

Symbol	Tr1:Pch	Tr2:Nch
V_{DSS}	-30V	30V
$R_{DS(on)}(Max.)$	80mΩ	35mΩ
I_D	±5.5A	±7.0A
P_D	4.0W	

●Features

- 1) Low on - resistance
- 2) Small Surface Mount Package
- 3) Pb-free plating ; RoHS compliant
- 4) Halogen Free

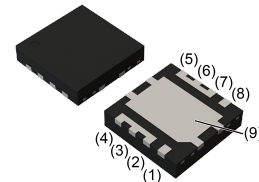
●Application

Switching
Motor Drive

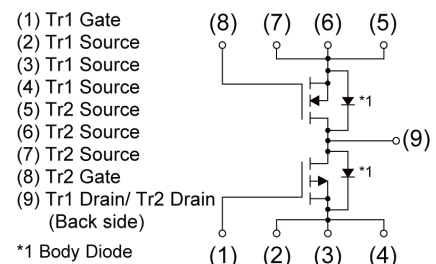
●Outline

DFN3333-9DC

HSML3333L9



●Inner circuit



●Packaging specifications

Type	Packing	Embossed Tape
	Reel size (mm)	180
	Tape width (mm)	12
	Quantity (pcs)	1000
	Taping code	TCR1
	Marking	HS8MA2

●Absolute maximum ratings ($T_a = 25^\circ\text{C}$,unless otherwise specified)

Parameter		Symbol	Value		Unit
			Tr1:Pch	Tr2:Nch	
Drain - Source voltage		V _{DSS}	-30	30	V
Continuous drain current		I _D ^{*1}	±5.5	±7.0	A
Pulsed drain current		I _{DP} ^{*2}	±30	±30	A
Gate - Source voltage		V _{GSS}	±20	±20	V
Power dissipation	total	P _D ^{*1}	4.0		W
		P _D ^{*3}	2.0		
Junction temperature		T _j	150		°C
Operating junction and storage temperature range		T _{stg}	-55 to +150		°C

● Thermal resistance

Parameter	Symbol	Values			Unit
		Min.	Typ.	Max.	
Thermal resistance, junction - ambient	R_{thJA}^{*3}	-	-	83.3	°C/W

● Electrical characteristics ($T_a = 25^\circ\text{C}$)

Parameter	Symbol	Type	Conditions	Values			Unit
				Min.	Typ.	Max.	
Drain - Source breakdown voltage	$V_{(BR)DSS}$	Tr1	$V_{GS} = 0V, I_D = -1mA$	-30	-	-	V
		Tr2	$V_{GS} = 0V, I_D = 1mA$	30	-	-	
Breakdown voltage temperature coefficient	$\Delta V_{(BR)DSS}$	Tr1	$I_D = -1mA$, referenced to 25°C	-	-22	-	mV/°C
	ΔT_j	Tr2	$I_D = 1mA$, referenced to 25°C	-	21	-	
Zero gate voltage drain current	I_{DSS}	Tr1	$V_{DS} = -30V, V_{GS} = 0V$	-	-	-1	μA
		Tr2	$V_{DS} = 30V, V_{GS} = 0V$	-	-	1	
Gate - Source leakage current	I_{GSS}	Tr1	$V_{GS} = \pm 20V, V_{DS} = 0V$	-	-	± 100	nA
		Tr2	$V_{GS} = \pm 20V, V_{DS} = 0V$	-	-	± 100	
Gate threshold voltage	$V_{GS(th)}$	Tr1	$V_{DS} = -10V, I_D = -1mA$	-1.0	-	-2.5	V
		Tr2	$V_{DS} = 10V, I_D = 1mA$	1.0	-	2.5	
Gate threshold voltage temperature coefficient	$\Delta V_{GS(th)}$	Tr1	$I_D = -1mA$, referenced to 25°C	-	2.9	-	mV/°C
	ΔT_j	Tr2	$I_D = 1mA$, referenced to 25°C	-	-3	-	
Static drain - source on - state resistance	$R_{DS(on)}^{*4}$	Tr1	$V_{GS} = -10V, I_D = -5.5A$	-	55	80	mΩ
			$V_{GS} = -4.5V, I_D = -5.5A$	-	80	115	
		Tr2	$V_{GS} = 10V, I_D = 7.0A$	-	25	35	
			$V_{GS} = 4.5V, I_D = 7.0A$	-	40	56	
Gate resistance	R_G	Tr1	$f=1MHz$, open drain	-	10	-	Ω
		Tr2		-	3	-	
Forward Transfer Admittance	$ Y_{fs} ^{*4}$	Tr1	$V_{DS} = -5V, I_D = -3A$	1.9	-	-	S
		Tr2	$V_{DS} = 5V, I_D = 4.5A$	1.4	-	-	

*1 $P_w \leq 1s$, Limited only by maximum temperature allowed.

*2 $P_w \leq 10\mu s$, Duty cycle $\leq 1\%$

*3 Mounted on a ceramic board (30×30×0.8mm)

*4 Pulsed

●Electrical characteristics ($T_a = 25^\circ\text{C}$)

<Tr1>

Parameter	Symbol	Conditions	Values			Unit
			Min.	Typ.	Max.	
Input capacitance	C_{iss}	$V_{GS} = 0V$	-	320	-	pF
Output capacitance	C_{oss}	$V_{DS} = -10V$	-	68	-	
Reverse transfer capacitance	C_{rss}	$f = 1\text{MHz}$	-	54	-	
Turn - on delay time	$t_{d(on)}^{*4}$	$V_{DD} \approx -15V, V_{GS} = -10V$	-	7.9	-	ns
Rise time	t_r^{*4}	$I_D = -1.5A$	-	16.8	-	
Turn - off delay time	$t_{d(off)}^{*4}$	$R_L = 10\Omega$	-	27.6	-	
Fall time	t_f^{*4}	$R_G = 10\Omega$	-	8.5	-	

<Tr2>

Parameter	Symbol	Conditions	Values			Unit
			Min.	Typ.	Max.	
Input capacitance	C_{iss}	$V_{GS} = 0V$	-	365	-	pF
Output capacitance	C_{oss}	$V_{DS} = 10V$	-	62	-	
Reverse transfer capacitance	C_{rss}	$f = 1\text{MHz}$	-	50	-	
Turn - on delay time	$t_{d(on)}^{*4}$	$V_{DD} \approx 15V, V_{GS} = 10V$	-	7.2	-	ns
Rise time	t_r^{*4}	$I_D = 2.2A$	-	8.0	-	
Turn - off delay time	$t_{d(off)}^{*4}$	$R_L = 6.8\Omega$	-	12.0	-	
Fall time	t_f^{*4}	$R_G = 10\Omega$	-	5.7	-	

● Gate charge characteristics ($T_a = 25^\circ\text{C}$)

<Tr1>

Parameter	Symbol	Conditions		Values			Unit
				Min.	Typ.	Max.	
Total gate charge	Q_g^{*4}	$V_{DD} \simeq -15V$ $I_D = -3A$	$V_{GS} = -10V$	-	7.8	-	nC
Gate - Source charge	Q_{gs}^{*4}		$V_{GS} = -4.5V$	-	4.3	-	
Gate - Drain charge	Q_{gd}^{*4}			-	1.6	-	
				-	1.5	-	

<Tr2>

Parameter	Symbol	Conditions		Values			Unit
				Min.	Typ.	Max.	
Total gate charge	Q_g^{*4}	$V_{DD} \simeq 15V$ $I_D = 4.5A$	$V_{GS} = 10V$	-	8.4	-	nC
Gate - Source charge	Q_{gs}^{*4}		$V_{GS} = 4.5V$	-	4.7	-	
Gate - Drain charge	Q_{gd}^{*4}			-	1.6	-	

● Body diode electrical characteristics (Source-Drain) ($T_a = 25^\circ\text{C}$)

<Tr1>

Parameter	Symbol	Conditions	Values			Unit
			Min.	Typ.	Max.	
Continuous forward current	I_S	$T_a = 25^\circ\text{C}$	-	-	-1.0	A
Pulse forward current	I_{SP}^{*2}		-	-	-30	
Forward voltage	V_{SD}^{*4}	$V_{GS} = 0\text{V}, I_S = -1.0\text{A}$	-	-	-1.2	V

<Tr2>

Parameter	Symbol	Conditions	Values			Unit
			Min.	Typ.	Max.	
Continuous forward current	I_S	$T_a = 25^\circ\text{C}$	-	-	1.0	A
Pulse forward current	I_{SP}^{*2}		-	-	30	
Forward voltage	V_{SD}^{*4}	$V_{GS} = 0\text{V}, I_S = 1.0\text{A}$	-	-	1.2	V

