

FML60N146S2HF

Super J MOS[®] S2 series

N-Channel enhancement mode power MOSFET

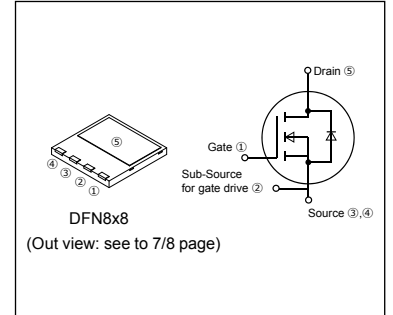
Features

- Pb-free lead terminal
- RoHS compliant
- Halogen-free molding compound
- MSL:1, Reflow available

Applications

- For switching

Package and Internal circuit chart



Absolute Maximum Ratings at $T_c=25^\circ\text{C}$ (unless otherwise specified)

Parameter	Symbol	Characteristics	Unit	Remarks
Drain-Source Voltage	V_{DS}	600	V	
	V_{DSX}	600	V	$V_{GS}=-30V$
Continuous Drain Current	I_D	28.7	A	$T_c=25^\circ\text{C}$ Note*1,2
		18.2	A	$T_c=100^\circ\text{C}$ Note*1,2
Pulsed Drain Current	I_{DP}	83.6	A	Note *2
Gate-Source Voltage	V_{GS}	± 30	V	
Non-Repetitive Maximum Avalanche Current	I_{AS}	3.5	A	Note *3
Non-Repetitive Maximum Avalanche Energy	E_{AS}	517.5	mJ	Note *4
Maximum MOSFET dv/dt	dv_{DS}/dt	50	V/ns	$V_{GS} \leq 600V$
Continuous Diode Forward Current	I_{DR}	28.7	A	$T_c=25^\circ\text{C}$ Note*1,2
		18.2	A	$T_c=100^\circ\text{C}$ Note*1,2
Pulsed Diode Forward Current	I_{DRP}	83.6	A	Note *2
Peak Diode Recovery dv/dt	dv/dt	15	V/ns	Note *5
Peak Diode Recovery $-di_{DR}/dt$	$-di_{DR}/dt$	100	A/ μs	Note *6
Maximum Power Dissipation	P_{tot}	159	W	$T_c=25^\circ\text{C}$
		2.78	W	$T_a=25^\circ\text{C}$
Operating Channel Temperature	T_{ch}	150	$^\circ\text{C}$	
Storage Temperature	T_{stg}	-55 to +150	$^\circ\text{C}$	

Note *1 : Maximum duty cycle $D=0.53$

Note *2 : Limited by maximum channel temperature.

Note *3 : $T_{ch} \leq 150^\circ\text{C}$, See Figure 1 and 2.

Note *4 : Starting $T_{ch} = 25^\circ\text{C}$, $I_{AS} = 2.1\text{ A}$, $L = 215\text{ mH}$, $V_{DD} = 60\text{ V}$, $R_G = 50\ \Omega$, See Figure 1 and 2.

E_{AS} limited by maximum channel temperature and avalanche current.

Note *5 : $I_{DR} \leq 22.7\text{ A}$, $-di_{DR}/dt \leq 100\text{ A}/\mu\text{s}$, $V_{DS\text{ peak}} \leq 600\text{ V}$, $T_{ch} \leq 150^\circ\text{C}$.

Note *6 : $I_{DR} \leq 22.7\text{ A}$, $dv/dt \leq 30\text{ V/ns}$, $V_{DS\text{ peak}} \leq 600\text{ V}$, $T_{ch} \leq 150^\circ\text{C}$.

Electrical Characteristics at $T_c=25^\circ\text{C}$ (unless otherwise specified)

• Static characteristics

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Drain-Source Breakdown Voltage	$V_{(BR)DSS}$	$V_{GS} = 0\text{ V}$ $I_D = 250\ \mu\text{A}$	600	-	-	V
Gate Threshold Voltage	$V_{GS(th)}$	$V_{DS} = V_{GS}$ $I_D = 1.22\ \text{mA}$	3.5	4.0	4.5	V
Zero Gate Voltage Drain Current	I_{DSS}	$V_{DS} = 600\ \text{V}$ $V_{GS} = 0\ \text{V}$ $T_{ch} = 25^\circ\text{C}$	-	-	25	μA
		$V_{DS} = 480\ \text{V}$ $V_{GS} = 0\ \text{V}$ $T_{ch} = 125^\circ\text{C}$	-	-	250	
Gate-Source Leakage Current	I_{GSS}	$V_{DS} = 0\ \text{V}$ $V_{GS} = \pm 30\ \text{V}$	-	10	100	nA
Drain-Source On-State Resistance	$R_{DS(on)}$	$V_{GS} = 10\ \text{V}$ $I_D = 5.7\ \text{A}$	-	0.130	0.146	Ω
Gate resistance	r_g	$f = 1\ \text{MHz}$, open drain	-	3.0	-	Ω

