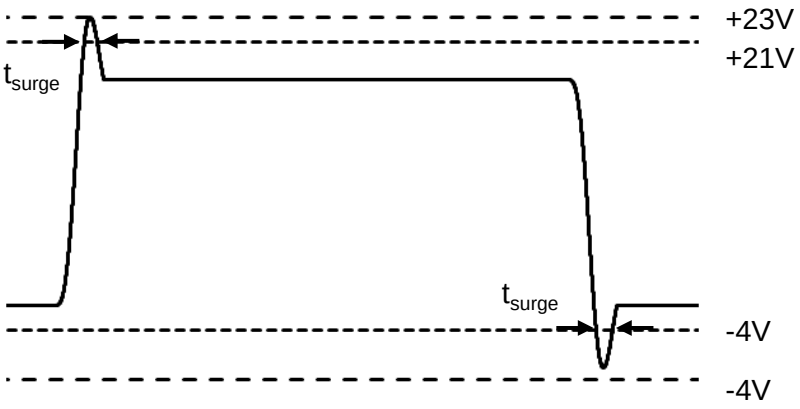
*1 Limited by maximum T_{vj} and assumes R_{thJC} < 0.85K/W. The value is based on TO-247 package.

*2 Pulse width and duty cycle are limited by $T_{vj,max}$. The value is based on TO-247 package.

*3 Only for body-diode, Repititive pulse, PW ≤ 1.5μs, Duty cycle ≤ 5%

*4 When used as a protective function, PW ≤ 10μs

*5 Example of acceptable V_{GS} waveform



Please note especially when using driver source that V_{GSS_surge} must be in the range of absolute maximum rating.

*6 Please be advised not to use SiC-MOSFETs with V_{GS} below 10V as doing so may cause thermal runaway.

*7 Tested after applying V_{GS} = 21V for 100ms.

*8 Pulsed

●Electrical characteristic curves

Fig.1 T_{vj} = 25ºC Typical Output Characteristics(I)

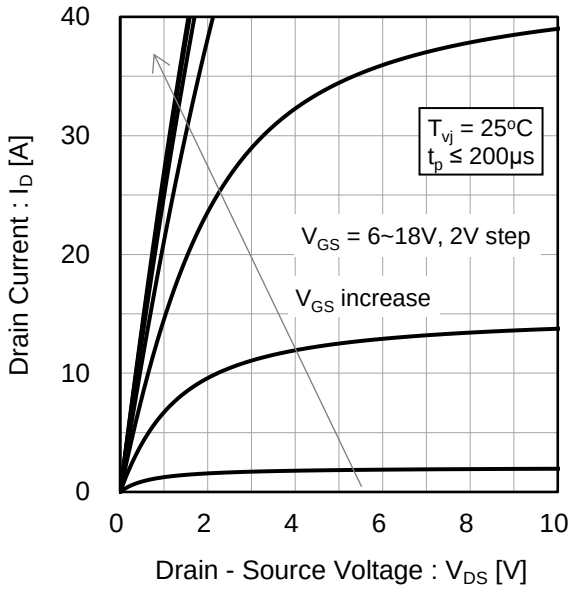


Fig.2 T_{vj} = 25ºC Typical Output Characteristics(II)

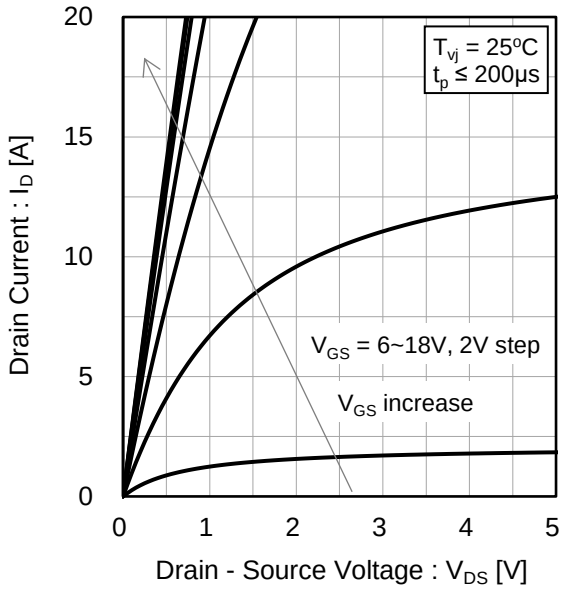
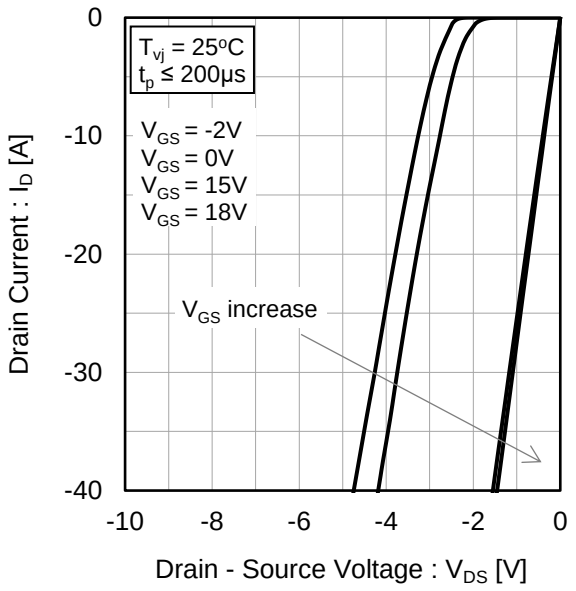


