

# FMI13N60ES

FUJI POWER MOSFET

## Super FAP-E<sup>3S</sup> series

## N-CHANNEL SILICON POWER MOSFET

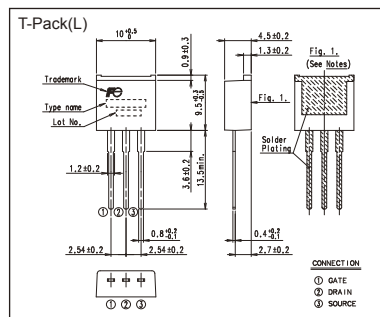
### Features

- Maintains both low power loss and low noise
- Lower  $R_{DS(on)}$  characteristic
- More controllable switching  $dv/dt$  by gate resistance
- Smaller  $V_{GS}$  ringing waveform during switching
- Narrow band of the gate threshold voltage ( $4.2 \pm 0.5V$ )
- High avalanche durability

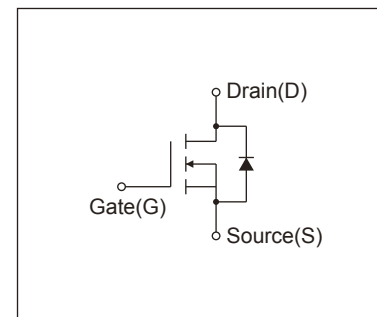
### Applications

- Switching regulators
- UPS (Uninterruptible Power Supply)
- DC-DC converters

### Outline Drawings [mm]



### Equivalent circuit schematic



### Maximum Ratings and Characteristics

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

Description	Symbol	Characteristics	Unit	Remarks
Drain-Source Voltage	$V_{DS}$	600	V	
	$V_{DSX}$	600	V	$V_{GS} = -30V$
Continuous Drain Current	$I_D$	$\pm 13$	A	
Pulsed Drain Current	$I_{DP}$	$\pm 52$	A	
Gate-Source Voltage	$V_{GS}$	$\pm 30$	V	
Repetitive and Non-Repetitive Maximum Avalanche Current	$I_{AR}$	13	A	Note*1
Non-Repetitive Maximum Avalanche Energy	$E_{AS}$	471.5	mJ	Note*2
Repetitive Maximum Avalanche Energy	$E_{AR}$	22.5	mJ	Note*3
Peak Diode Recovery $dV/dt$	$dV/dt$	4.7	kV/ $\mu\text{s}$	Note*4
Peak Diode Recovery $-di/dt$	$-di/dt$	100	A/ $\mu\text{s}$	Note*5
Maximum Power Dissipation	$P_D$	1.67	W	$T_a=25^\circ\text{C}$
		225		$T_c=25^\circ\text{C}$
Operating and Storage Temperature range	$T_{ch}$	150	$^\circ\text{C}$	
	$T_{stg}$	-55 to + 150	$^\circ\text{C}$	

