Fuji Electric

Innovating Energy Technology

FML60N104S2FDHF

http://www.fujielectric.com/products/semiconductor/

FUJI POWER MOSFET

Super J MOS® S2 series

N-Channel enhancement mode power MOSFET

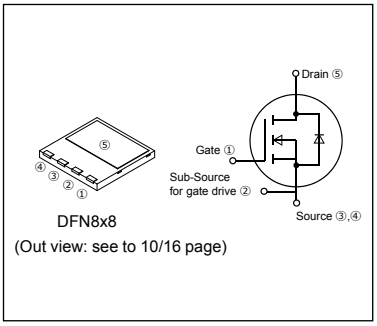
Features

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

Applications

For switching

Package and Internal circuit chart



(Out view: see to 10/16 page)

Absolute Maximum Ratings at T_C=25°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	41.3	A	T_C=25°C Note*1,2
		26.1	A	T_C=100°C Note*1,2
Pulsed Drain Current	I_{DP}	120.4	A	Note *2
Gate-Source Voltage	V_{GS}	±30	V	
Non-Repetitive Maximum Avalanche Current	I_{AS}	4.9	A	Note *3
Non-Repetitive Maximum Avalanche Energy	E_{AS}	809.3	mJ	Note *4
Maximum MOSFET dv/dt	dv_{DS}/dt	50	V/ns	V_{DS}≤ 600V
Continuous Diode Forward Current	I_{DR}	41.3	A	T_C=25°C Note*1,2
		26.1	A	T_C=100°C Note*1,2
Pulsed Diode Forward Current	I_{DRP}	120.4	A	Note *2
Peak Diode Recovery dv/dt	dv/dt	30	V/ns	Note *5
Peak Diode Recovery -di_{DR}/dt	-di_{DR}/dt	100	A/μs	Note *6
Maximum Power Dissipation	P_{tot}	232	W	T_C=25°C
		2.78	W	T_a=25°C
Operating Channel Temperature	T_{ch}	150	°C	
Storage Temperature	T_{stg}	-55 to +150	°C	

Note *1 : Maximum duty cycle D=0.53
Note *2 : Limited by maximum channel temperature.
Note *3 : T_{ch} ≤ 150 °C, See Figure 1 and 2.
Note *4 : Starting T_{ch} = 25 °C, I_{AS} = 3 A, L = 165 mH, V_{DD} = 60 V, R_G = 50 Ω, See Figure 1 and 2.
E_{AS} limited by maximum channel temperature and avalanche current.
Note *5 : I_{DR} ≤32.8 A , -di_{DR}/dt ≤ 100 A/μs, $V_{DS\ peak}$ ≤ 600 V, T_{ch} ≤ 150 °C.
Note *6 : I_{DR} ≤32.8 A , dv/dt ≤ 30 V/ns, $V_{DS\ peak}$ ≤ 600 V, T_{ch} ≤ 150 °C.

9191
NOVEMBER 2017

Electrical Characteristics at T_c=25°C (unless otherwise specified)

• Static characteristics

Parameter	Symbol	Conditions		Min.	Typ.	Max.	Unit
Drain-Source Breakdown Voltage	$V_{(BR)DSS}$	V_{GS} = 0 V I_D = 250 µA		600	-	-	V
Gate Threshold Voltage	$V_{GS(th)}$	V_{DS} = V_{GS} I_D = 4.9 mA		3.0	4.0	5.0	V
Zero Gate Voltage Drain Current	I_{DSS}	V_{DS} = 600 V V_{GS} = 0 V	T_{ch} = 25 °C	-	-	25	µA
		V_{DS} = 480 V V_{GS} = 0 V	T_{ch} = 125 °C	-	-	-	
Gate-Source Leakage Current	I_{GSS}	V_{DS} = 0 V V_{GS} = ± 30 V		-	10	100	nA
Drain-Source On-State Resistance	$R_{DS(on)}$	V_{GS} = 10 V I_D = 8.2 A		-	0.093	0.104	Ω
Gate resistance	r_g	f = 1 MHz, open drain		-	7.5	-	Ω

• Dynamic characteristics

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Forward Transconductance	g_{fs}	V_{DS} = 25 V I_D = 16.4 A	6	24	-	S
Input Capacitance	C_{iss}	V_{DS} = 400 V V_{GS} = 0 V f = 250 kHz	-	1720	-	pF
Output Capacitance	C_{oss}		-	60	-	
Reverse Transfer Capacitance	C_{rss}		-	7.9	-	
Effective output capacitance, energy related (Note *7)	$C_{o(er)}$	V_{DS} = 0…400 V V_{GS} = 0 V	-	139	-	
Effective output capacitance, time related (Note *8)	$C_{o(tr)}$	V_{DS} = 0…400 V V_{GS} = 0 V I_D = constant	-	569	-	
Turn-On Time	$t_{d(on)}$	V_{DD} = 400 V, V_{GS} = 10 V I_D = 16.4 A, R_G = 20 Ω See Figure 3 and 4	-	30	-	ns
	t_r		-	19	-	
Turn-Off Time	$t_{d(off)}$		-	223	-	
	t_f		-	23	-	
Total Gate Charge	Q_G	V_{DD} = 400 V, V_{GS} = 10 V I_D = 32.8 A See Figure 5	-	83	-	nC
Gate-Source Charge	Q_{GS}		-	35	-	
Gate-Drain Charge	Q_{GD}		-	39	-	

Note *7 : $C_{o(er)}$ is a fixed capacitance that gives the same stored energy as C_{oss} while V_{DS} is rising from 0 to 400V.
Note *8 : $C_{o(tr)}$ is a fixed capacitance that gives the same charging times as C_{oss} while V_{DS} is rising from 0 to 400V.