Fig.3 T_{vj} = 25ºC 3rd Quadrant Characteristics



●Electrical characteristic curves

Fig.4 T_{vj} = 150ºC Typical Output Characteristics(I)

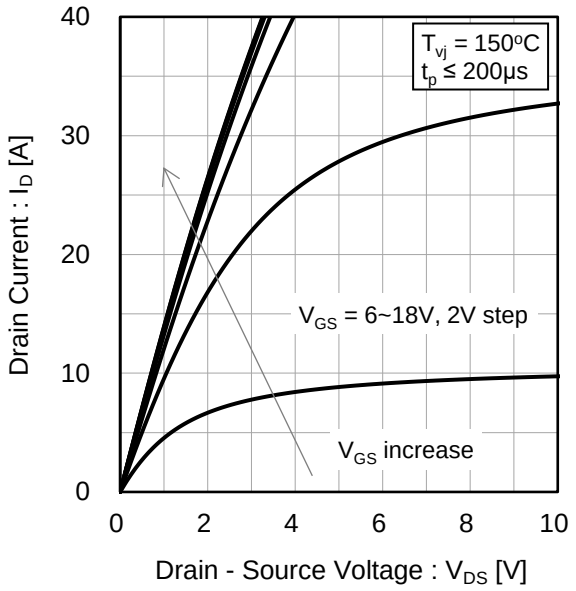


Fig.5 T_{vj} = 150ºC Typical Output Characteristics(II)