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

Description	Symbol	Conditions	min.	typ.	max.	Unit
Drain-Source Breakdown Voltage	$BV_{DSS}$	$I_D=250\mu\text{A}$ , $V_{GS}=0V$	600	-	-	V
Gate Threshold Voltage	$V_{GS(th)}$	$I_D=250\mu\text{A}$ , $V_{DS}=V_{GS}$	3.7	4.2	4.7	V
Zero Gate Voltage Drain Current	$I_{DSS}$	$V_{DS}=600V$ , $V_{GS}=0V$ , $T_{ch}=25^\circ\text{C}$	-	-	25	$\mu\text{A}$
		$V_{DS}=480V$ , $V_{GS}=0V$ , $T_{ch}=125^\circ\text{C}$	-	-	250	
Gate-Source Leakage Current	$I_{GSS}$	$V_{GS}=\pm 30V$ , $V_{DS}=0V$	-	10	100	nA
Drain-Source On-State Resistance	$R_{DS(on)}$	$I_D=6.5A$ , $V_{GS}=10V$	-	0.50	0.58	$\Omega$
Forward Transconductance	$g_{fs}$	$I_D=6.5A$ , $V_{DS}=25V$	5	10	-	S
Input Capacitance	$C_{iss}$	$V_{DS}=25V$	-	1700	2550	pF
Output Capacitance	$C_{oss}$	$V_{GS}=0V$	-	190	285	
Reverse Transfer Capacitance	$C_{rss}$	$f=1\text{MHz}$	-	10	15	
Turn-On Time	$t_{d(on)}$	$V_{cc}=300V$	-	38	57	ns
	$t_r$	$V_{GS}=10V$	-	24	36	
Turn-Off Time	$t_{d(off)}$	$I_D=6.5A$	-	86	129	
	$t_f$	$R_G=18\Omega$	-	16	24	
Total Gate Charge	$Q_G$	$V_{cc}=300V$	-	48	72	nC
Gate-Source Charge	$Q_{GS}$	$I_D=13A$	-	16	24	
Gate-Drain Charge	$Q_{GD}$	$V_{GS}=10V$	-	16	24	
Gate-Drain Crossover Charge	$Q_{SW}$		-	7	10.5	
Avalanche Capability	$I_{AV}$	$L=2.36\text{mH}$ , $T_{ch}=25^\circ\text{C}$	13	-	-	A
Diode Forward On-Voltage	$V_{SD}$	$I_F=13A$ , $V_{GS}=0V$ , $T_{ch}=25^\circ\text{C}$	-	0.90	1.08	V
Reverse Recovery Time	$t_{rr}$	$I_F=13A$ , $V_{GS}=0V$	-	0.7	-	$\mu\text{s}$
Reverse Recovery Charge	$Q_{rr}$	$-di/dt=100A/\mu\text{s}$ , $T_{ch}=25^\circ\text{C}$	-	8	-	$\mu\text{C}$

### Thermal Characteristics

Description	Symbol	Test Conditions	min.	typ.	max.	Unit
Thermal resistance	$R_{th(ch-c)}$	Channel to case			0.560	$^\circ\text{C/W}$
	$R_{th(ch-a)}$	Channel to ambient			75.0	$^\circ\text{C/W}$

Note \*1 :  $T_{ch} \leq 150^\circ\text{C}$

Note \*2 : Stating  $T_{ch}=25^\circ\text{C}$ ,  $I_{AS}=6A$ ,  $L=24.0\text{mH}$ ,  $V_{cc}=60V$ ,  $R_G=50\Omega$

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

See to 'Avalanche Energy' graph.

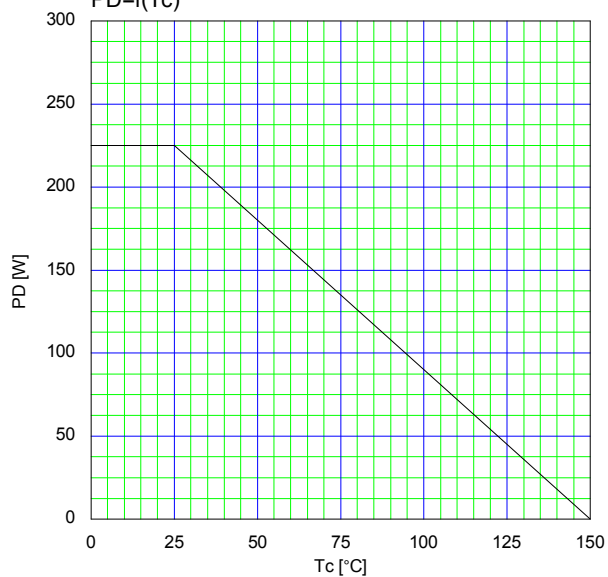
Note \*3 : Repetitive rating : Pulse width limited by maximum channel temperature.

See to the 'Transient Thermal Impedance' graph.