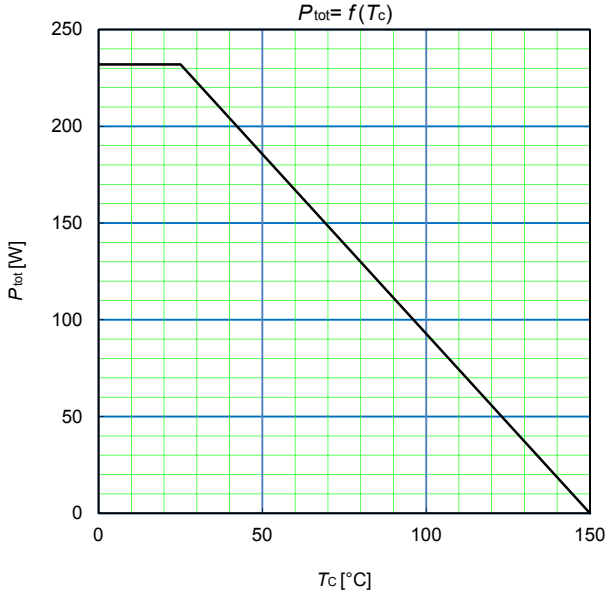
• Reverse diode characteristics

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Diode Forward On-Voltage	V_{DSR}	I_{DR} = 32.8 A, V_{GS} = 0 V T_{ch} = 25 °C	-	1.00	1.35	V
Reverse Recovery Time	t_{rr}	V_{DD} = 400 V I_{DR} = 32.8 A V_{GS} = 0 V -di_{DR}/dt = 100 A/µs T_{ch} = 25 °C See Figure 6 and 7	-	185	-	ns
Reverse Recovery Charge	Q_{rr}		-	1.6	-	µC
Peak Reverse Recovery Current	I_{rrm}		-	15.8	-	A

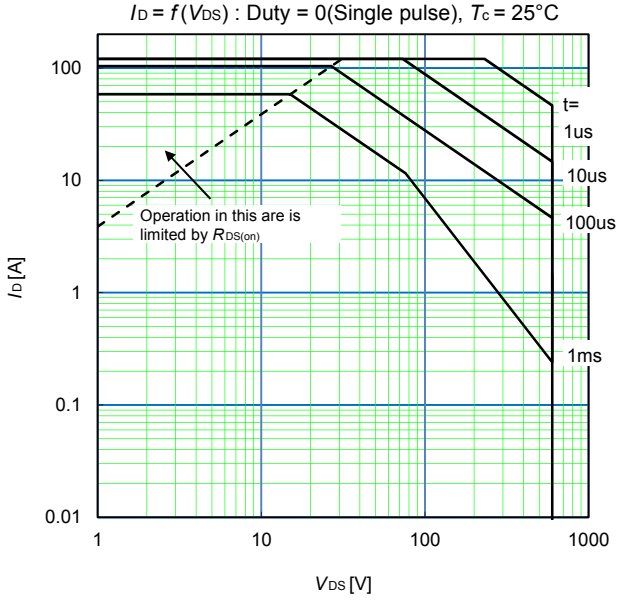
Thermal Resistance

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 6cm² copper area (one layer, 70µm thickness) for drain connection and cooling.	-	-	45	°C/W
Thermal Resistance, Channel – Case	$R_{th(ch-c)}$		-	-	0.539	°C/W

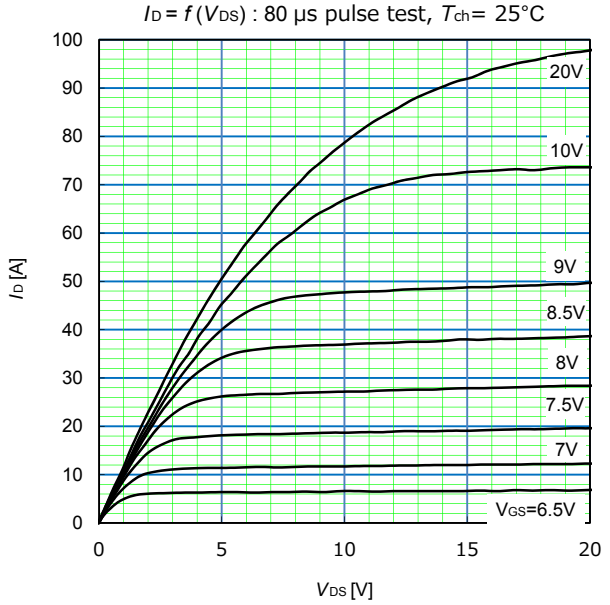
Allowable power dissipation
$P_{tot} = f(T_c)$