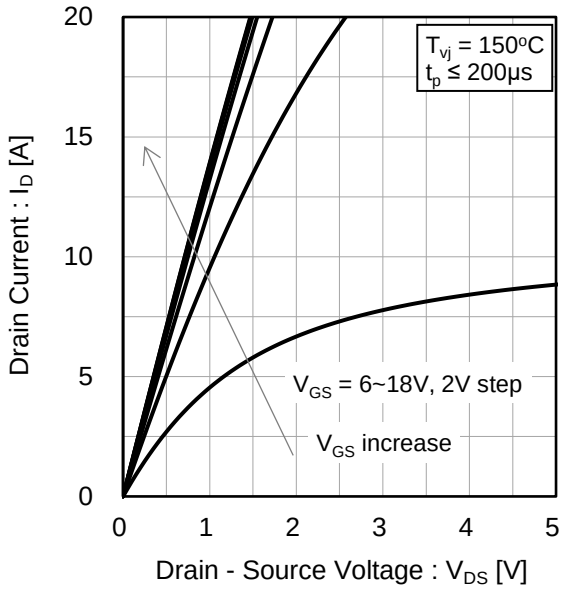


Fig.6 T_{vj} = 150ºC 3rd Quadrant Characteristics

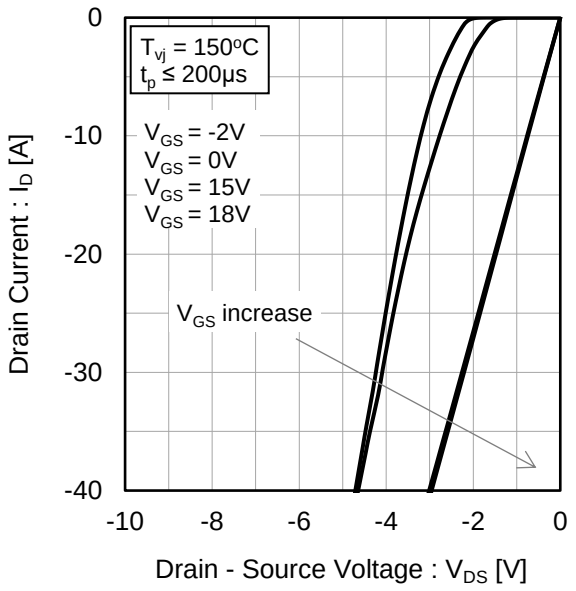
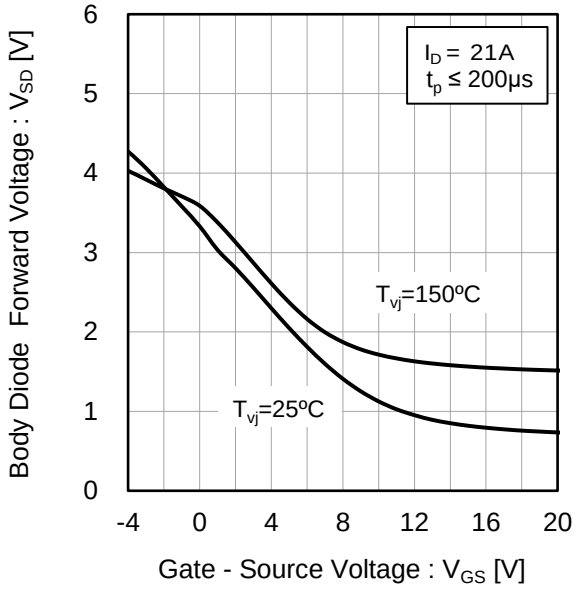


Fig.7 Body Diode Forward Voltage vs. Gate - Source Voltage



●Electrical characteristic curves

Fig.8 Typical Transfer Characteristics (I)

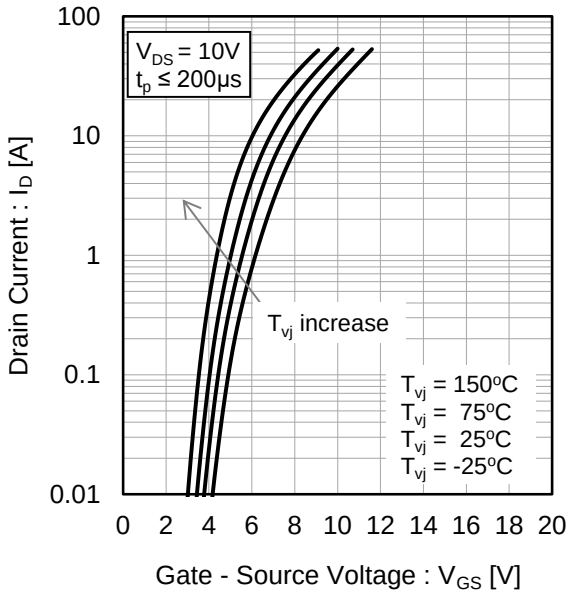


Fig.9 Typical Transfer Characteristics (II)