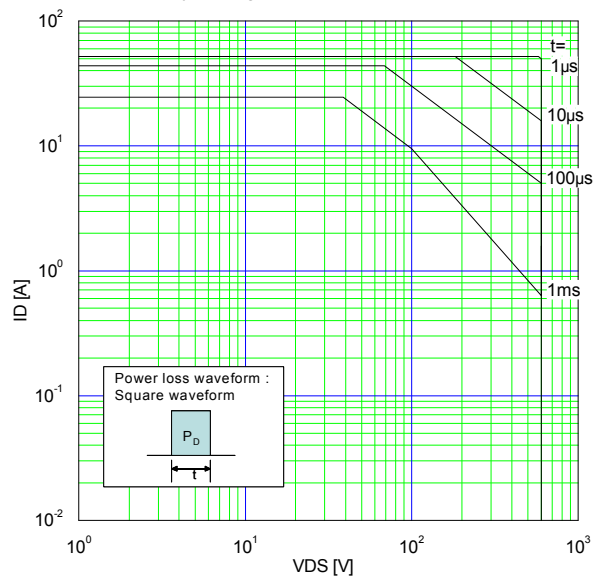
Note \*4 :  $I_F \leq I_D$ ,  $-di/dt=100A/\mu\text{s}$ ,  $V_{cc} \leq BV_{DSS}$ ,  $T_{ch} \leq 150^\circ\text{C}$ .

Note \*5 :  $I_F \leq I_D$ ,  $dv/dt=4.7kV/\mu\text{s}$ ,  $V_{cc} \leq BV_{DSS}$ ,  $T_{ch} \leq 150^\circ\text{C}$ .

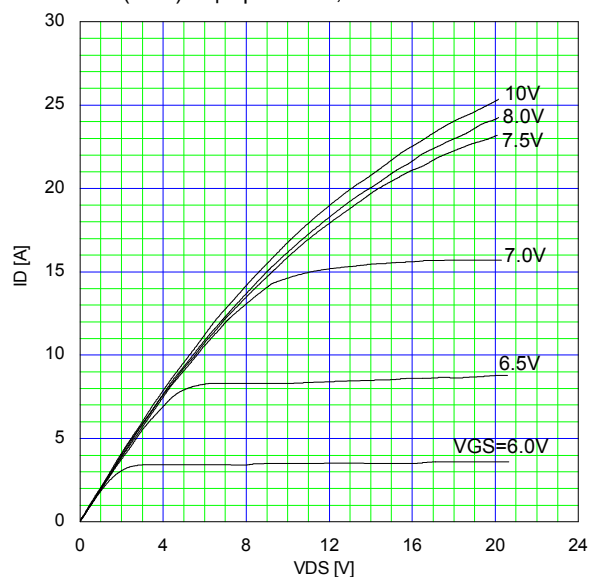
Allowable Power Dissipation  
 $P_D = f(T_c)$



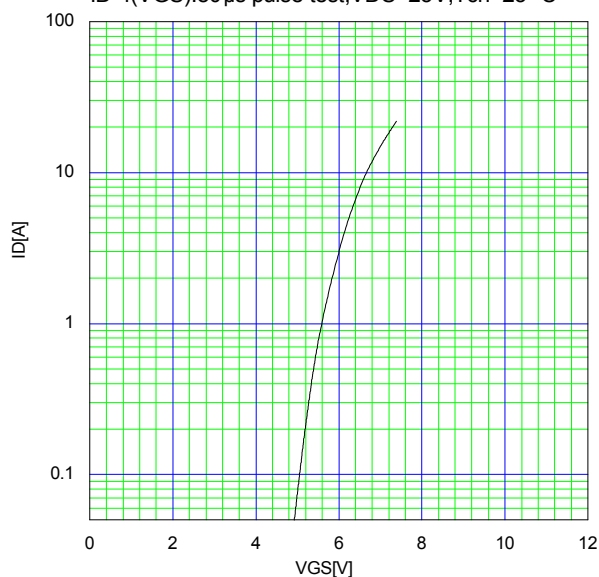
Safe Operating Area  
 $I_D = f(V_{DS})$ : Duty=0 (Single pulse),  $T_c = 25$  °C



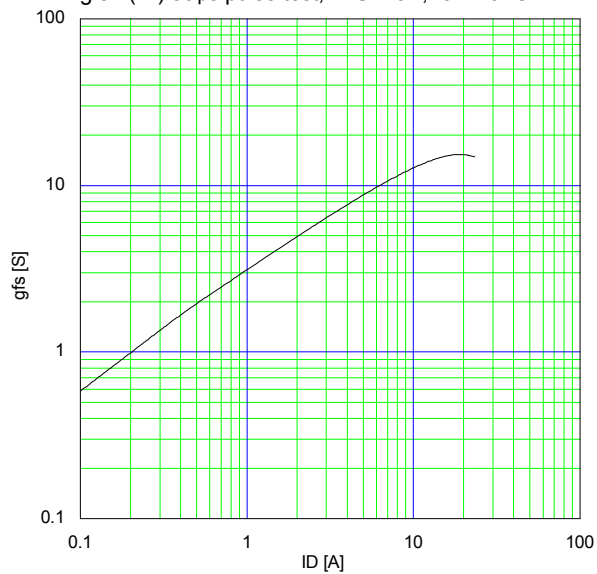
Typical Output Characteristics  
 $I_D = f(V_{DS})$ : 80  $\mu$ s pulse test,  $T_{ch} = 25$  °C