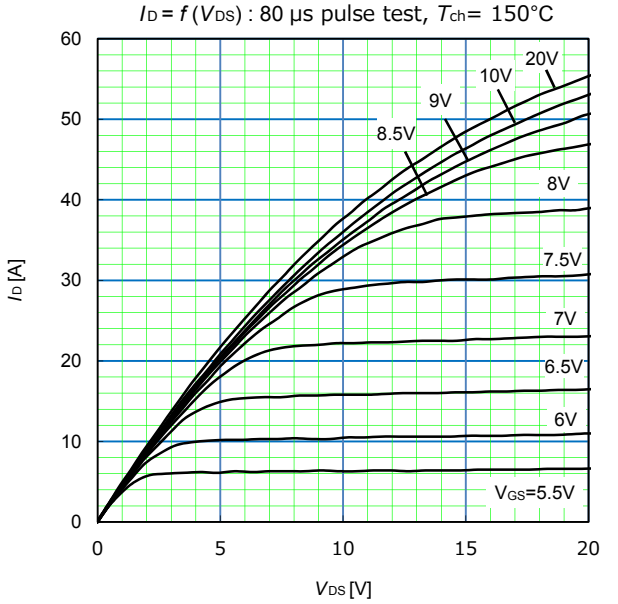
Safe operating area
$I_D = f(V_{DS})$: Duty = 0(Single pulse), T_c = 25°C



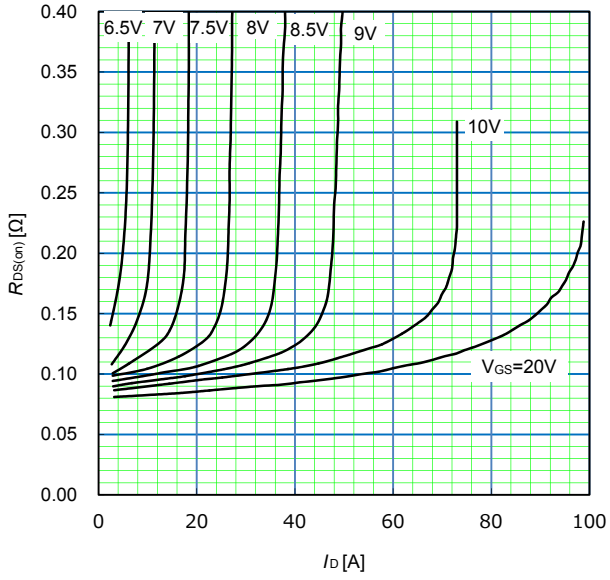
Typical output characteristics
$I_D = f(V_{DS})$: 80 µs pulse test, T_{ch}= 25°C



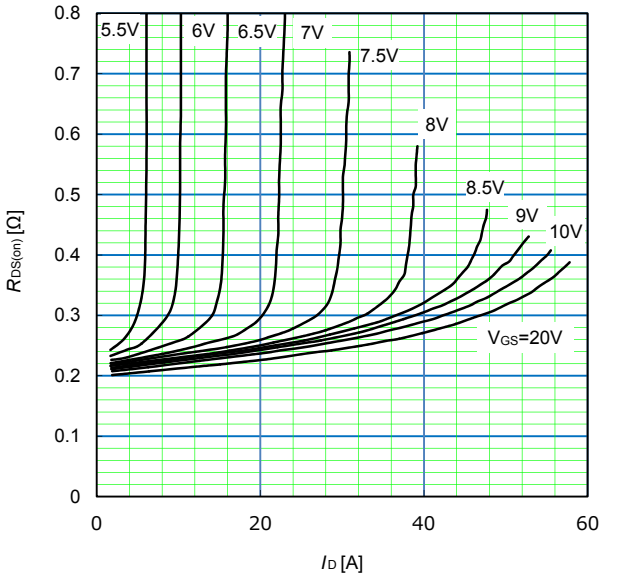
Typical output characteristics
$I_D = f(V_{DS})$: 80 µs pulse test, T_{ch}= 150°C



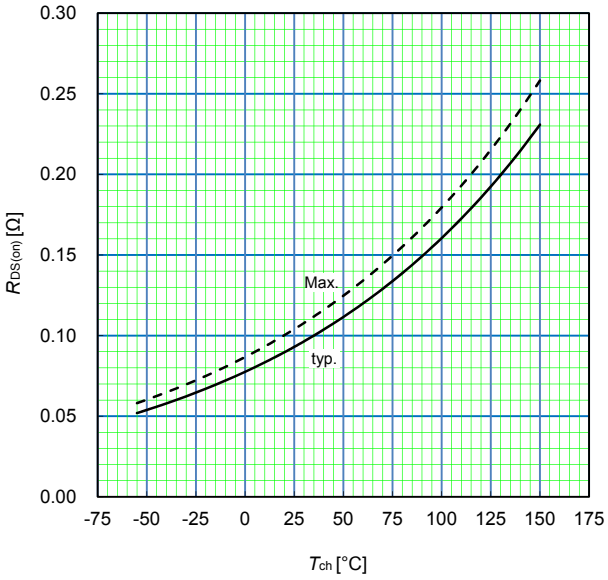
Typical drain-source on-state resistance
$I_D = f(V_{DS})$: 80 µs pulse test, T_{ch}= 25°C