• Dynamic characteristics

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Forward Transconductance	g_{fs}	$V_{DS} = 25\ \text{V}$ $I_D = 11.4\ \text{A}$	3.7	15	-	S
Input Capacitance	C_{iss}	$V_{DS} = 400\ \text{V}$ $V_{GS} = 0\ \text{V}$ $f = 250\ \text{kHz}$	-	1240	-	μF
Output Capacitance	C_{oss}		-	42	-	
Reverse Transfer Capacitance	C_{rss}		-	6.3	-	
Effective output capacitance, energy related (Note *7)	$C_{o(er)}$	$V_{DS} = 0 \dots 400\ \text{V}$ $V_{GS} = 0\ \text{V}$	-	102	-	pF
Effective output capacitance, time related (Note *8)	$C_{o(tr)}$	$V_{DS} = 0 \dots 400\ \text{V}$ $V_{GS} = 0\ \text{V}$ $I_D = \text{constant}$	-	391	-	
Turn-On Time	$t_{d(on)}$	$V_{DD} = 400\ \text{V}$, $V_{GS} = 10\ \text{V}$ $I_D = 11.4\ \text{A}$, $R_G = 39\ \Omega$ See Figure 3 and 4	-	29	-	ns
	t_r		-	16	-	
Turn-Off Time	$t_{d(off)}$		-	182	-	
	t_f		-	24	-	
Total Gate Charge	Q_G	$V_{DD} = 400\ \text{V}$, $V_{GS} = 10\ \text{V}$	-	53	-	nC
Gate-Source Charge	Q_{GS}	$I_D = 22.7\ \text{A}$	-	20	-	
Gate-Drain Charge	Q_{GD}	See Figure 5	-	20	-	

Note *6 : $C_{o(er)}$ is a fixed capacitance that gives the same stored energy as C_{oss} while V_{DS} is rising from 0 to 400V.