●Electrical characteristic curves <Tr1>

Fig.1 Power Dissipation Derating Curve

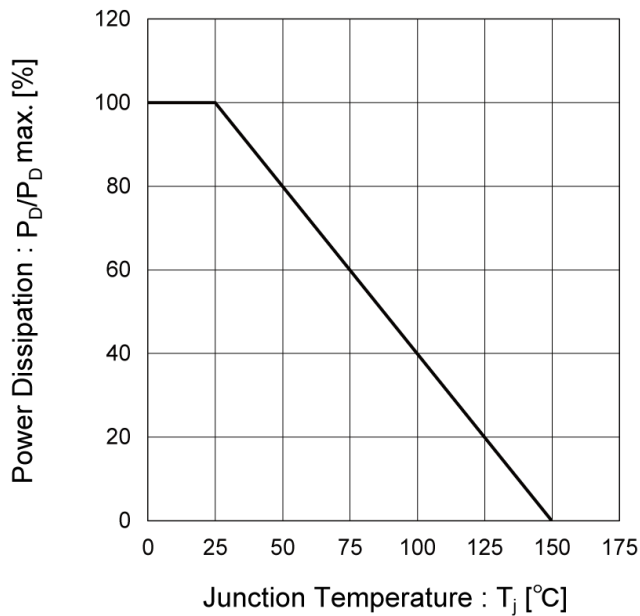


Fig.2 Maximum Safe Operating Area

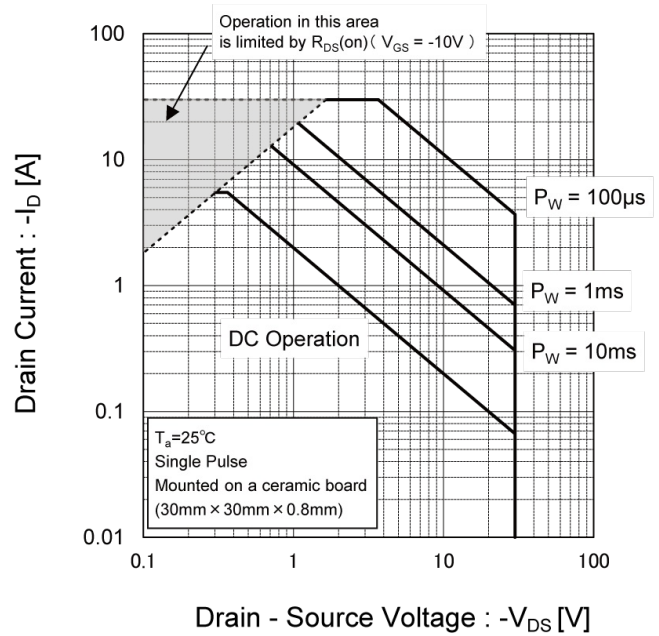


Fig.3 Normalized Transient Thermal Resistance vs. Pulse Width

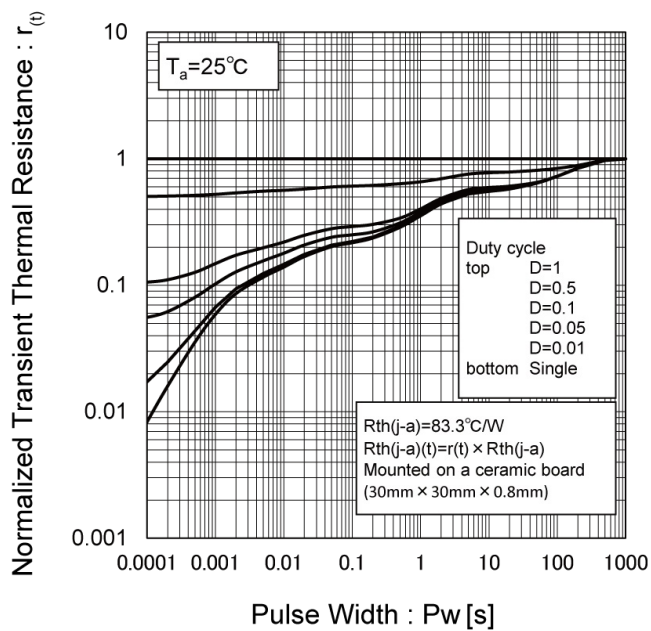
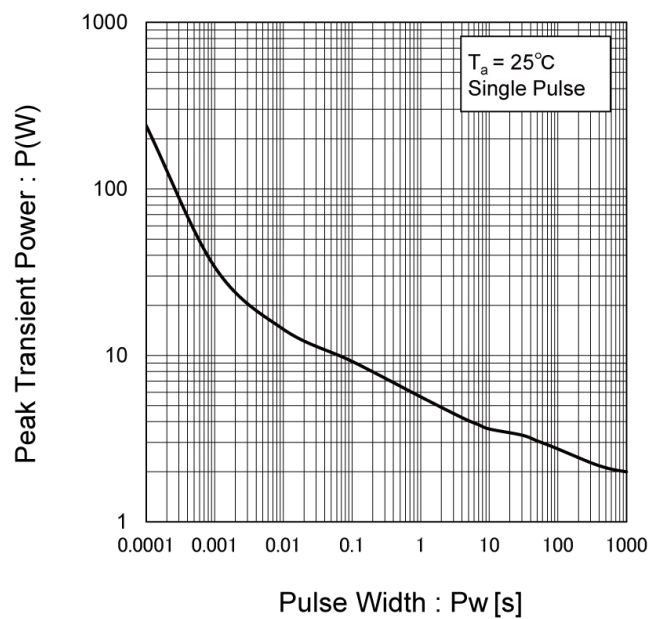


Fig.4 Single Pulse Maximum Power Dissipation



●Electrical characteristic curves <Tr1>

Fig.5 Typical Output Characteristics(I)

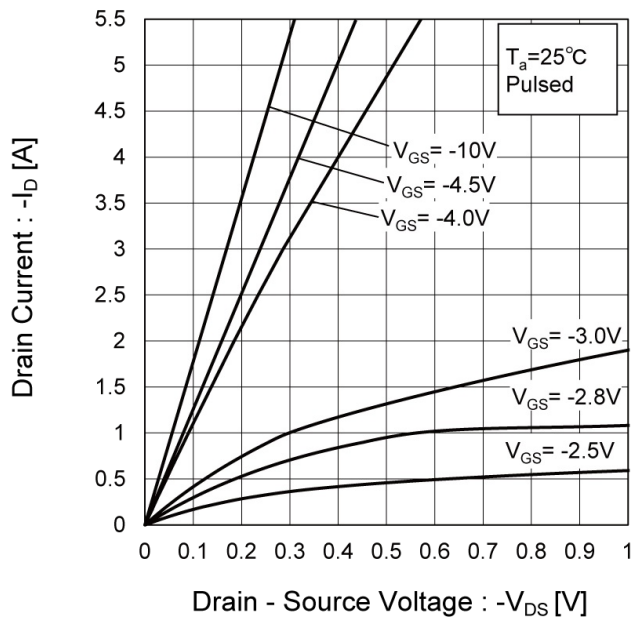


Fig.6 Typical Output Characteristics(II)

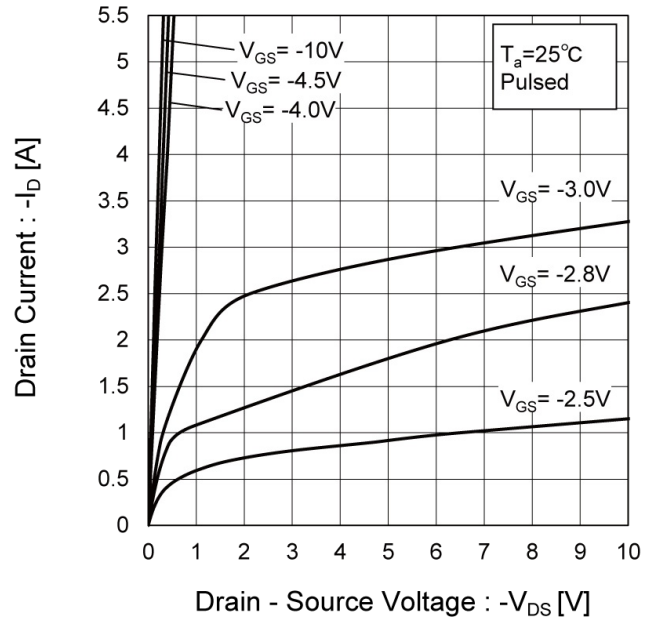
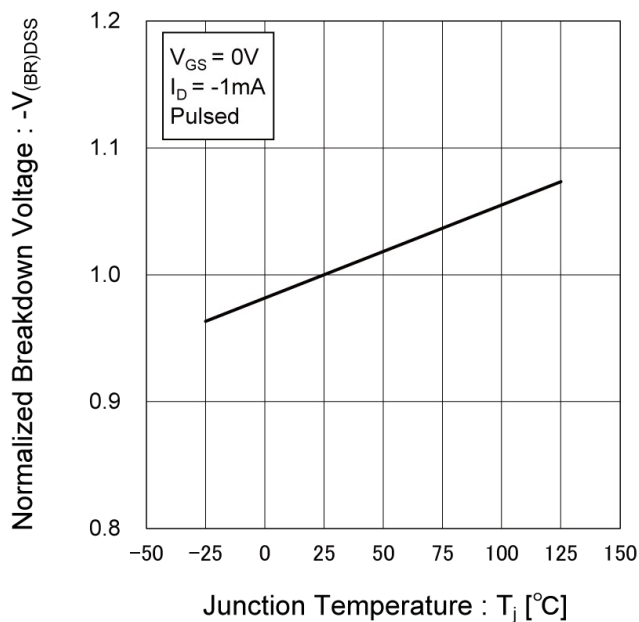