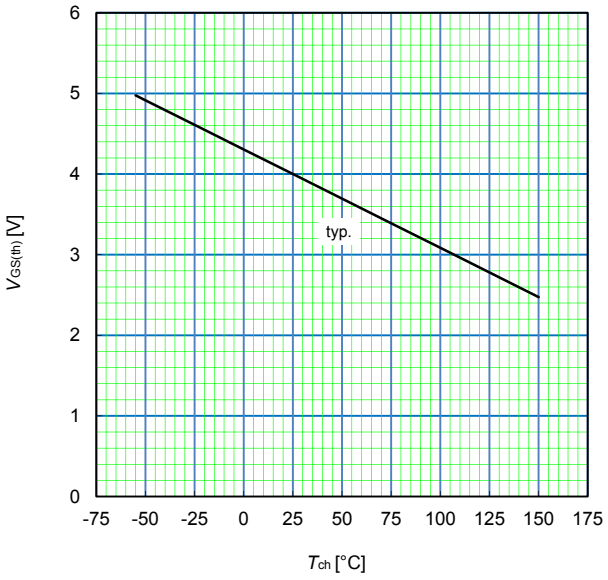
Typical drain-source on-state resistance
$I_D = f(V_{DS})$: 80 µs pulse test, T_{ch}= 150°C



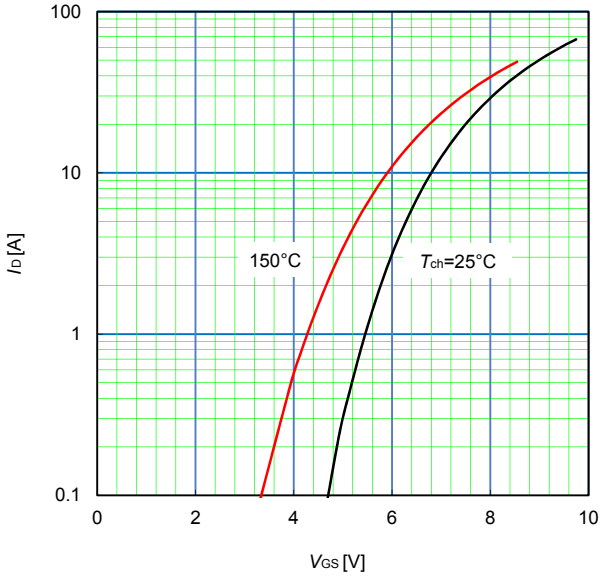
Drain-source on-state resistance
$R_{DS(on)}$= f (T_{ch}) : I_D= 16.4 A, V_{GS}= 10 V



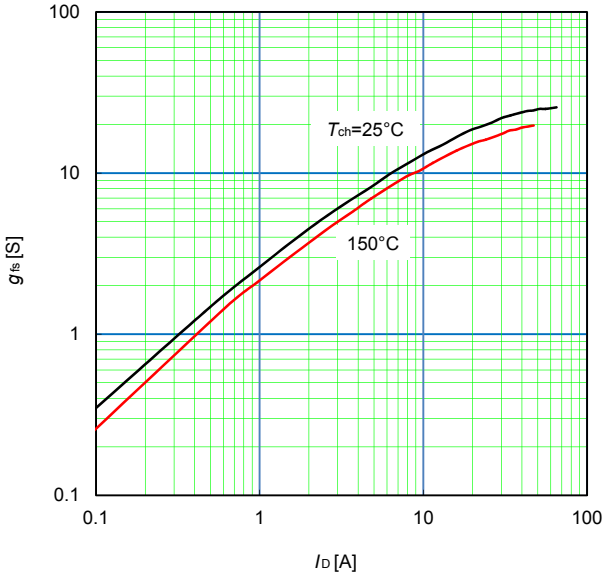
Gate threshold voltage
$V_{GS(th)}$= f (T_{ch}) : V_{DS}= V_{GS}, I_D= 4.9 mA



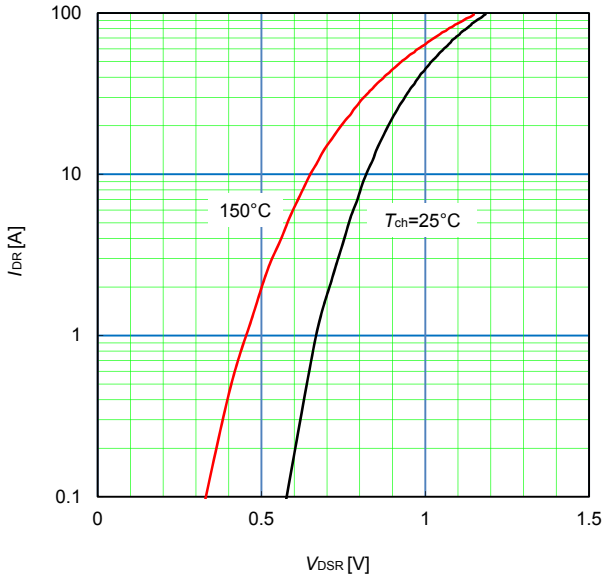
Typical transfer characteristic
I_D= f (V_{GS}) : 80 µs pulse test, V_{DS}= 25 V