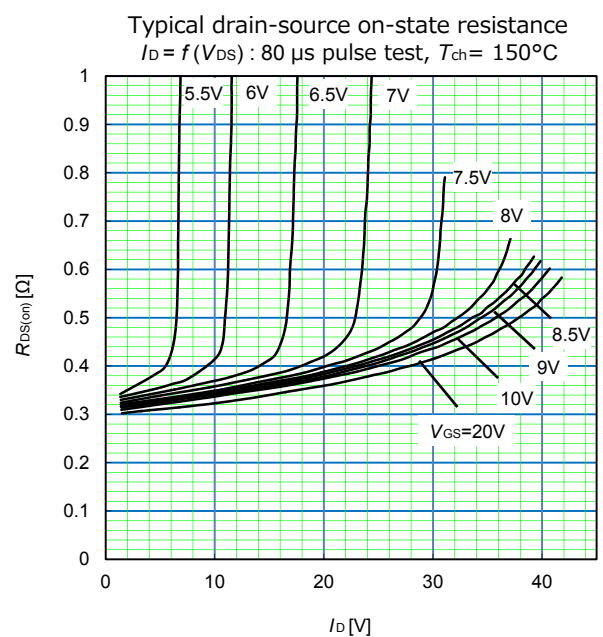
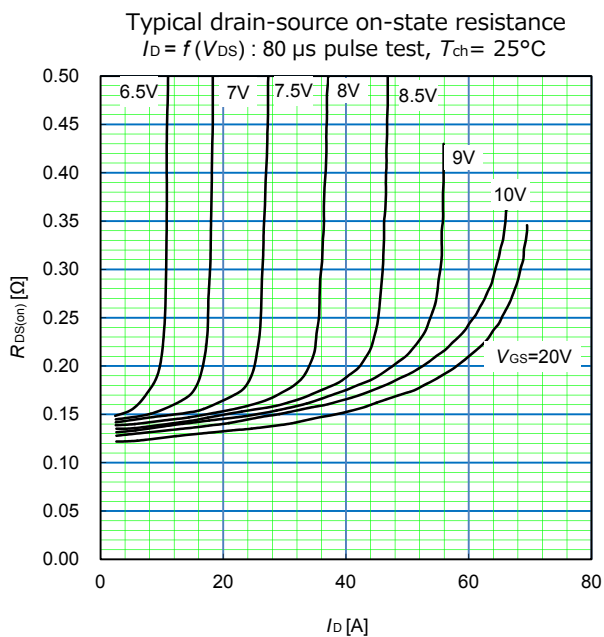
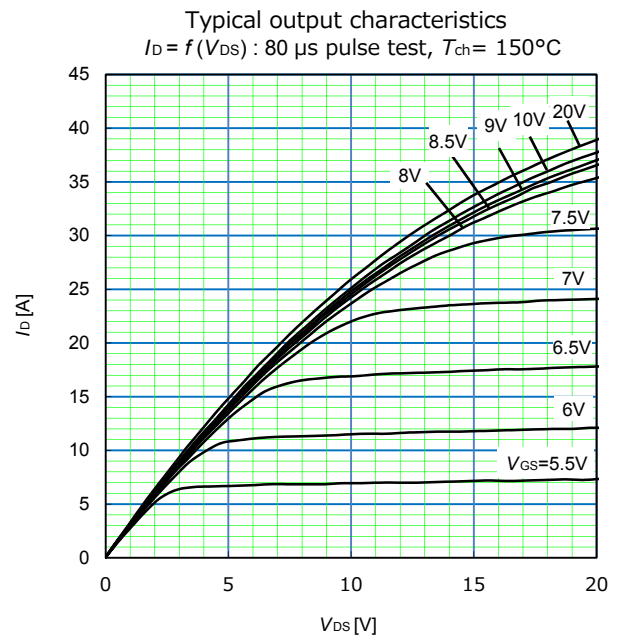
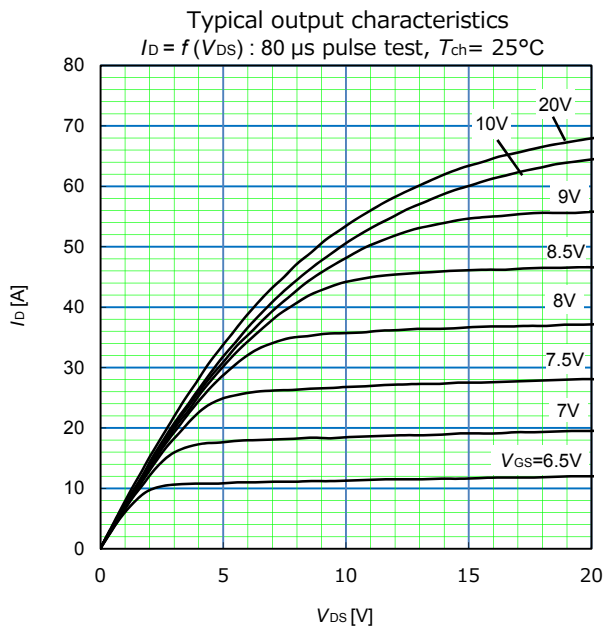
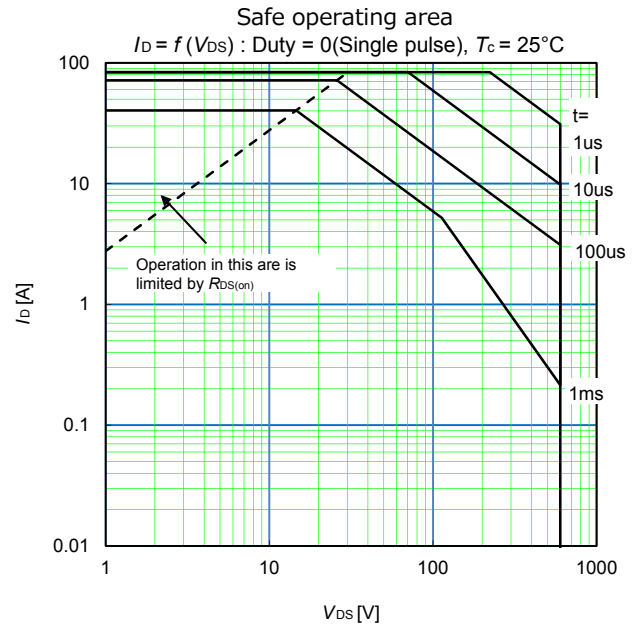
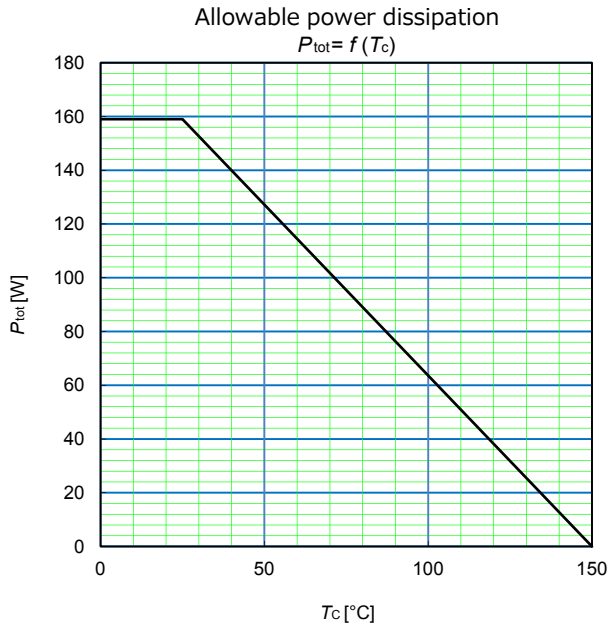
Note *7 : $C_{o(tr)}$ is a fixed capacitance that gives the same charging times as C_{oss} while V_{DS} is rising from 0 to 400V.

• Reverse diode characteristics

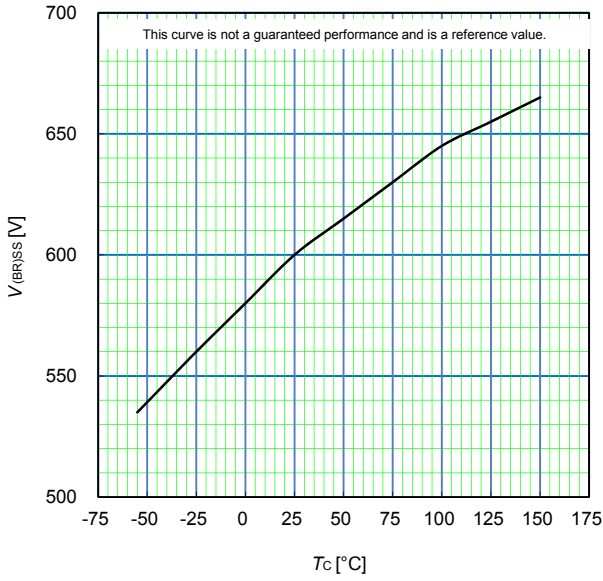
Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Diode Forward On-Voltage	V_{DSR}	$I_{DR} = 22.7\ \text{A}$, $V_{GS} = 0\ \text{V}$ $T_{ch} = 25^\circ\text{C}$	-	1.00	1.35	V
Reverse Recovery Time	t_{rr}	$V_{DD} = 400\ \text{V}$ $I_{DR} = 22.7\ \text{A}$ $V_{GS} = 0\ \text{V}$ $-di_{DR}/dt = 100\ \text{A}/\mu\text{s}$ $T_{ch} = 25^\circ\text{C}$ See Figure 6 and 7	-	310	-	ns
Reverse Recovery Charge	Q_{rr}		-	4.4	-	μC
Peak Reverse Recovery Current	I_{rrm}		-	27	-	A