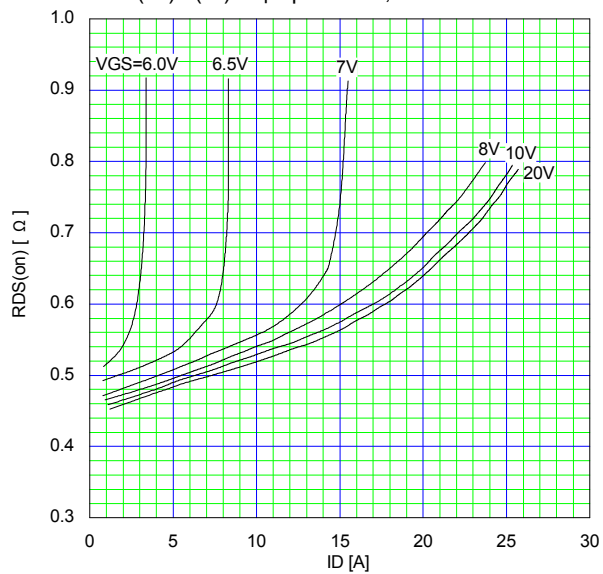
Typical Transfer Characteristic  
 $I_D = f(V_{GS})$ : 80  $\mu$ s pulse test,  $V_{DS} = 25$  V,  $T_{ch} = 25$  °C



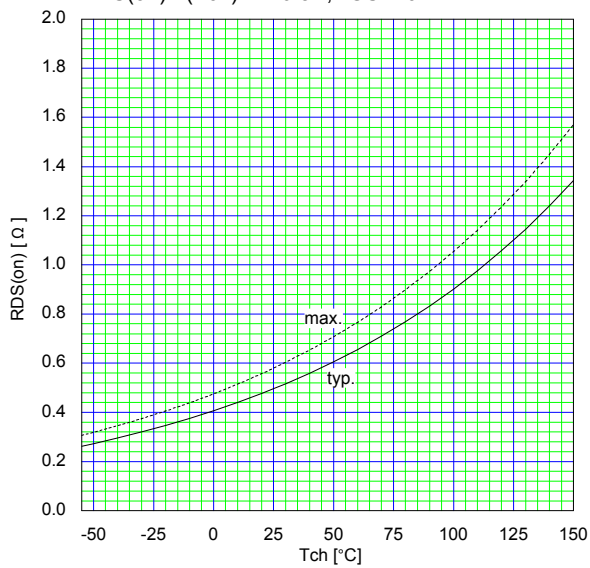
Typical Transconductance  
 $g_{fs} = f(I_D)$ : 80  $\mu$ s pulse test,  $V_{DS} = 25$  V,  $T_{ch} = 25$  °C



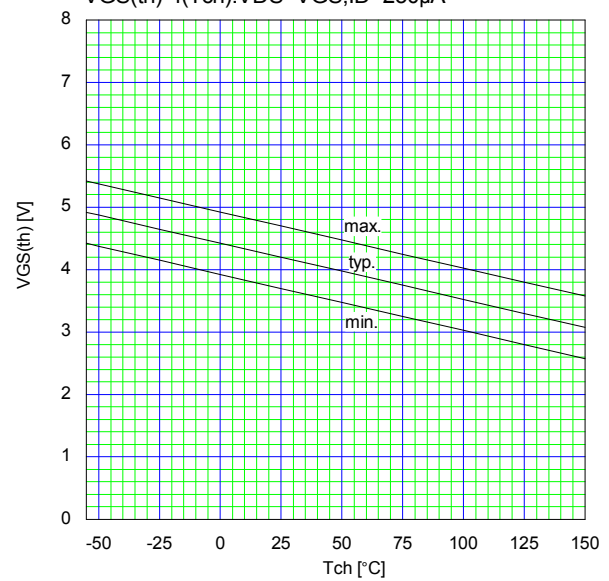
Typical Drain-Source on-state Resistance  
 $R_{DS(on)} = f(I_D)$ : 80  $\mu$ s pulse test,  $T_{ch} = 25$  °C