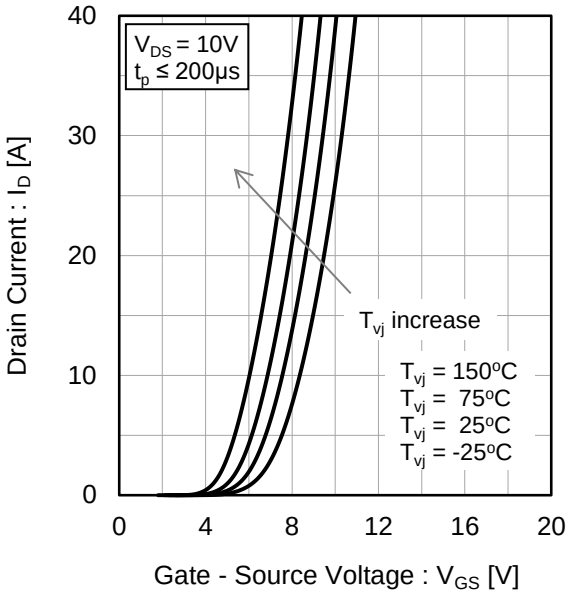


Fig.10 Gate Threshold Voltage vs. Junction Temperature

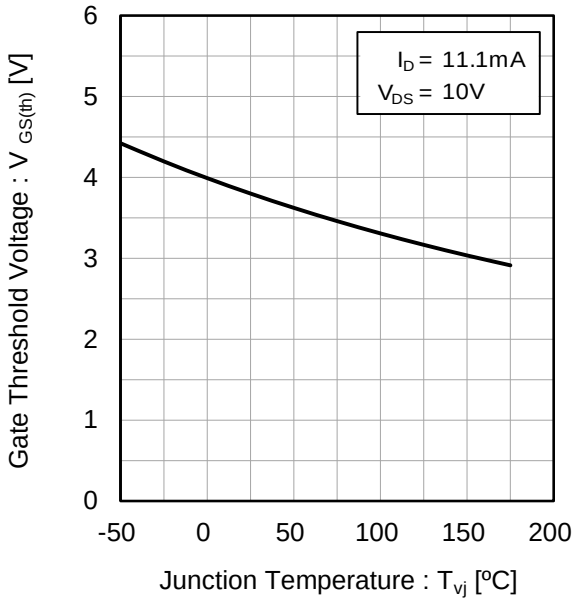
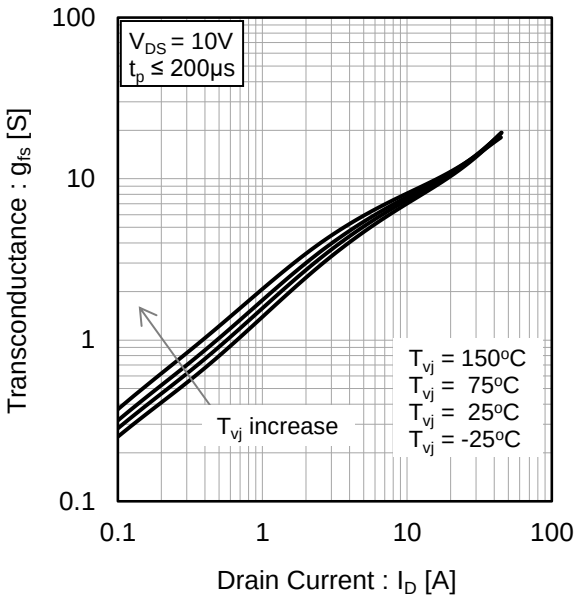