■ Thermal Resistance

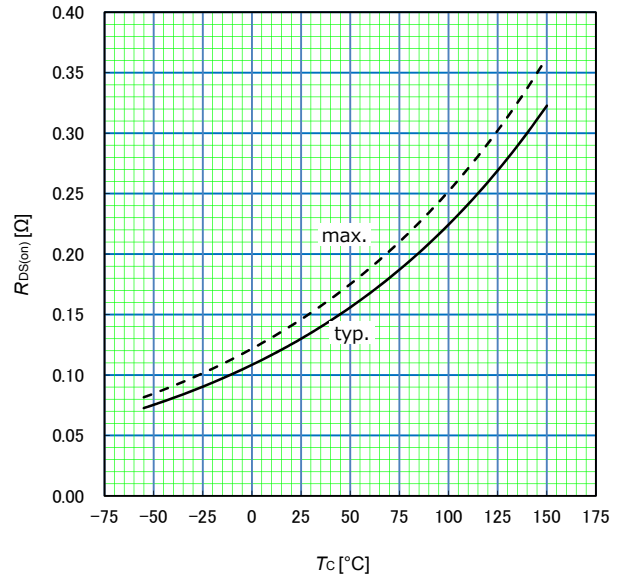
Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Thermal Resistance, Channel – Ambient	$R_{th(ch-a)}$	Device mounted on PCB (FR4) Size: 40mm*40mm*1.5mm with 6cm ² copper area (one layer, 70 μm thickness) for drain connection and cooling.	-	-	45	$^\circ\text{C}/\text{W}$
Thermal Resistance, Channel – Case	$R_{th(ch-c)}$		-	-	0.786	$^\circ\text{C}/\text{W}$



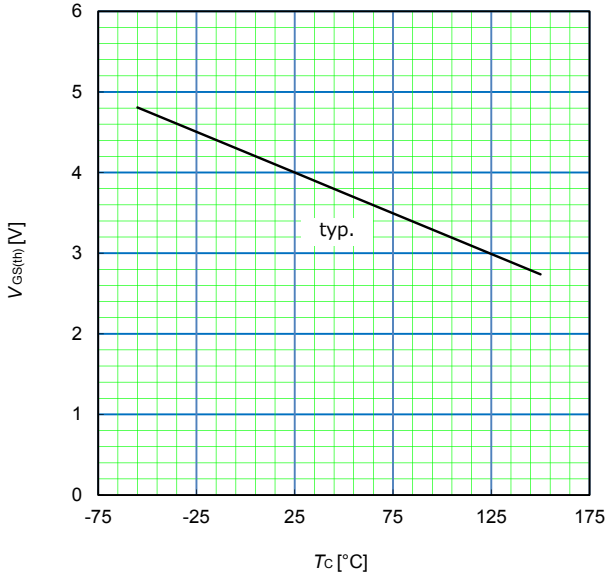
Drain-source breakdown voltage
 $V_{(BR)DSS} = f(T_{ch}) : I_D = 10 \text{ mA}, V_{GS} = 0 \text{ V}$



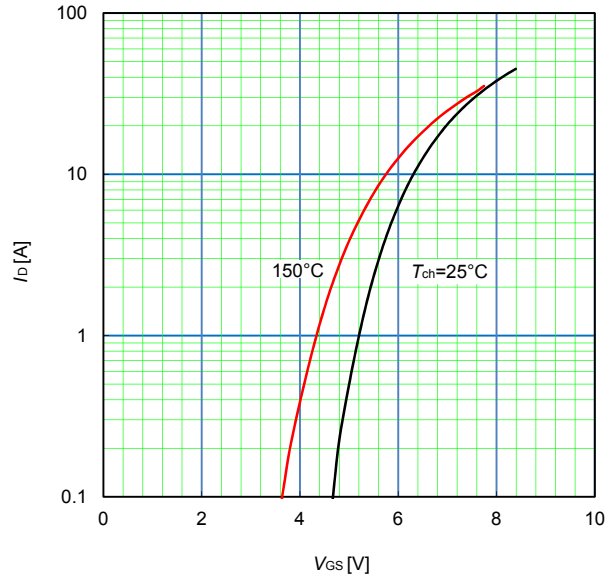
Drain-source on-state resistance
 $R_{DS(on)} = f(T_{ch}) : I_D = 5.7 \text{ A}, V_{GS} = 10 \text{ V}$