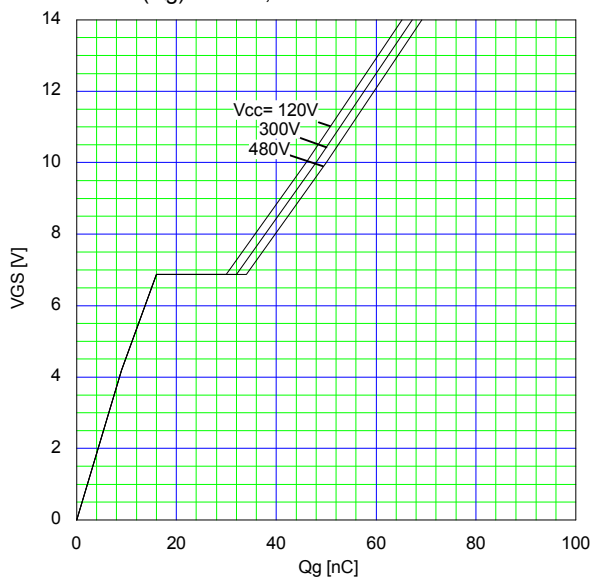
Drain-Source On-state Resistance  
 $R_{DS(on)} = f(T_{ch}): I_D = 6.5A, V_{GS} = 10V$



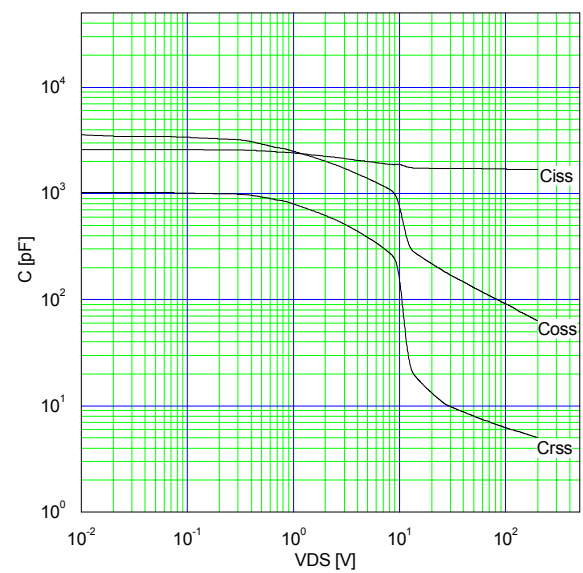
Gate Threshold Voltage vs.  $T_{ch}$   
 $V_{GS(th)} = f(T_{ch}): V_{DS} = V_{GS}, I_D = 250\mu A$



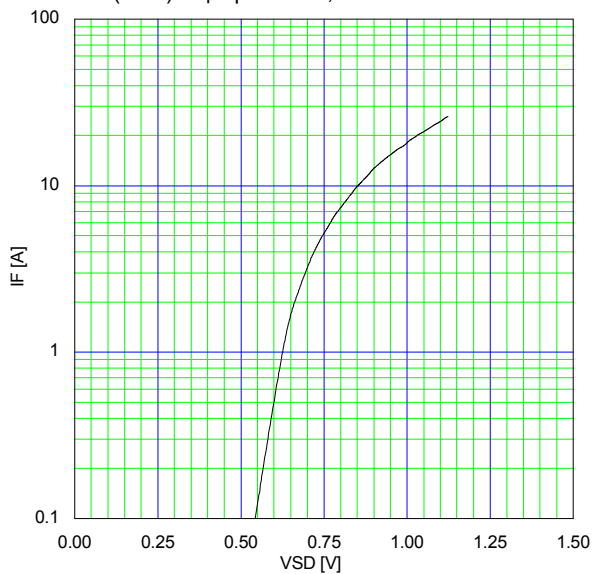
Typical Gate Charge Characteristics  
 $V_{GS} = f(Q_g): I_D = 13A, T_{ch} = 25^{\circ}C$