Fig.11 Transconductance vs. Drain Current



●Electrical characteristic curves

Fig.12 Static Drain - Source On - State Resistance vs. Gate - Source Voltage

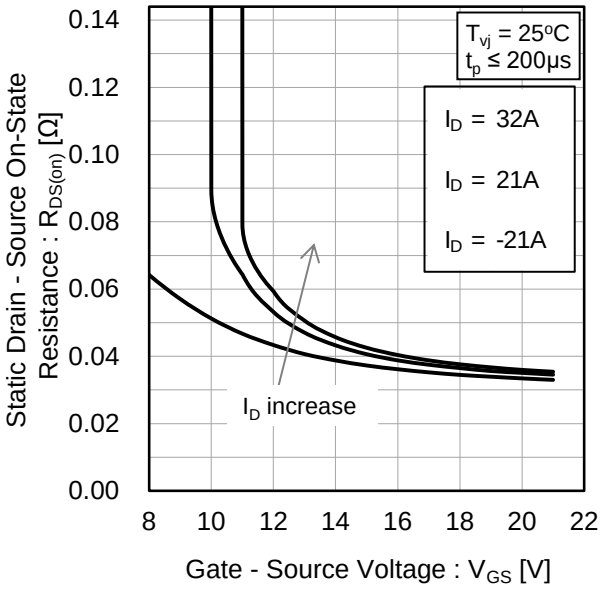


Fig.13 Static Drain - Source On - State Resistance vs. Junction Temperature

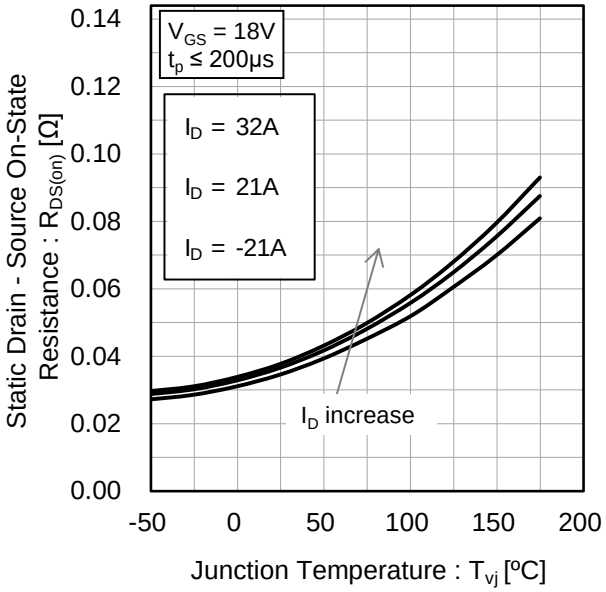


Fig.14 Static Drain - Source On - State Resistance vs. Drain Current

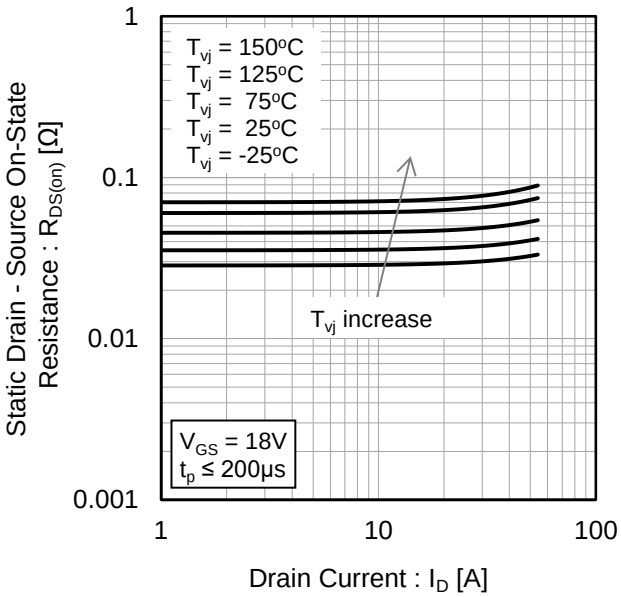
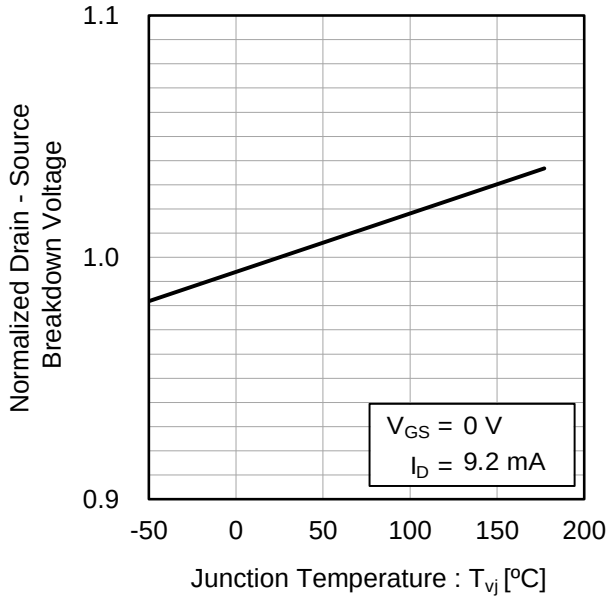