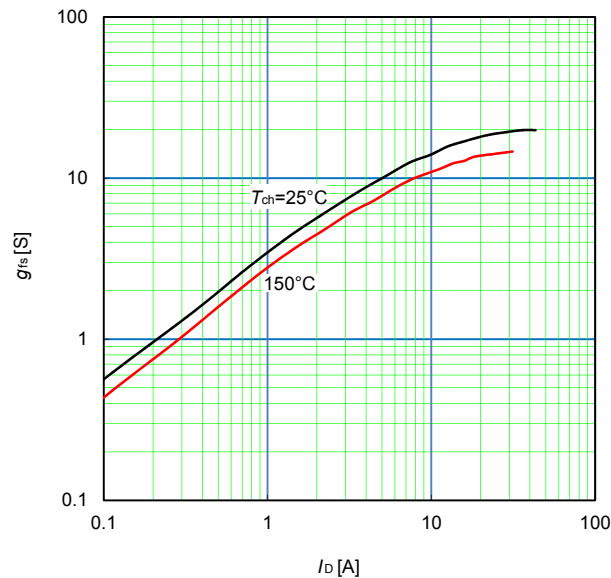
Gate threshold voltage
 $V_{GS(th)} = f(T_{ch}) : V_{DS} = V_{GS}, I_D = 1.54 \text{ mA}$



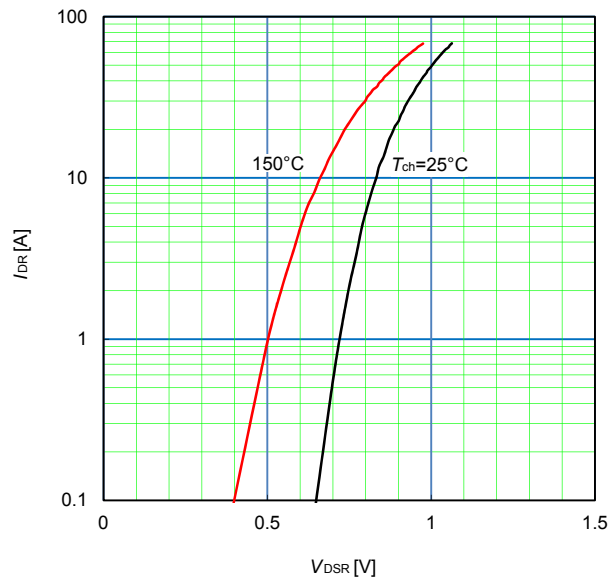
Typical transfer characteristic
 $I_D = f(V_{GS}) : 80 \mu\text{s pulse test}, V_{DS} = 25 \text{ V}$