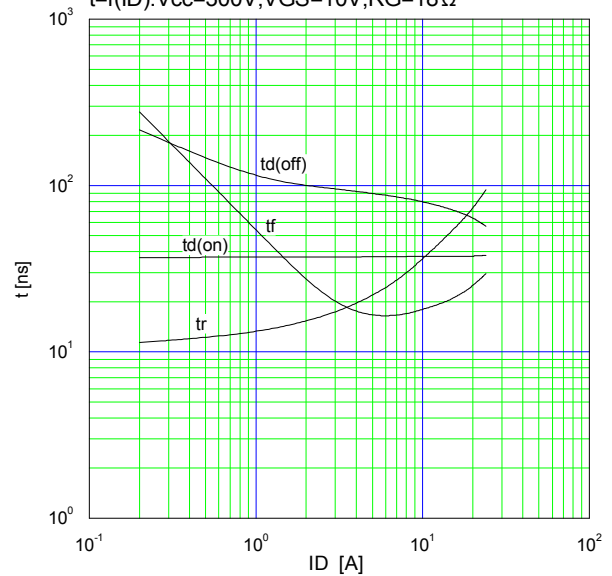
Typical Capacitance  
 $C = f(V_{DS}): V_{GS} = 0V, f = 1MHz$

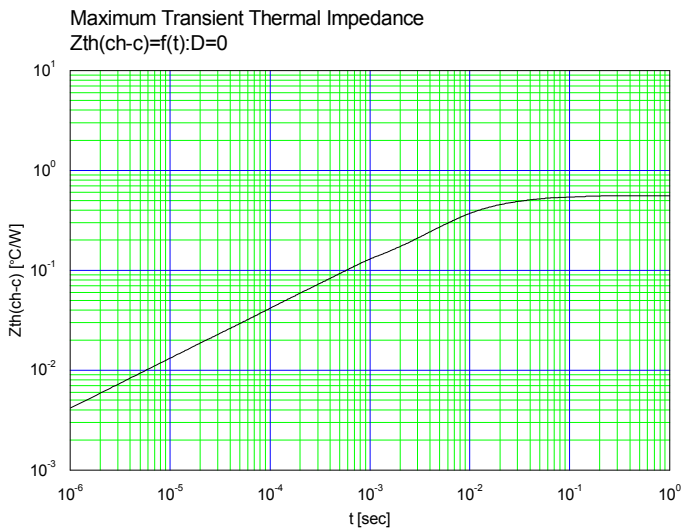
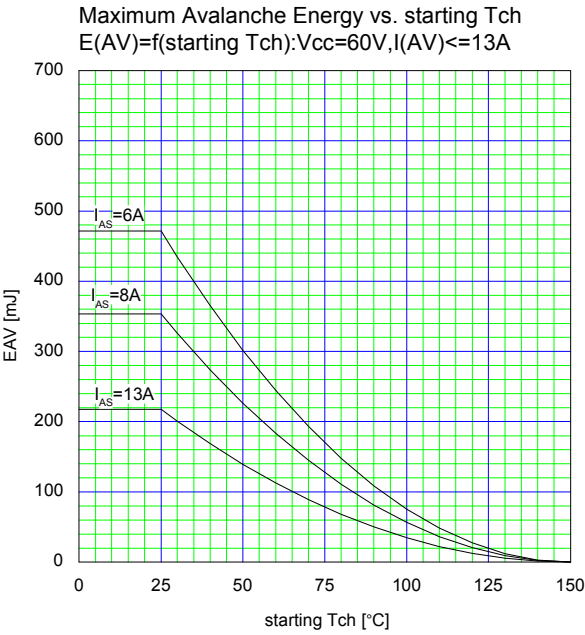


Typical Forward Characteristics of Reverse Diode  
 $I_F = f(V_{SD}): 80\mu s$  pulse test,  $T_{ch} = 25^{\circ}C$



Typical Switching Characteristics vs.  $I_D$   
 $t = f(I_D): V_{CC} = 300V, V_{GS} = 10V, R_G = 18\Omega$





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