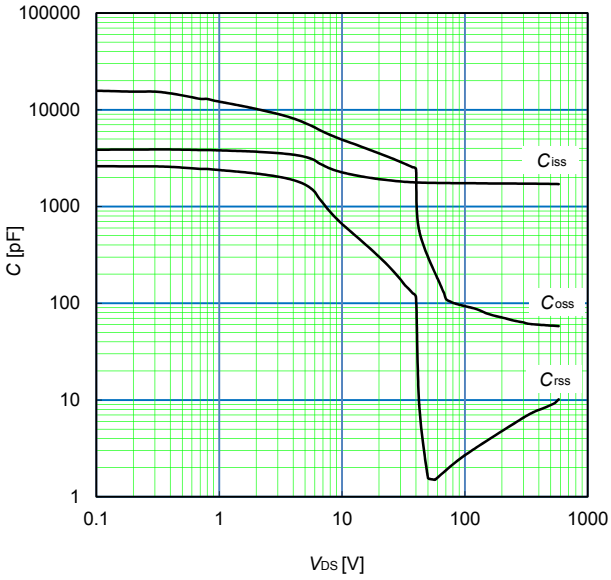
Typical transconductance
g_{fs}= f (I_D) : 80 µs pulse test, V_{DS}= 25 V



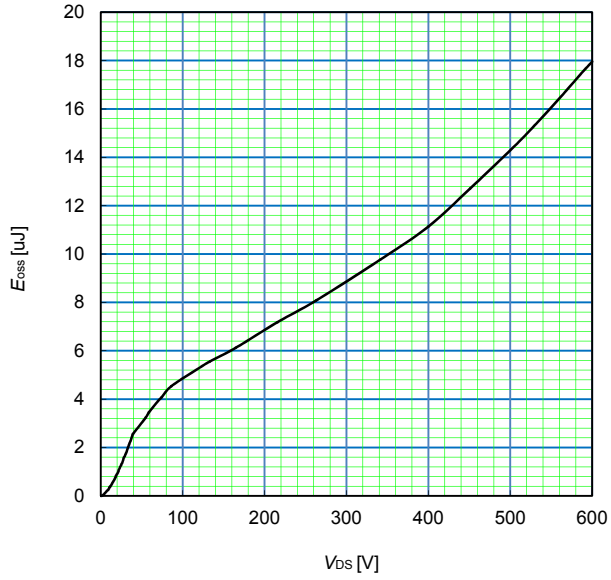
Typical forward characteristics of reverse diode
I_{DR}= f (V_{DSR}) : 80 µs pulse test



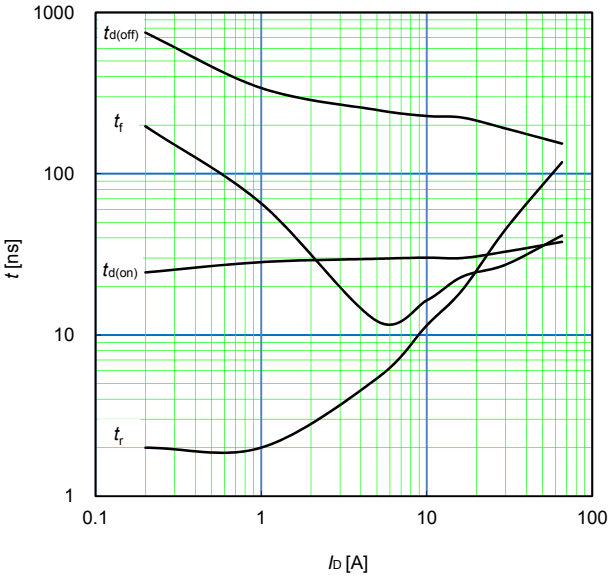
Typical capacitance
C= f (V_{DS}) : V_{GS}= 0 V, f= 250 kHz