Fig.7 Breakdown Voltage vs. Junction Temperature



●Electrical characteristic curves <Tr1>

Fig.8 Typical Transfer Characteristics

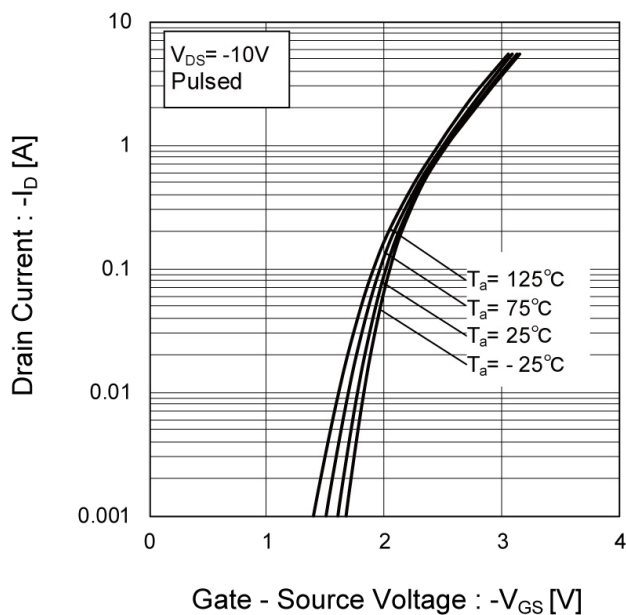


Fig.9 Gate Threshold Voltage vs. Junction Temperature

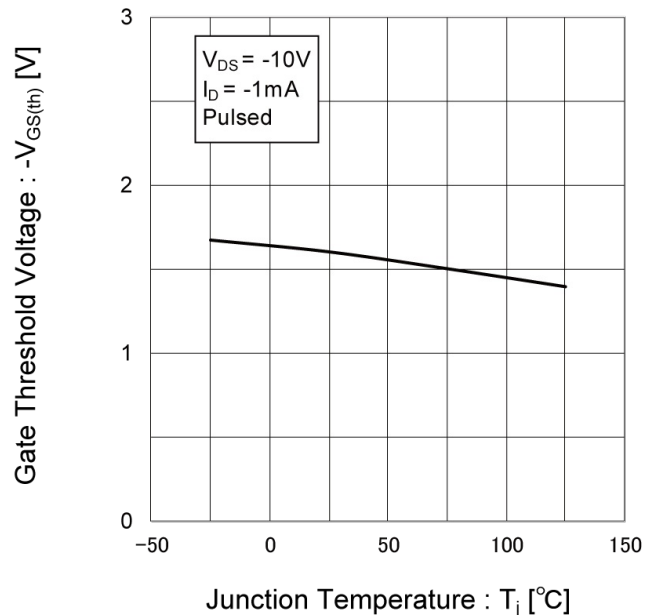
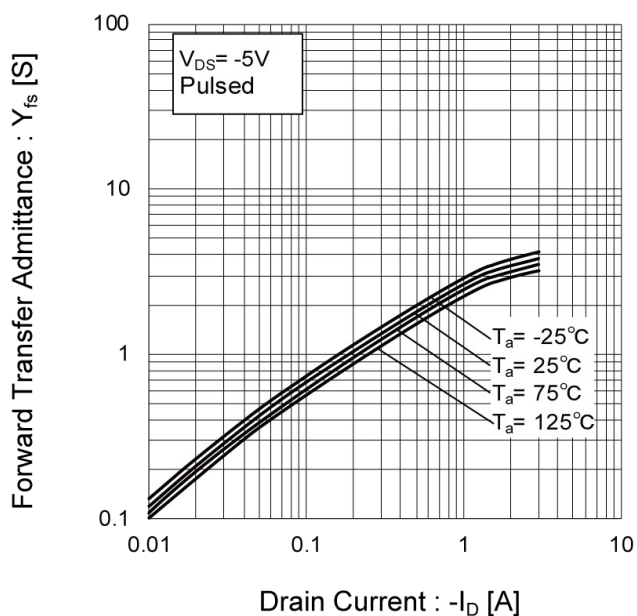


Fig.10 Forward Transfer Admittance vs. Drain Current



●Electrical characteristic curves <Tr1>

Fig.11 Drain Current Derating Curve

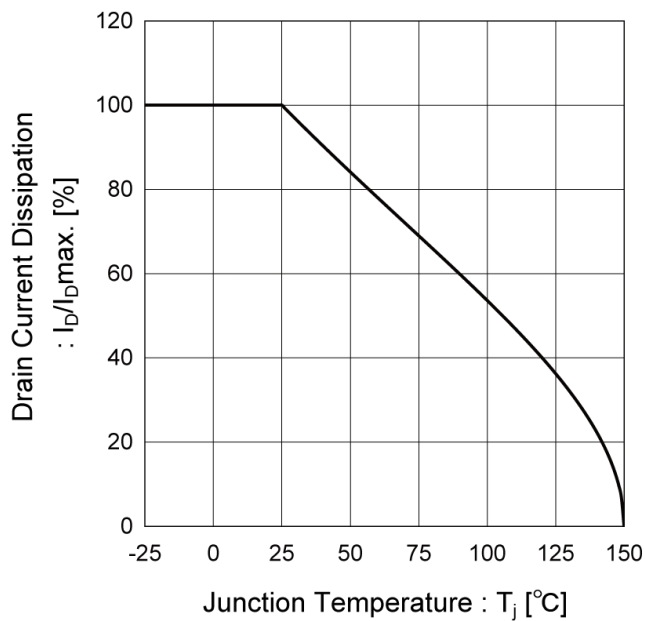


Fig.12 Static Drain - Source On - State Resistance vs. Gate Source Voltage

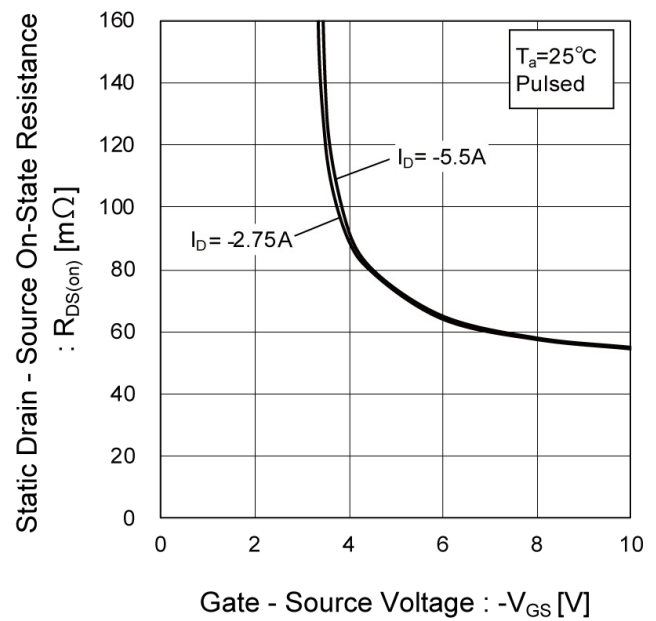
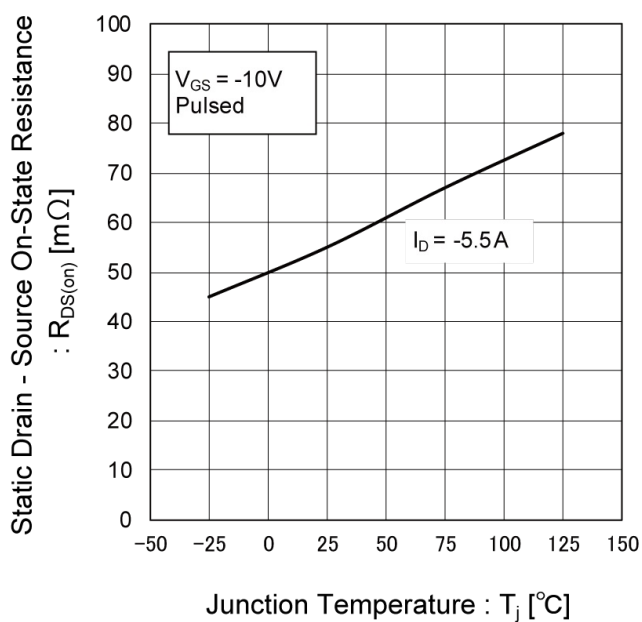