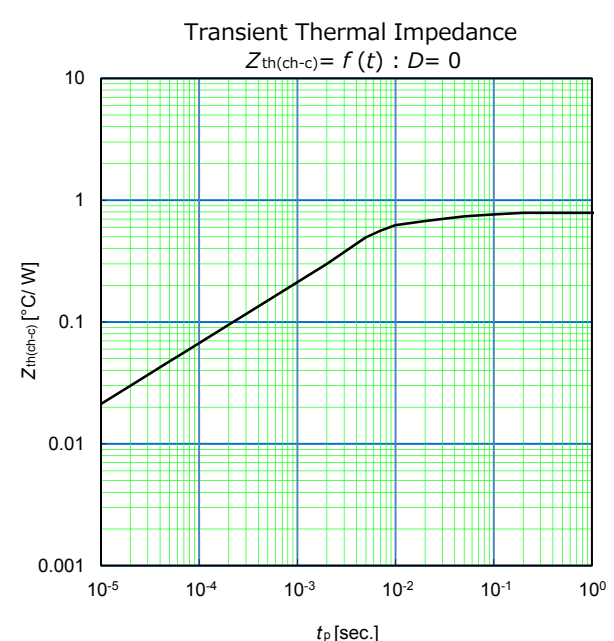
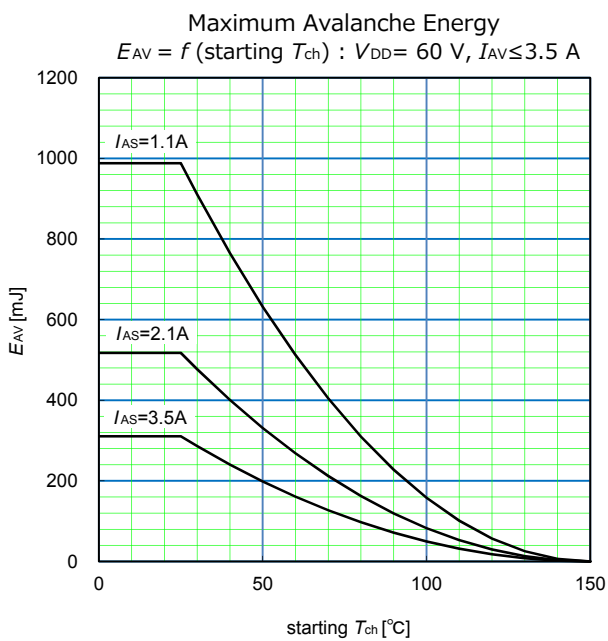
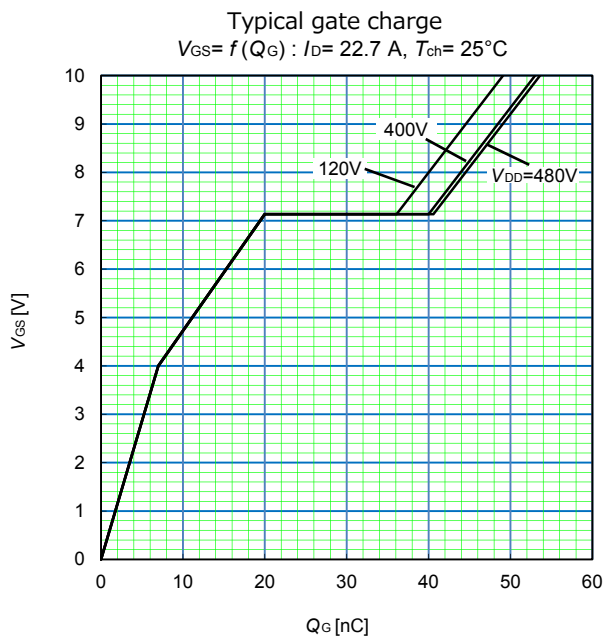
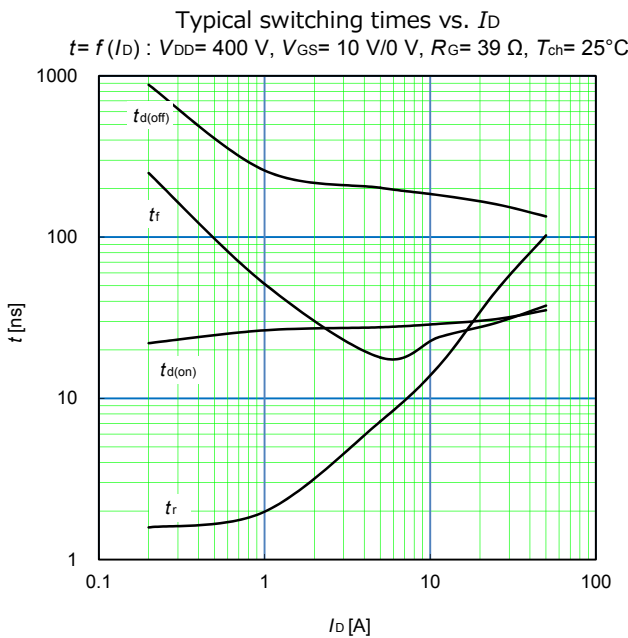
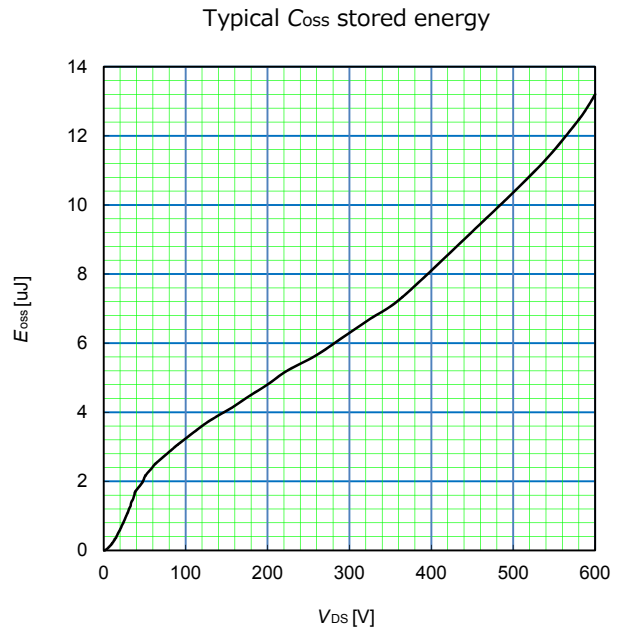
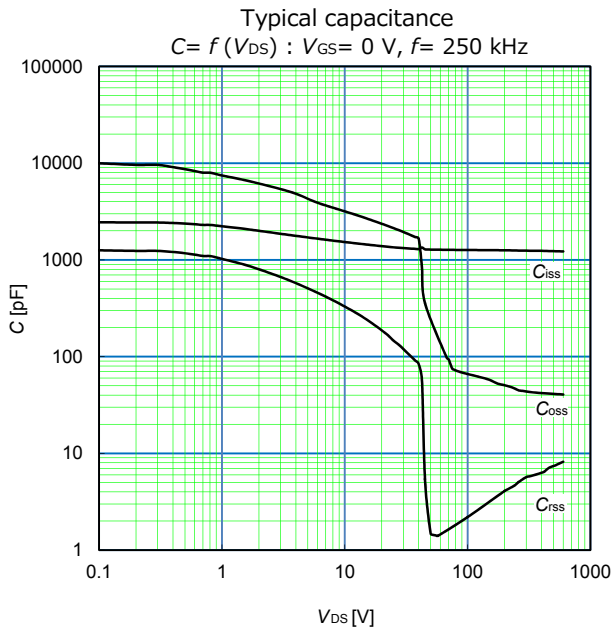


Typical transconductance
 $g_{fs} = f(I_D) : 80 \mu\text{s pulse test}, V_{DS} = 25 \text{ V}$