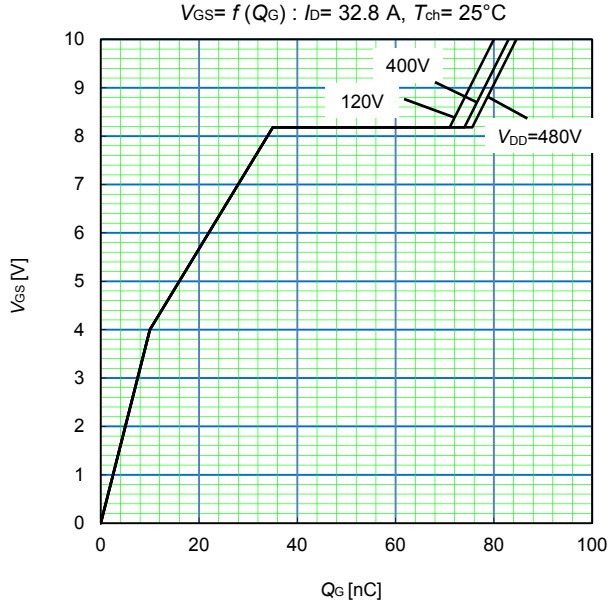
Typical C_{oss} stored energy



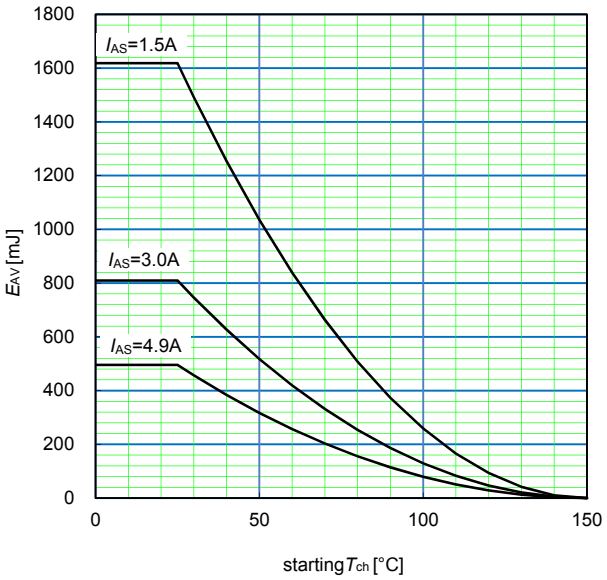
Typical switching times vs. I_D
$t = f(I_D)$: V_{DD}= 400 V, V_{GS}= 10 V/0 V, R_G= 20 Ω, T_{ch}= 25°C



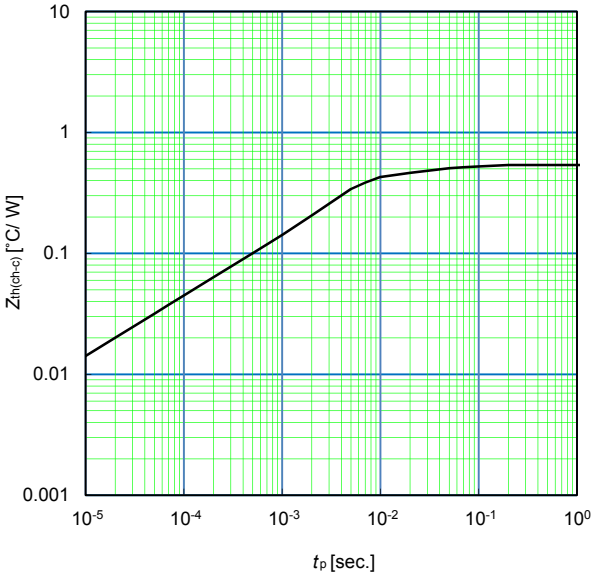
Typical gate charge
$V_{GS} = f(Q_G)$: I_D= 32.8 A, T_{ch}= 25°C



Maximum Avalanche Energy
$E_{AV} = f$ (starting T_{ch}) : V_{DD}= 60 V, $I_{AV} \leq$ 4.9 A