Fig.13 Static Drain - Source On - State Resistance vs. Junction Temperature



●Electrical characteristic curves <Tr1>

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

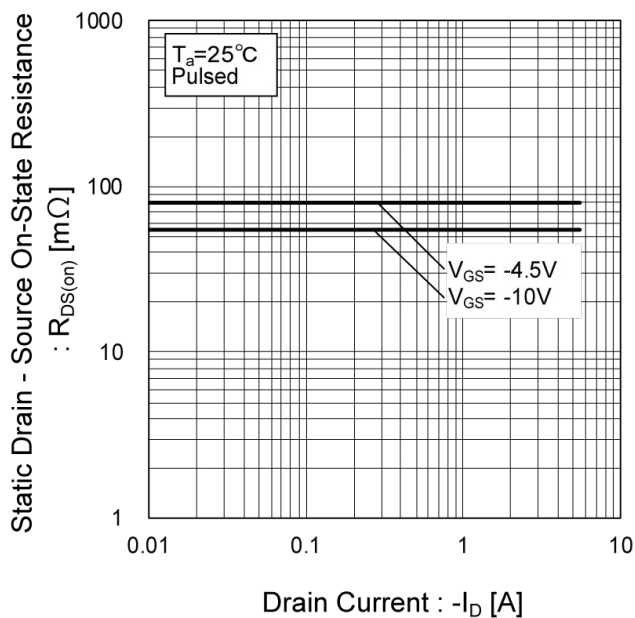


Fig.15 Static Drain - Source On - State
Resistance vs. Drain Current (II)

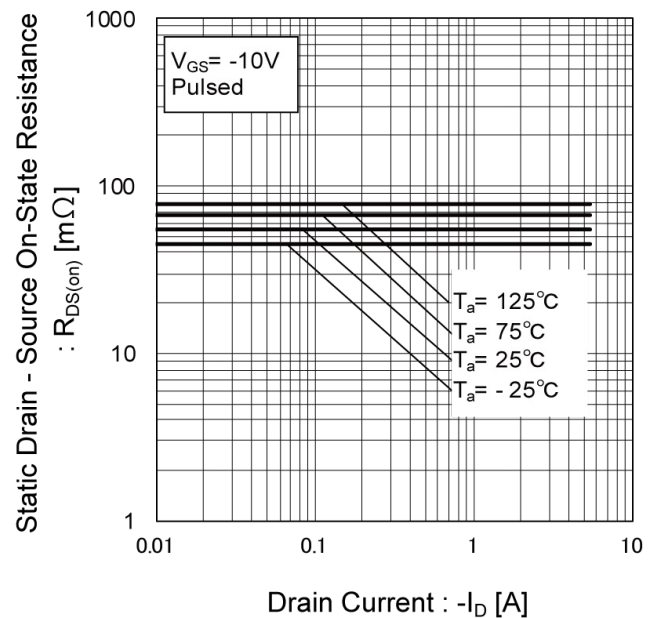
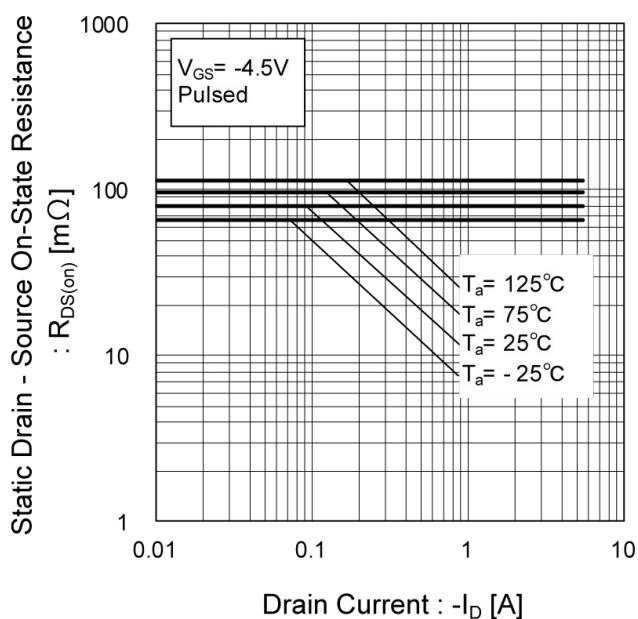


Fig.16 Static Drain - Source On - State
Resistance vs. Drain Current (III)



●Electrical characteristic curves <Tr1>

Fig.17 Typical Capacitances vs.
Drain - Source Voltage

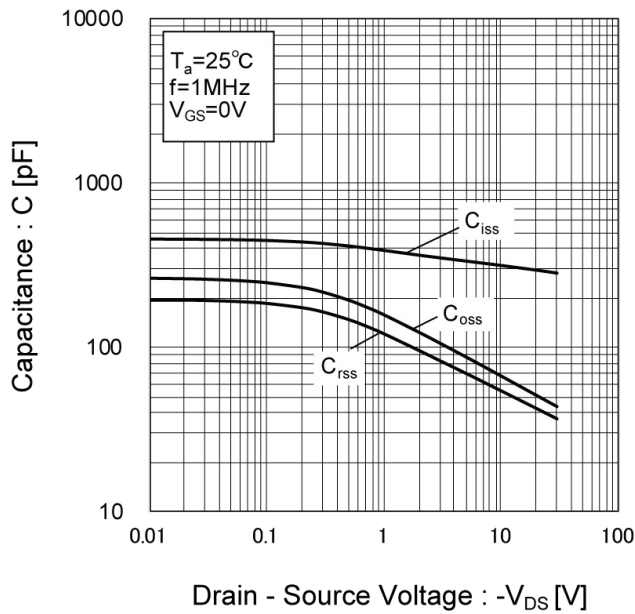


Fig.18 Switching Characteristics

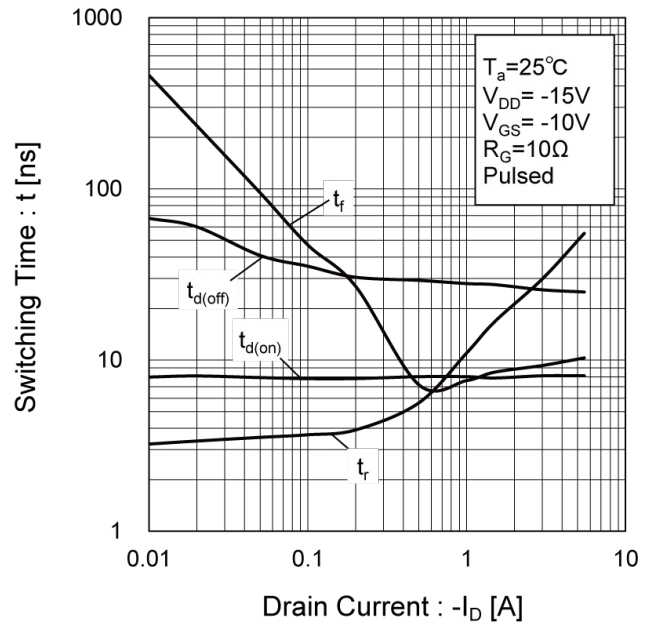


Fig.19 Typical Gate Charge

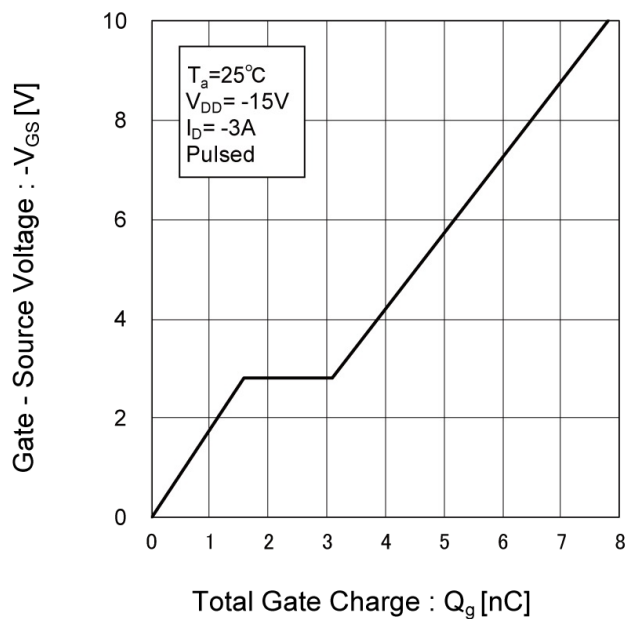
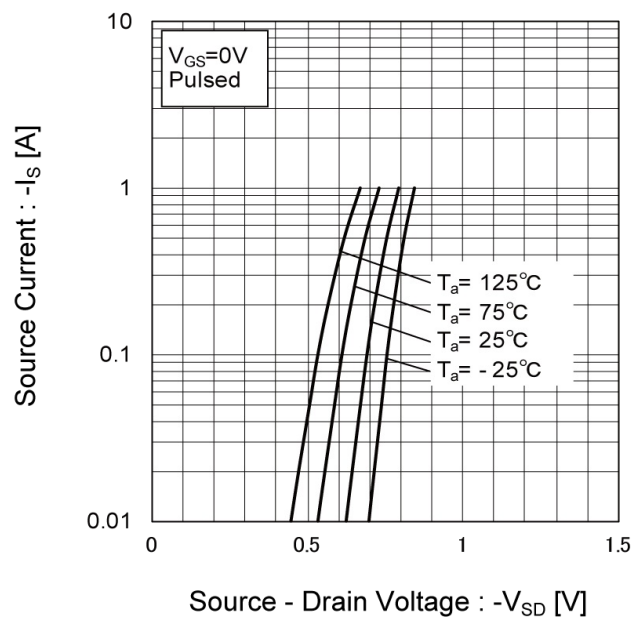