Typical forward characteristics of reverse diode
 $I_{DR} = f(V_{DSR}) : 80 \mu\text{s pulse test}$





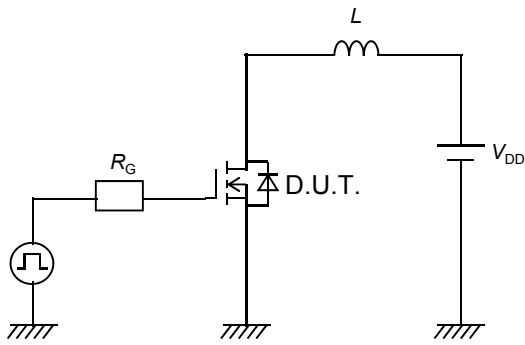


Figure 1. Unclamped inductive load test circuit

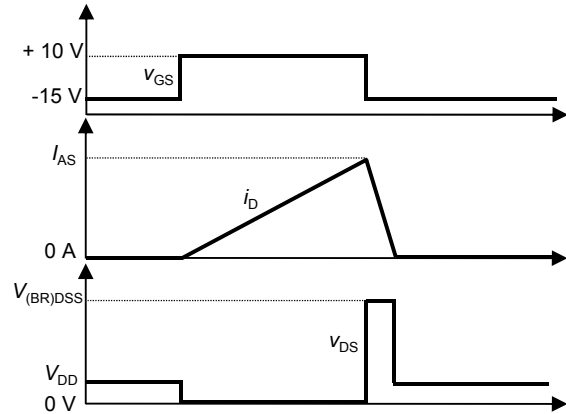


Figure 2. Unclamped inductive waveform

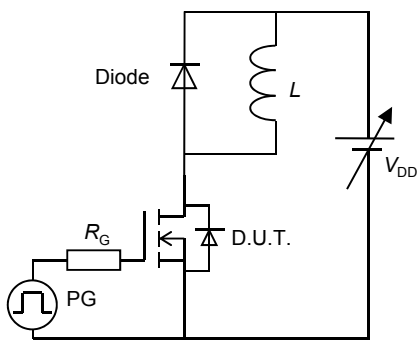


Figure 3. Switching test circuit

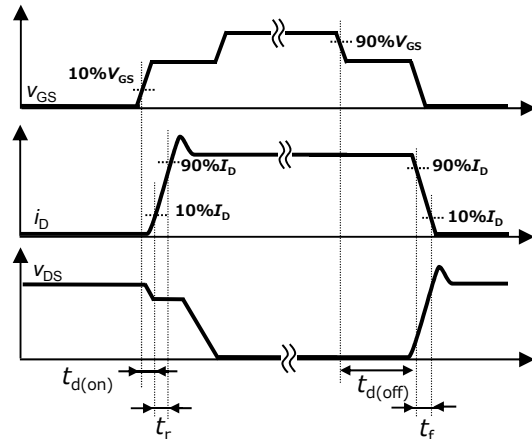


Figure 4. Switching times waveform

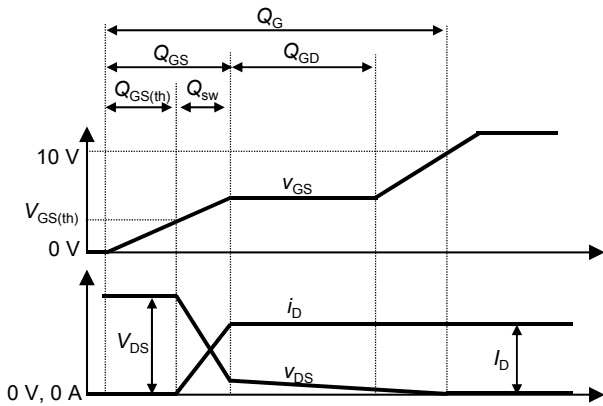


Figure 5. Gate charge waveform

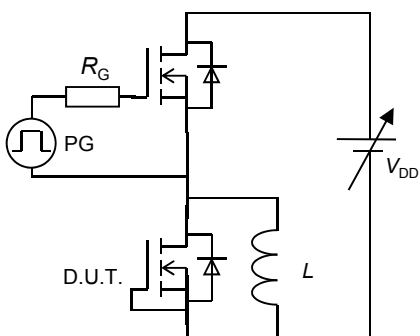


Figure 6. Diode reverse recovery test circuit

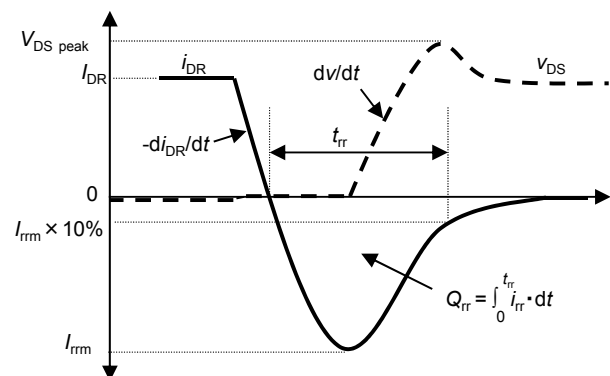