Transient Thermal Impedance
$Z_{th(ch-c)} = f(t)$: D= 0



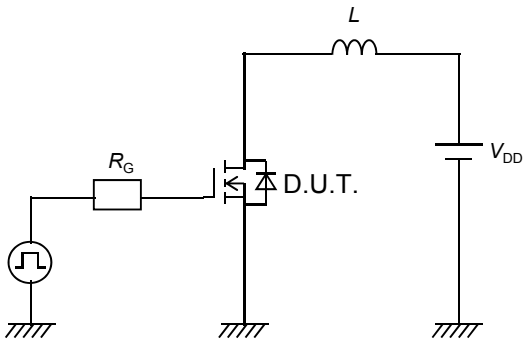


Figure 1. Unclamped inductive load test circuit

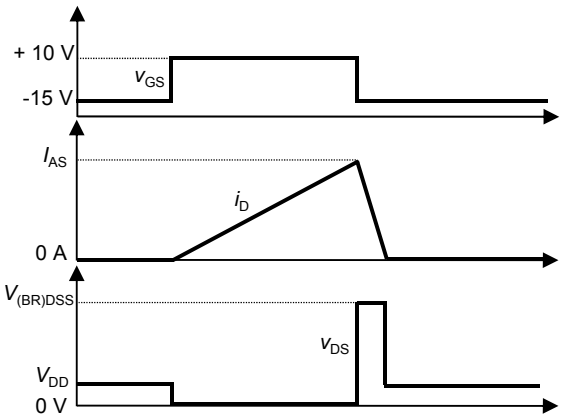


Figure 2. Unclamped inductive waveform

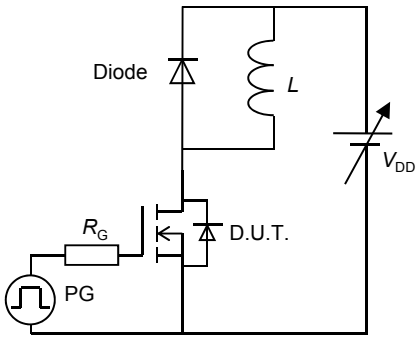


Figure 3. Switching test circuit

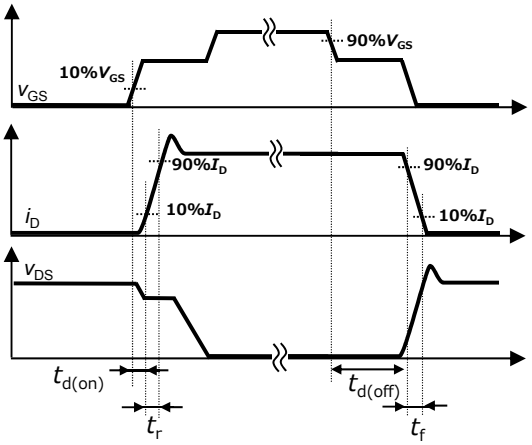


Figure 4. Switching times waveform

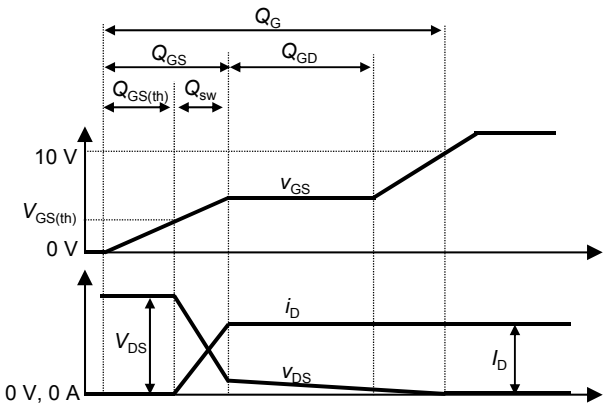


Figure 5. Gate charge waveform

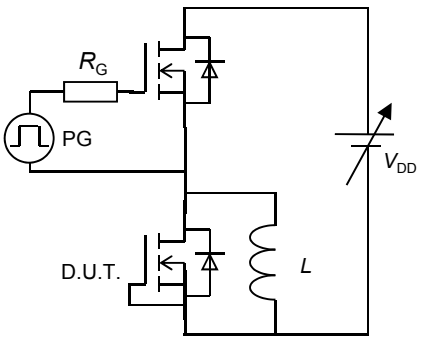


Figure 6. Diode reverse recovery test circuit

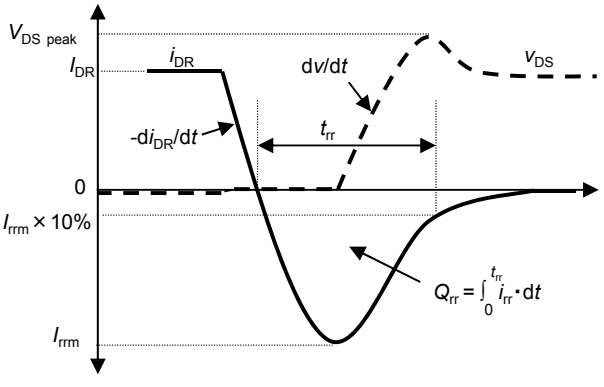
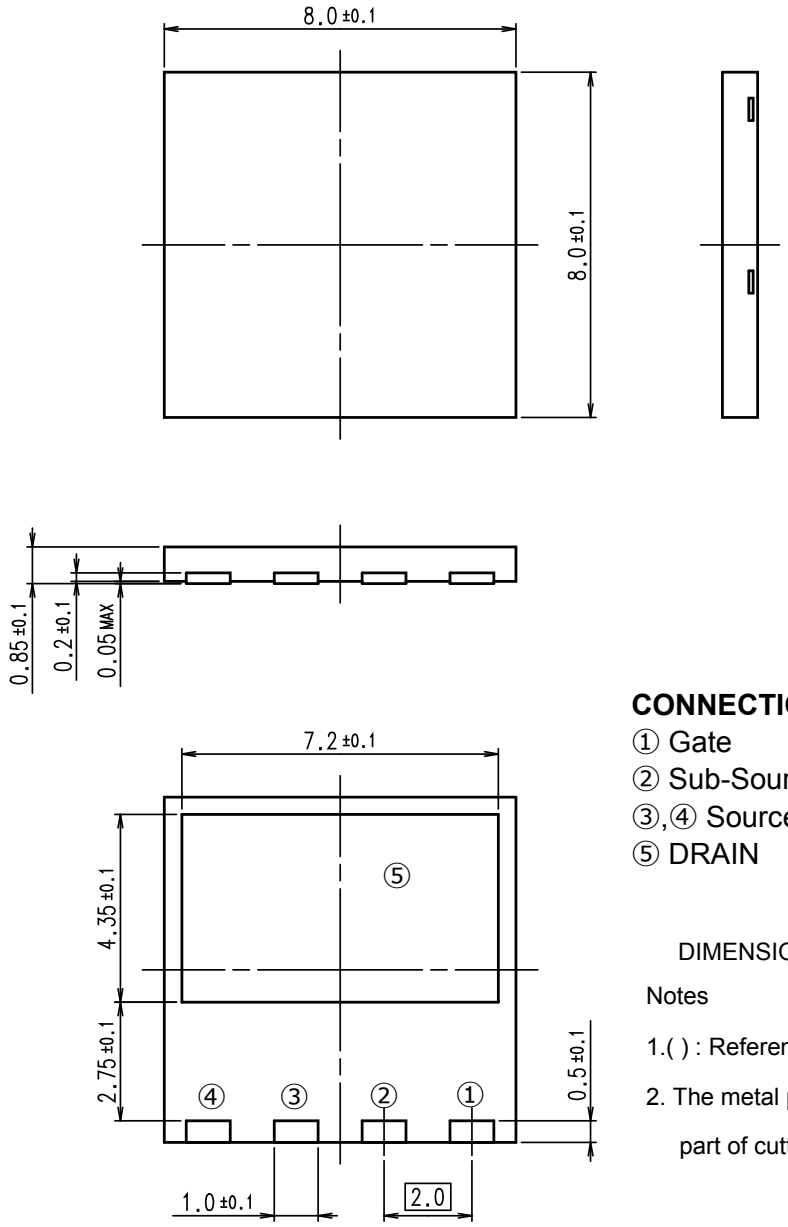