Fig.20 Source Current vs.
Source Drain Voltage



●Electrical characteristic curves <Tr2>

Fig.1 Power Dissipation Derating Curve

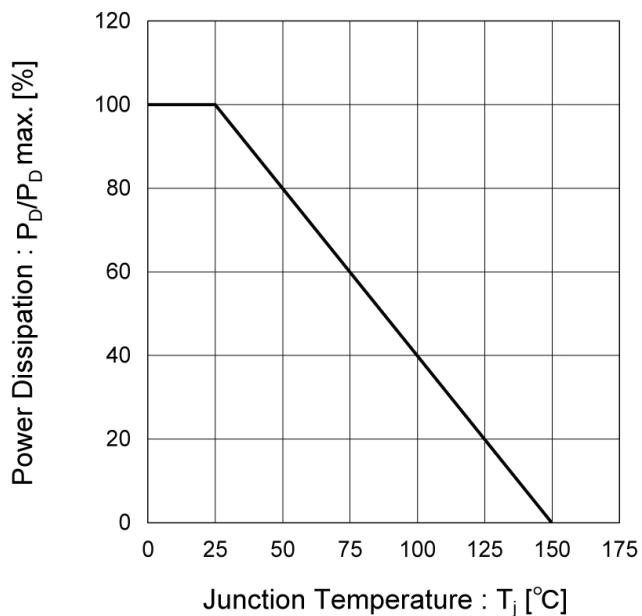


Fig.2 Maximum Safe Operating Area

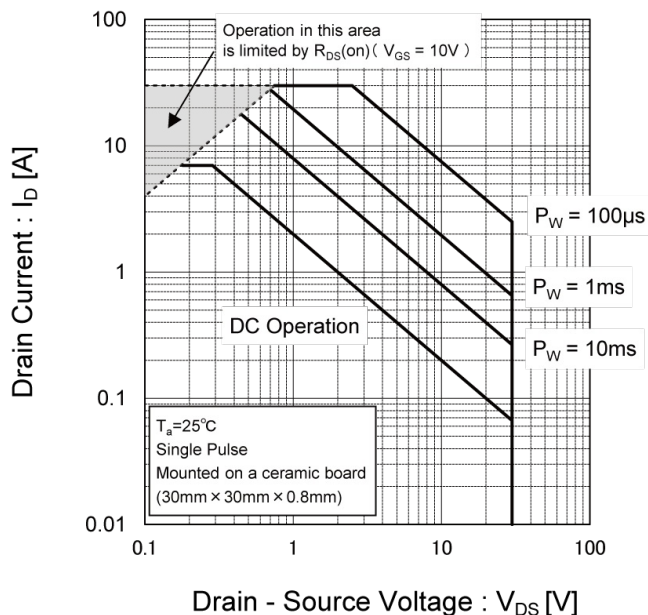


Fig.3 Normalized Transient Thermal Resistance vs. Pulse Width

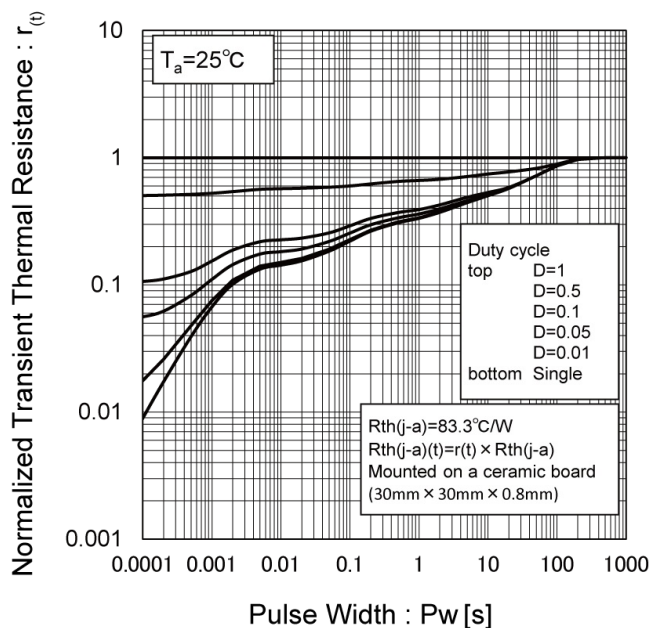
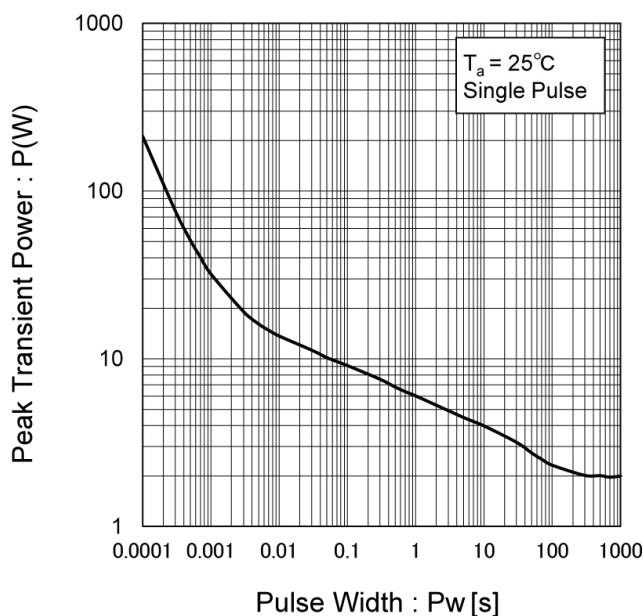


Fig.4 Single Pulse Maximum Power Dissipation



●Electrical characteristic curves <Tr2>

Fig.5 Typical Output Characteristics(I)

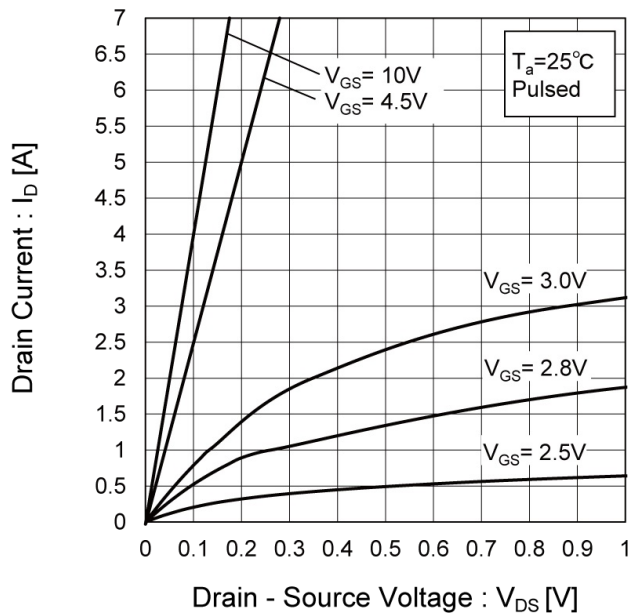


Fig.6 Typical Output Characteristics(II)

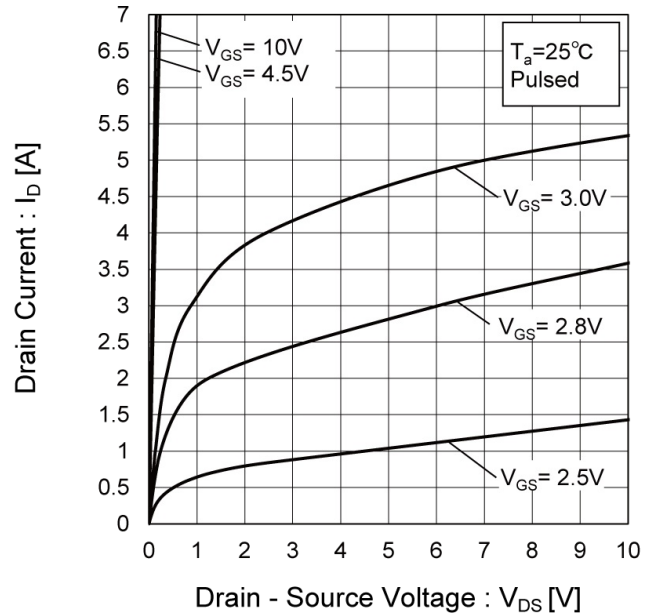
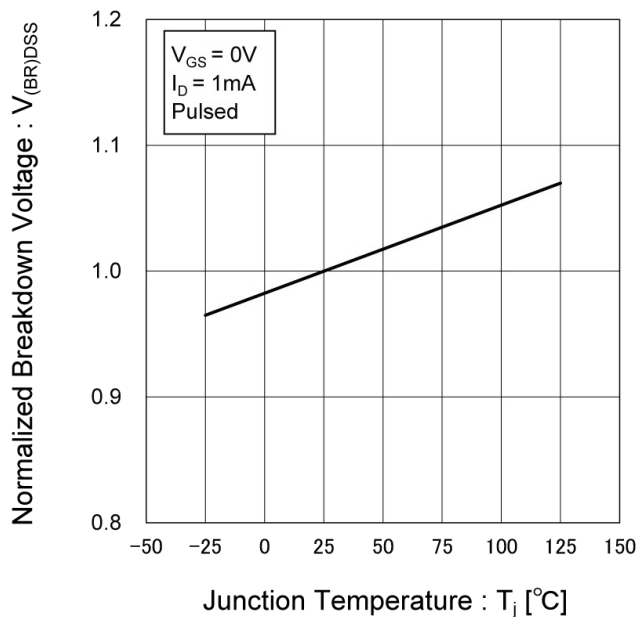