Fig.15 Normalized Drain - Source Breakdown Voltage vs. Junction Temperature



●Electrical characteristic curves

Fig.16 Typical Capacitance vs. Drain - Source Voltage

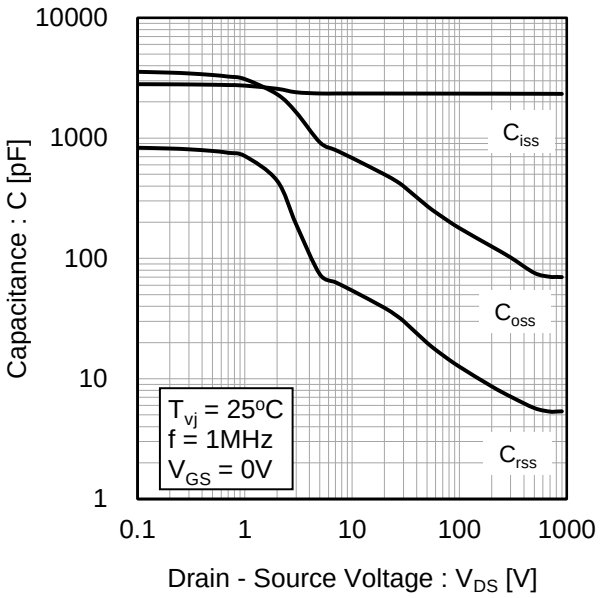


Fig.17 C_{oss} Stored Energy

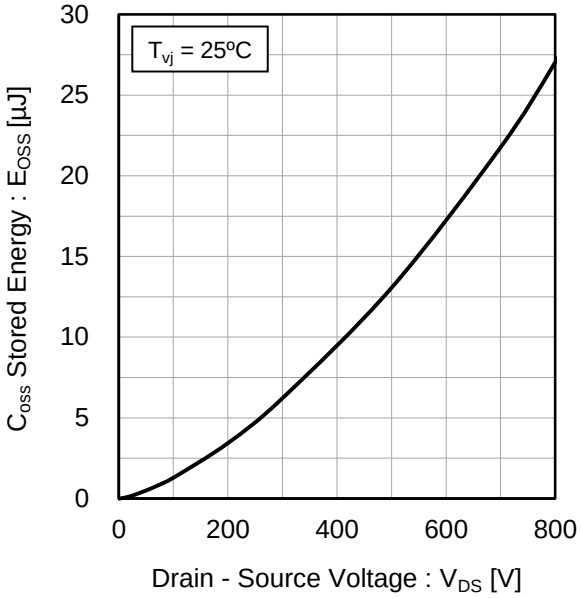
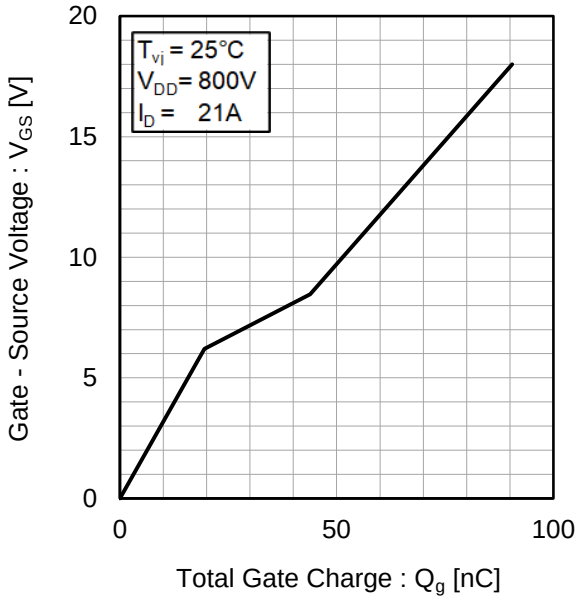