Figure 7. Diode reverse recovery waveform

Package Dimensions : DFN8x8 Package



CONNECTION

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

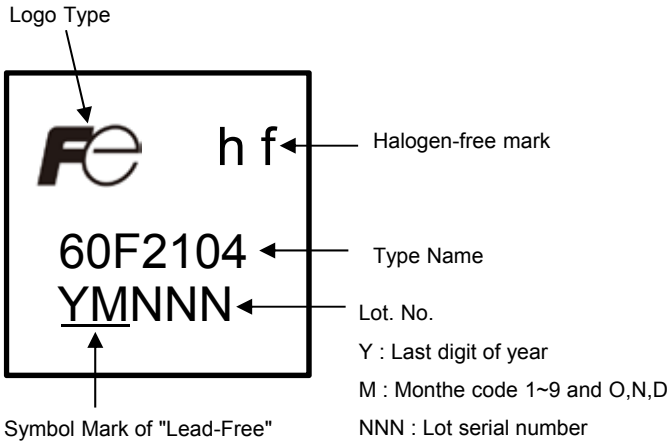
DIMENSIONS ARE IN MILLIMETERS

Notes

1.( ) : Reference dimensions.

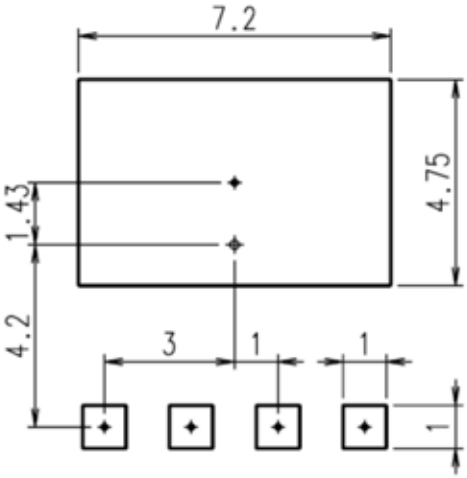
2. The metal part is covered with the solder plating, part of cutting is without the solder plating.

Marking



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

Recommended footprint



WARNING

1. This Catalog contains the product specifications, characteristics, data, materials, and structures as of November 2017.
The contents are subject to change without notice for specification changes or other reasons. When using a product listed in this Catalog, be sur to obtain the latest specifications.

2. All applications described in this Catalog exemplify the use of Fuji's products for your reference only. No right or license, either express or implied, under any patent, copyright, trade secret or other intellectual property right owned by Fuji Electric Co., Ltd. is (or shall be deemed) granted. Fuji Electric Co., Ltd. makes no representation or warranty, whether express or implied, relating to the infringement or alleged infringement of other's intellectual property rights which may arise from the use of the applications described herein.

3. Although Fuji Electric Co., Ltd. is enhancing product quality and reliability, a small percentage of semiconductor products may become faulty. When using Fuji Electric semiconductor products in your equipment, you are requested to take adequate safety measures to prevent the equipment from causing a physical injury, fire, or other problem if any of the products become faulty. It is recommended to make your design failsafe, flame retardant, and free of malfunction.

4. The products introduced in this Catalog are intended for use in the following electronic and electrical equipment which has normal reliability requirements.
- Computers
- OA equipment
- Communications equipment (terminal devices)
- Measurement equipment
- Machine tools
- Audiovisual equipment
- Electrical home appliances
- Personal equipment
- Industrial robots etc.

5. If you need to use a product in this Catalog for equipment requiring higher reliability than normal, such as for the equipment listed below, it is imperative to contact Fuji Electric Co., Ltd. to obtain prior approval. When using these products for such equipment, take adequate measures such as a backup system to prevent the equipment from malfunctioning even if a Fuji's product incorporated in the equipment becomes faulty.
- Transportation equipment (mounted on cars and ships)
- Trunk communications equipment
- Traffic-signal control equipment
- Gas leakage detectors with an auto-shut-off feature
- Emergency equipment for responding to disasters and anti-burglary devices
- Safety devices
- Medical equipment

6. Do not use products in this Catalog for the equipment requiring strict reliability such as the following and equivalents to strategic equipment (without limitation).
- Space equipment
- Aeronautic equipment
- Nuclear control equipment
- Submarine repeater equipment

8. If you have any question about any portion in this Catalog, ask Fuji Electric Co., Ltd. or its sales agents before using the product.
Neither Fuji Electric Co., Ltd. nor its agents shall be liable for any injury caused by any use of the products not in accordance with instructions set forth herein.