Fig.7 Breakdown Voltage vs. Junction Temperature



●Electrical characteristic curves <Tr2>

Fig.8 Typical Transfer Characteristics

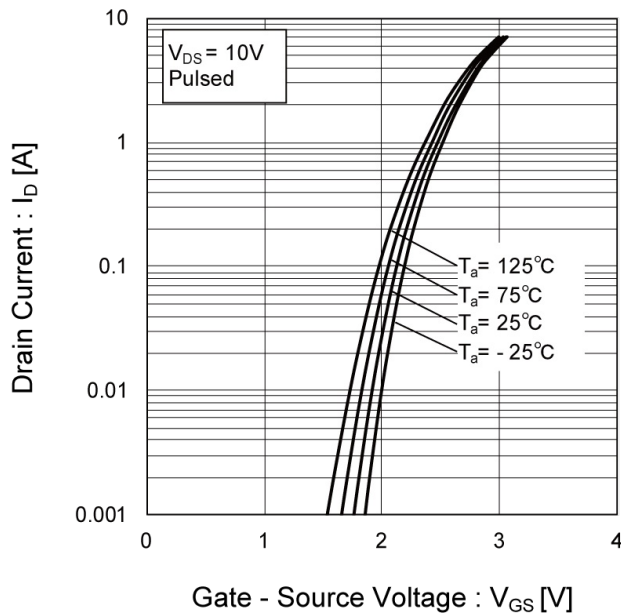


Fig.9 Gate Threshold Voltage vs. Junction Temperature

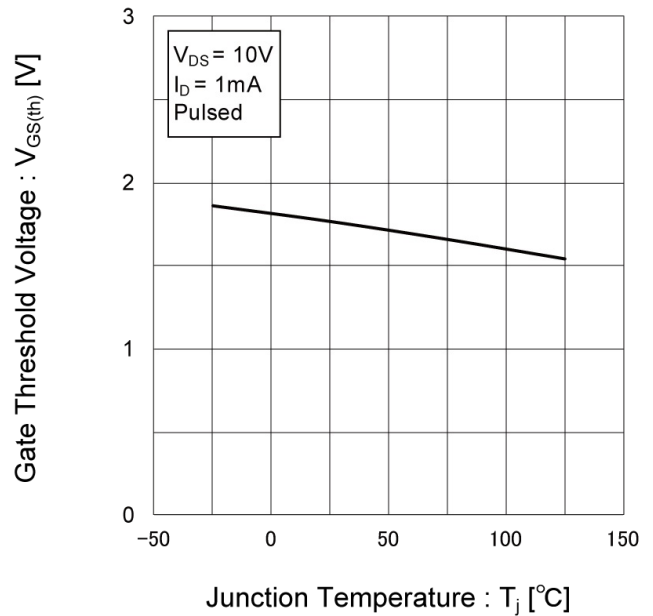
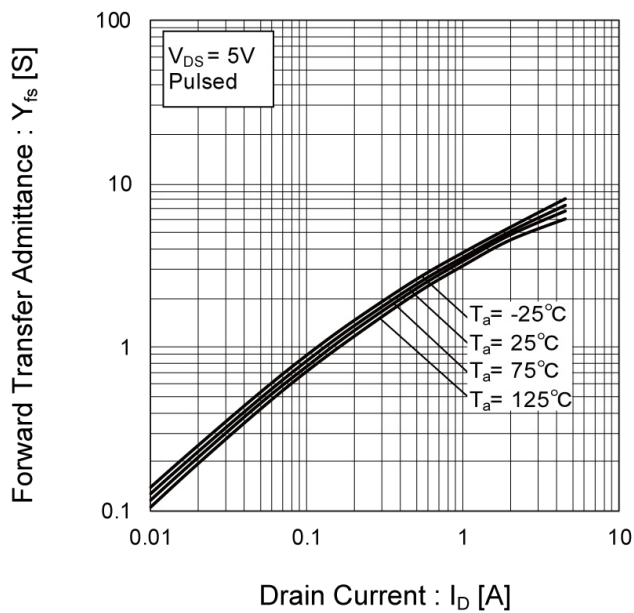


Fig.10 Forward Transfer Admittance vs. Drain Current



●Electrical characteristic curves <Tr2>

Fig.11 Drain Current Derating Curve

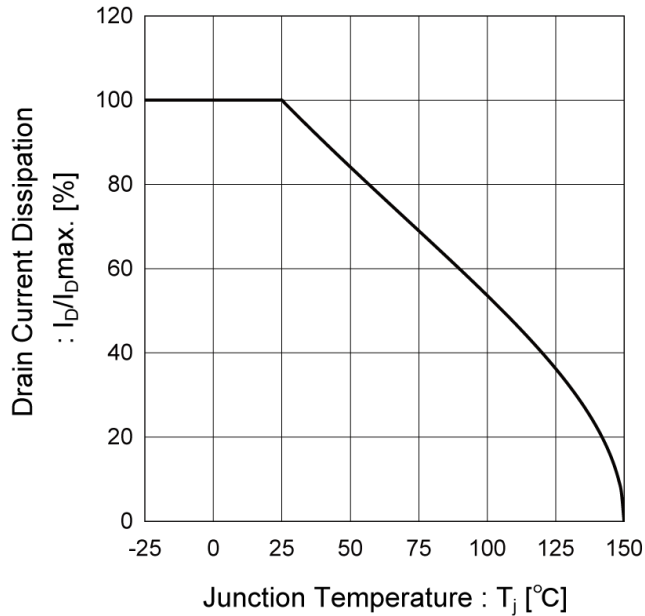


Fig.12 Static Drain - Source On - State Resistance vs. Gate Source Voltage

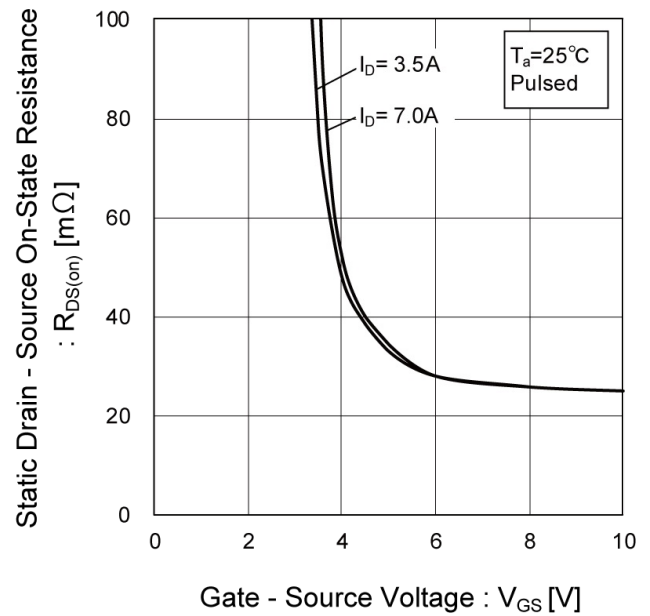
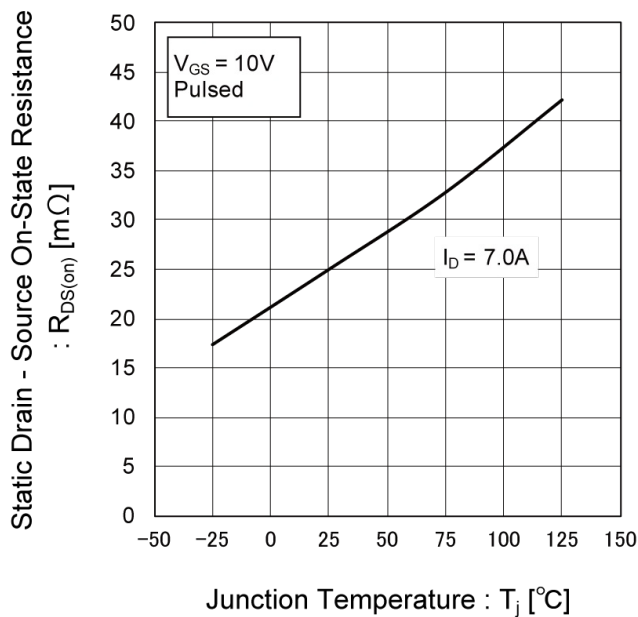


Fig.13 Static Drain - Source On - State Resistance vs. Junction Temperature



●Electrical characteristic curves <Tr2>

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

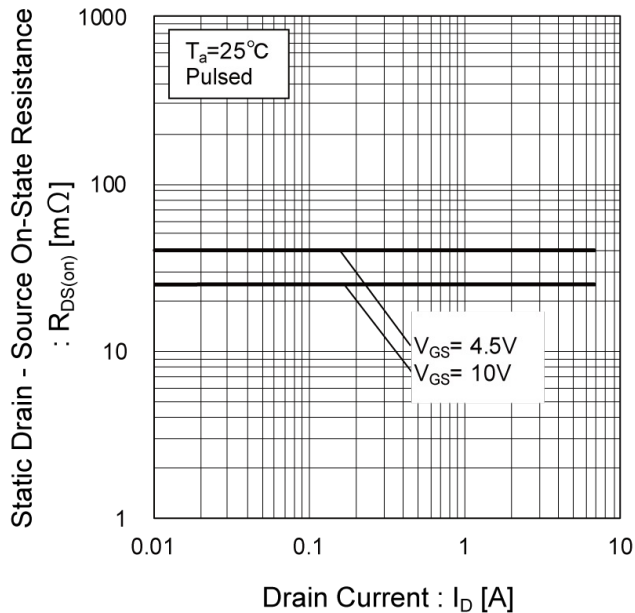


Fig.15 Static Drain - Source On - State Resistance vs. Drain Current (II)