Fig.18 Dynamic Input Characteristics



●Electrical characteristic curves

Fig.19 Typical Switching Time vs. External Gate Resistance

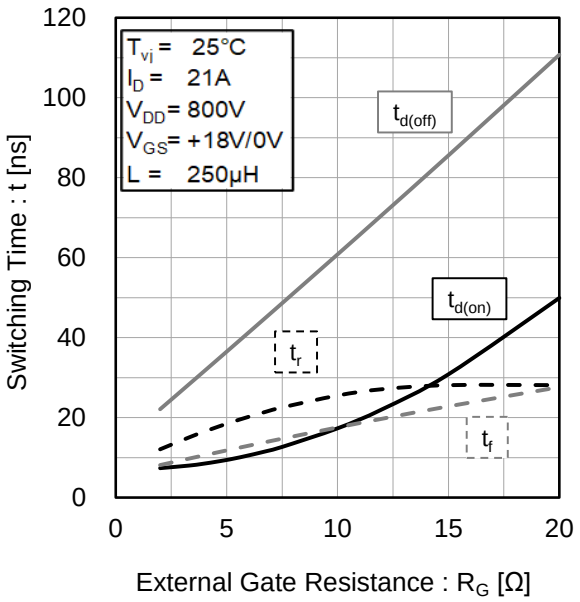


Fig.20 Typical Switching Loss vs. Drain - Source Voltage

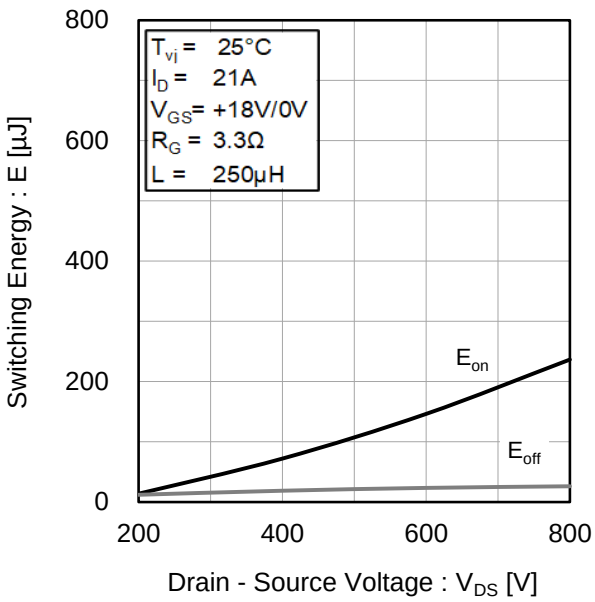


Fig.21 Typical Switching Loss vs. Drain Current

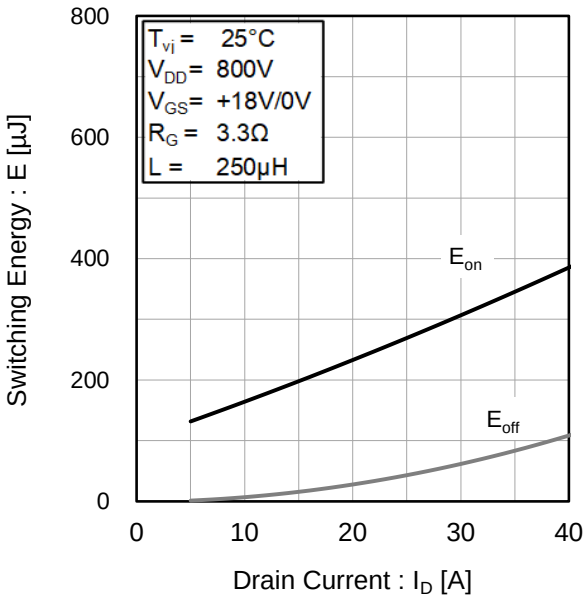
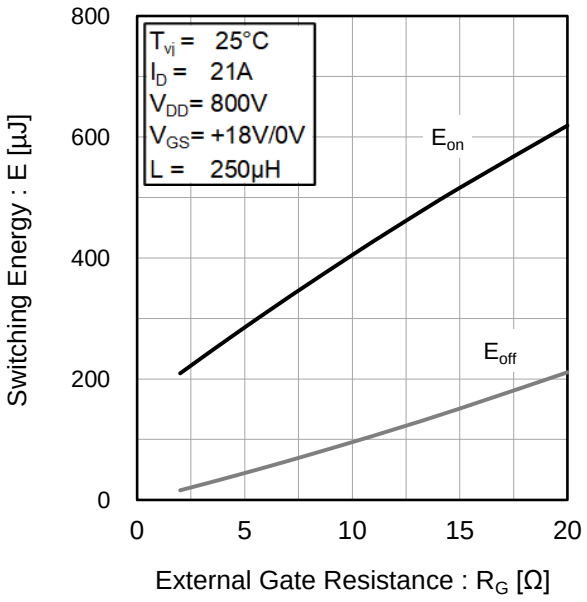