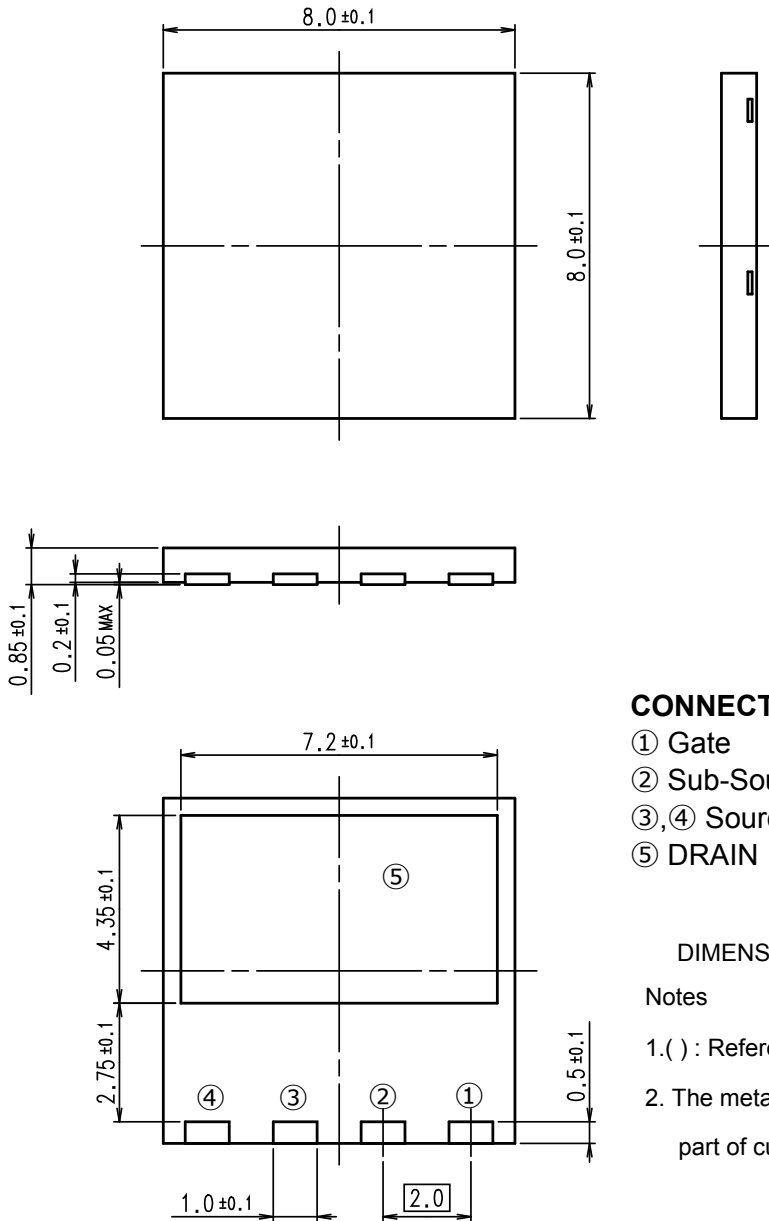


Figure 7. Diode reverse recovery waveform

■ Package Dimensions : DFN8x8 Package



CONNECTION

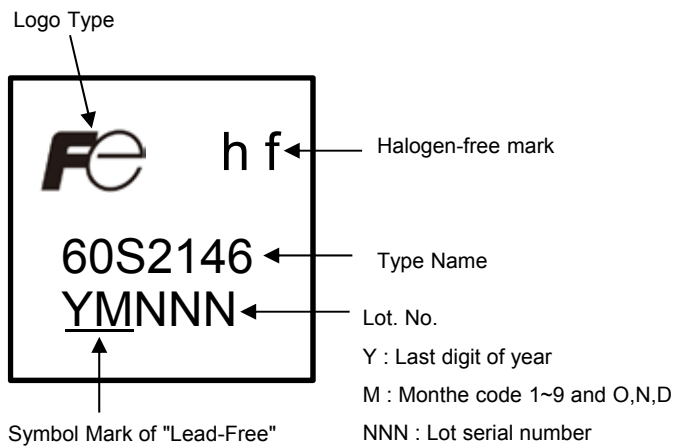
- ① Gate
- ② Sub-Source for Gate Drive
- ③,④ Source
- ⑤ DRAIN

DIMENSIONS ARE IN MILLIMETERS

Notes

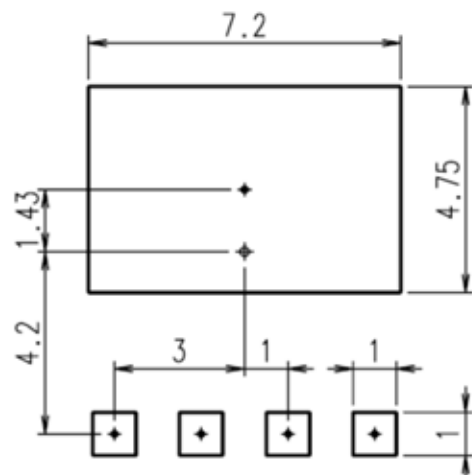
- 1.() : Reference dimensions.
- 2. The metal part is covered with the solder plating, part of cutting is without the solder plating.

■ Marking



* The font (font type,size) and the trademark-size might be actually different.

■ Recommended footprint



WARNING

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