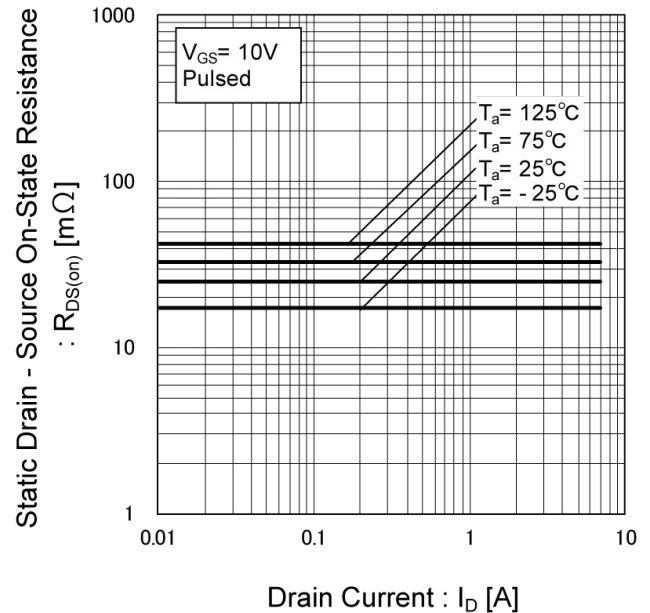
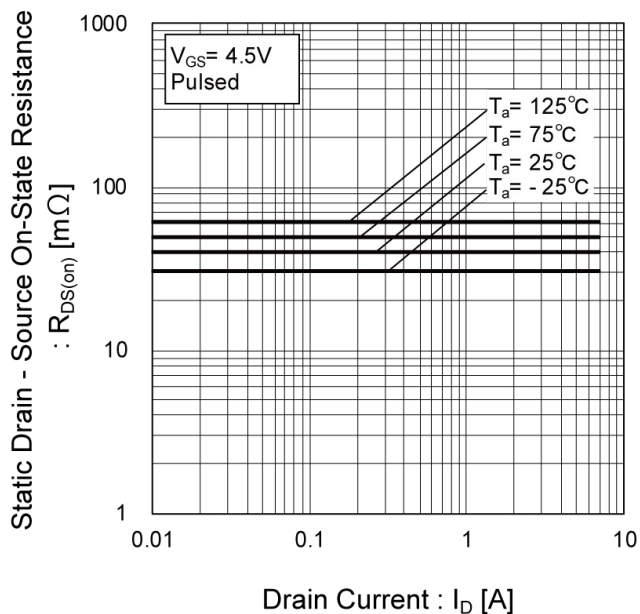


Fig.16 Static Drain - Source On - State Resistance vs. Drain Current (III)



●Electrical characteristic curves <Tr2>

Fig.17 Typical Capacitances vs.
Drain - Source Voltage

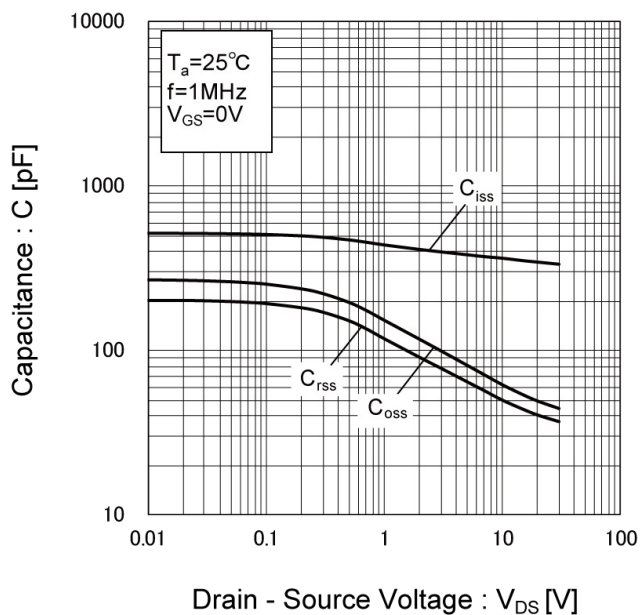


Fig.18 Switching Characteristics

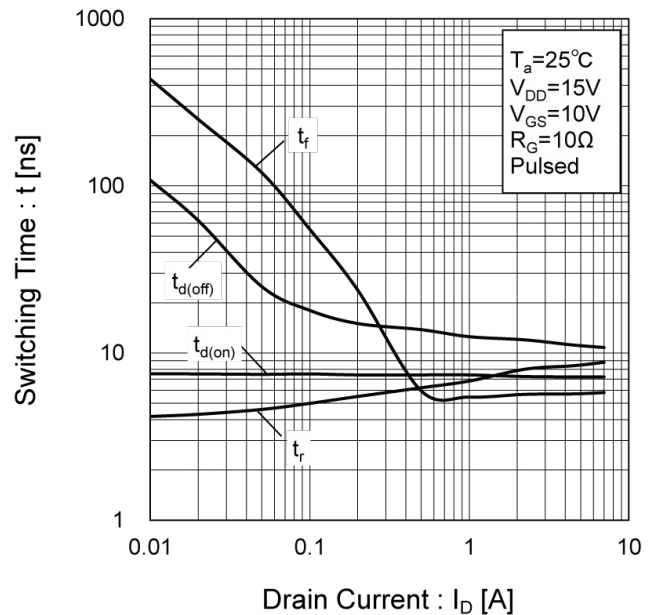


Fig.19 Typical Gate Charge

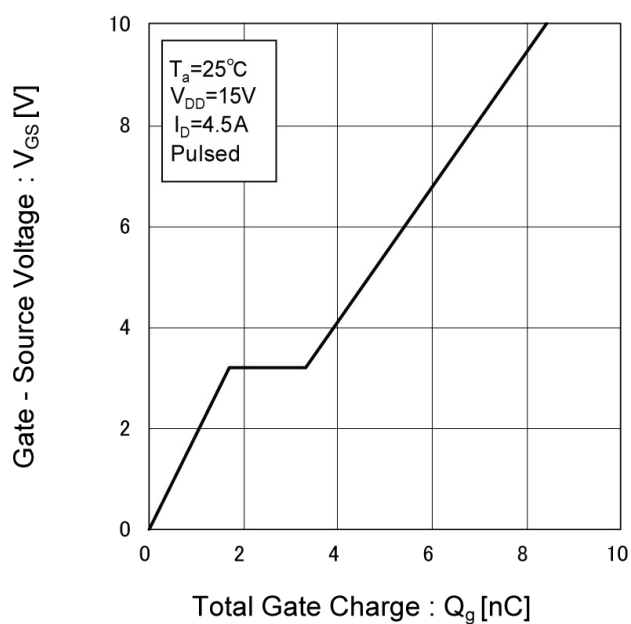
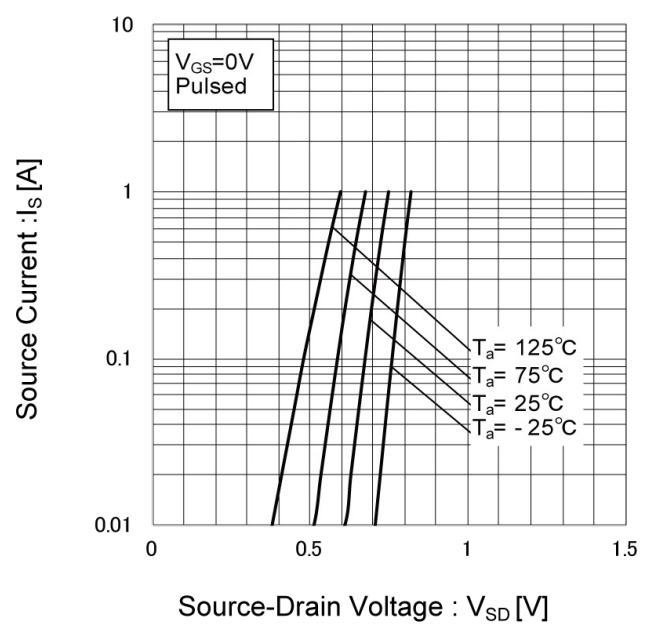