Fig.22 Typical Switching Loss vs. External Gate Resistance



●Measurement circuits and waveforms

Fig.1-1 Gate Charge Measurement Circuit

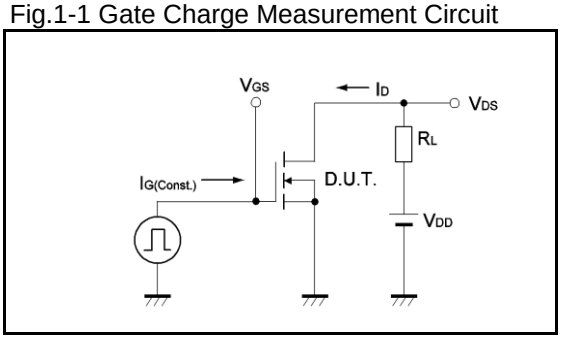


Fig.1-2 Gate Charge Waveform

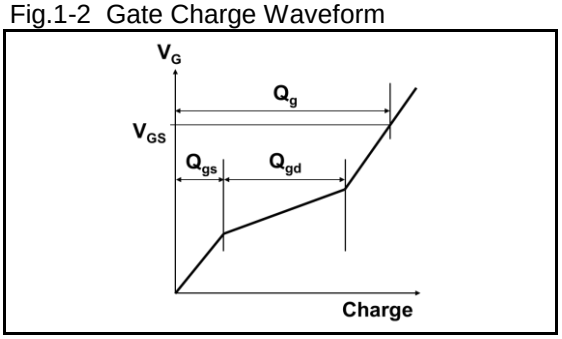


Fig.2-1 Switching Characteristics Measurement Circuit

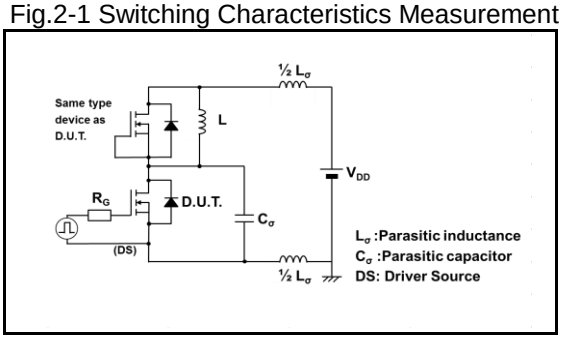


Fig.2-2 Waveforms for Switching Time

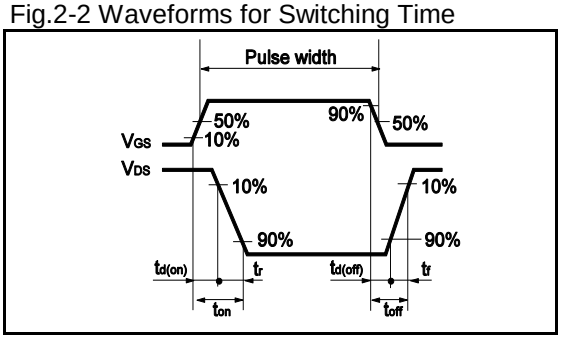


Fig.2-3 Waveforms for Switching Energy Loss

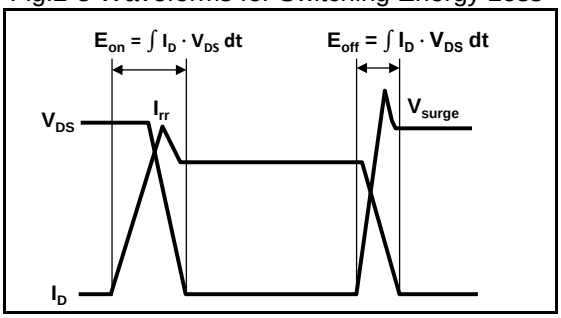


Fig.3-1 Reverse Recovery Time Measurement Circuit

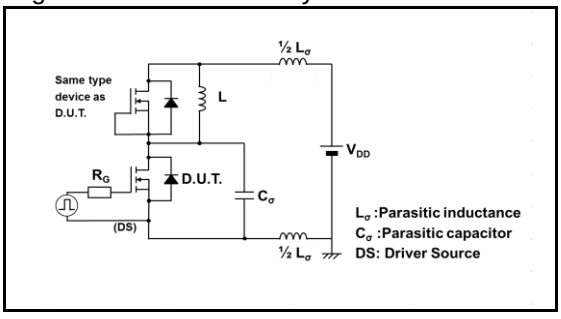
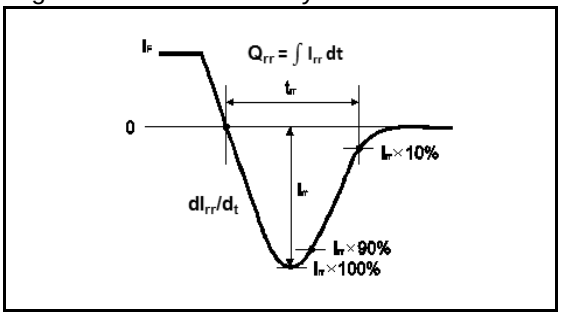


Fig.3-2 Reverse Recovery Waveform

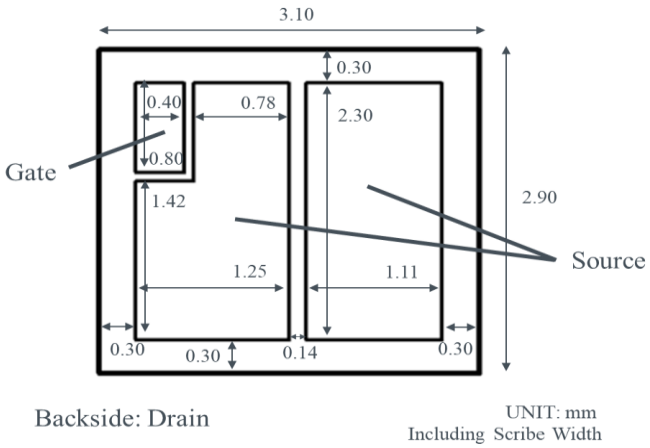


●Mechanical Parameters

Die Size	3.10 mm x 2.90 mm (Including Scribe Width)
Thickness	150 ± 15 µm
Source Pad Size	See Pad Layout.
Gate Pad Size	0.40 mm x 0.80 mm

Wafer Size	150 mm
Topside Metallization	AlCu
Backside Metallization	Ti-Ni(1.2µm)-Au(0.07µm)
Passivation	Polyimide

●Pad Layout



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