Fig.20 Source Current vs.
Source Drain Voltage



● Measurement circuits <Tr1>

Fig.1-1 Switching Time Measurement Circuit

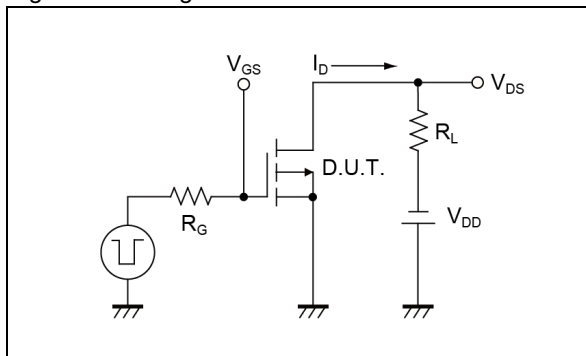


Fig.1-2 Switching Waveforms

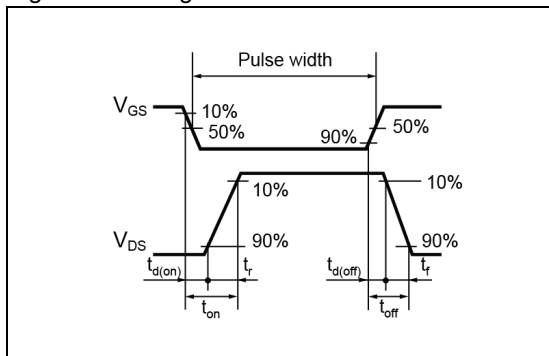


Fig.2-1 Gate Charge Measurement Circuit

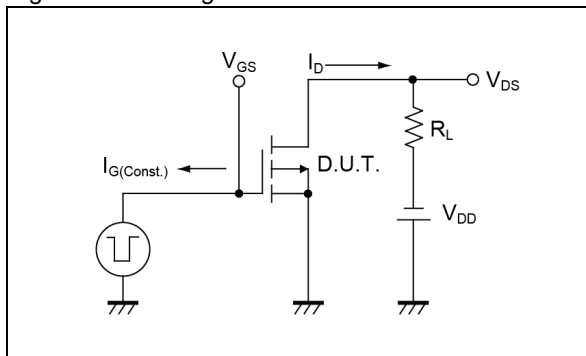
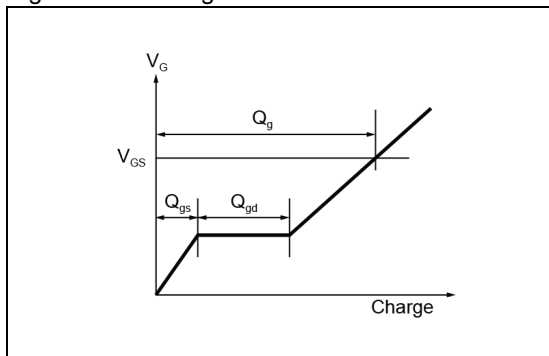


Fig.2-2 Gate Charge Waveform



● Measurement circuits <Tr2>

Fig.3-1 Switching Time Measurement Circuit

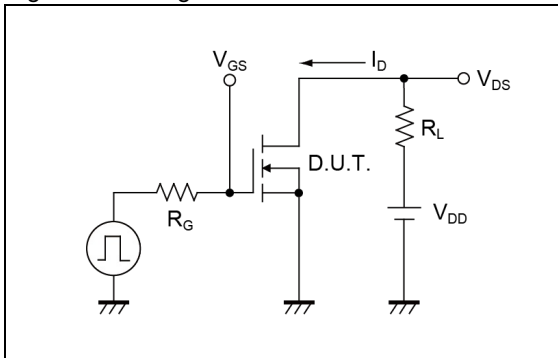


Fig.3-2 Switching Waveforms

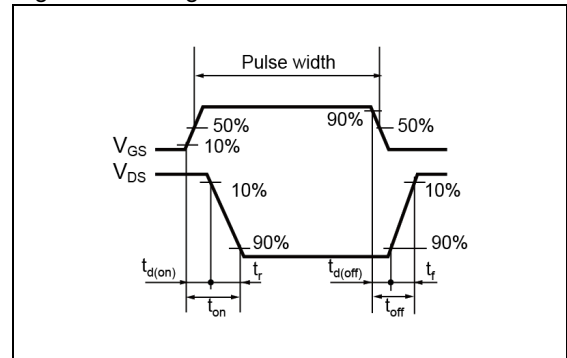


Fig.4-1 Gate Charge Measurement Circuit

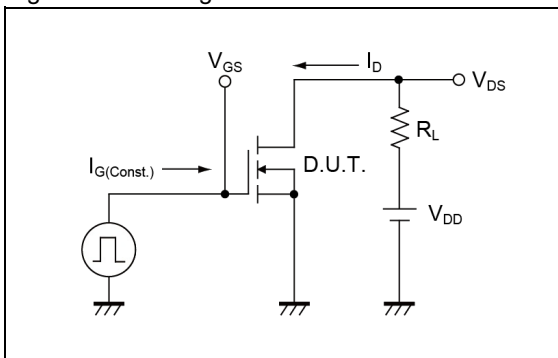
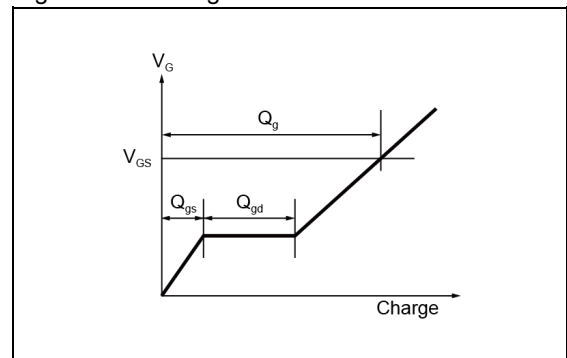


Fig.4-2 Gate Charge Waveform



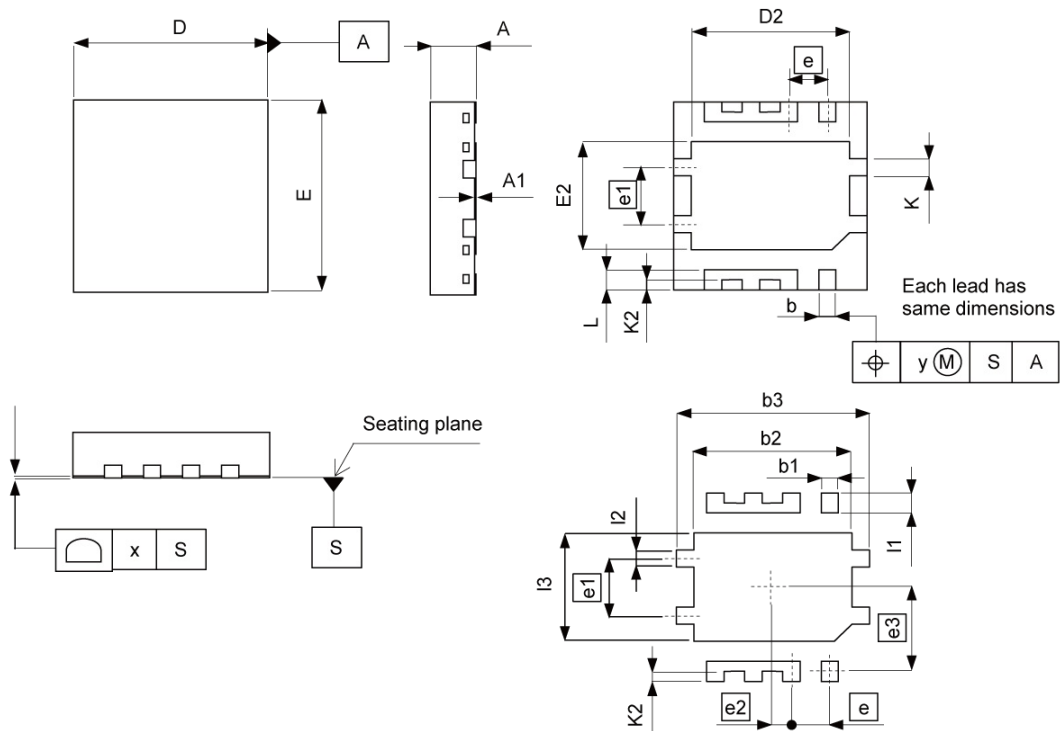
● Notice

This product might cause chip aging and breakdown under the large electrified environment.
Please consider to design ESD protection circuit.

●Dimensions

HSML3333L9

(Drain common)



Pattern of terminal position areas
[Not a recommended pattern of soldering pads]

DIM	MILIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	0.70	0.80	0.028	0.032
A1	0.00	0.05	0.000	0.002
b	0.25	0.35	0.010	0.014
D	3.20	3.40	0.126	0.134
D2	2.65	2.75	0.104	0.108
E	3.20	3.40	0.126	0.134
E2	1.80	2.00	0.071	0.079
e	0.65		0.026	
e1	1.00		0.039	
K	0.30		0.012	
K2	0.175		0.007	
L	0.30	0.40	0.012	0.016
x	0.10		0.004	
y	0.10		0.004	

DIM	MILIMETERS		INCHES	
	MIN	MAX	MIN	MAX
b1	-	0.45	-	0.018
b2	-	2.75	-	0.108
b3	-	3.40	-	0.134
e2	0.325		0.013	
e3	1.45		0.057	
l1	-	0.50	-	0.020
l2	-	0.35	-	0.014
l3	-	2.00	-	0.079

Dimension in mm/inches

