

# FMH23N60ES

FUJI POWER MOSFET

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

## N-CHANNEL SILICON POWER MOSFET

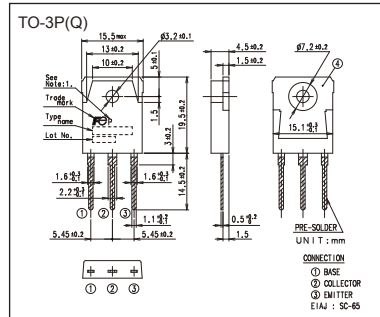
### Features

- 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

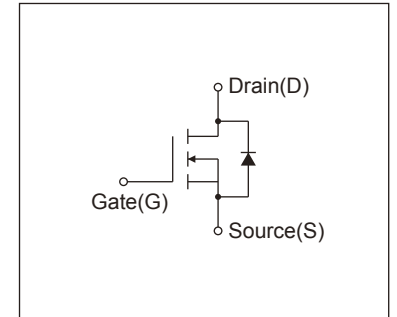
### Applications

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

### Outline Drawings [mm]



### Equivalent circuit schematic



### Maximum Ratings and Characteristics

#### Absolute Maximum Ratings at $T_c=25^\circ C$ (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	$I_D$	$\pm 23$	A	
Pulsed Drain Current	$I_{DP}$	$\pm 92$	A	
Gate-Source Voltage	$V_{GS}$	$\pm 30$	V	
Repetitive and Non-Repetitive Maximum Avalanche Current	$I_{AR}$	23	A	Note*1
Non-Repetitive Maximum Avalanche Energy	$E_{AS}$	1033.1	mJ	Note*2
Repetitive Maximum Avalanche Energy	$E_{AR}$	40	mJ	Note*3
Peak Diode Recovery $dV/dt$	$dV/dt$	4.7	kV/ $\mu s$	Note*4
Peak Diode Recovery $-di/dt$	$-di/dt$	100	A/ $\mu s$	Note*5
Maximum Power Dissipation	$P_D$	2.50	W	$T_a=25^\circ C$
		400		$T_c=25^\circ C$
Operating and Storage Temperature range	$T_{ch}$	150	$^\circ C$	
	$T_{stg}$	-55 to +150	$^\circ C$	

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

Description	Symbol	Conditions	min.	typ.	max.	Unit
Drain-Source Breakdown Voltage	$BV_{DSS}$	$I_D=250\mu A, V_{GS}=0V$	600	-	-	V
Gate Threshold Voltage	$V_{GS(th)}$	$I_D=250\mu A, V_{DS}=V_{GS}$	3.7	4.2	4.7	V
Zero Gate Voltage Drain Current	$I_{DSS}$	$V_{DS}=600V, V_{GS}=0V$	-	-	25	$\mu A$
		$V_{DS}=480V, V_{GS}=0V$	-	-	250	
Gate-Source Leakage Current	$I_{GSS}$	$V_{GS}=\pm 30V, V_{DS}=0V$	-	10	100	nA
Drain-Source On-State Resistance	$R_{DS(on)}$	$I_D=11.5A, V_{GS}=10V$	-	0.24	0.28	$\Omega$
Forward Transconductance	$g_{fs}$	$I_D=11.5A, V_{DS}=25V$	9	18	-	S
Input Capacitance	$C_{iss}$	$V_{DS}=25V$	-	3500	5250	pF
Output Capacitance	$C_{oss}$	$V_{GS}=0V$	-	380	570	
Reverse Transfer Capacitance	$C_{rss}$	$f=1MHz$	-	22	33	
Turn-On Time	$t_{d(on)}$	$V_{cc}=300V$	-	45	68	ns
	$t_r$	$V_{GS}=10V$	-	34	51	
Turn-Off Time	$t_{d(off)}$	$I_D=11.5A$	-	110	165	
	$t_f$	$R_G=8.2\Omega$	-	16	24	
Total Gate Charge	$Q_G$	$V_{cc}=300V$	-	92	138	nC
Gate-Source Charge	$Q_{GS}$	$I_D=23A$	-	28	42	
Gate-Drain Charge	$Q_{GD}$	$V_{GS}=10V$	-	33	50	
Gate-Drain Crossover Charge	$Q_{SW}$		-	11	17	
Avalanche Capability	$I_{AV}$	$L=1.56mH, T_{ch}=25^\circ C$	23	-	-	A
Diode Forward On-Voltage	$V_{SD}$	$I_F=23A, V_{GS}=0V, T_{ch}=25^\circ C$	-	0.90	1.35	V
Reverse Recovery Time	$t_{rr}$	$I_F=23A, V_{GS}=0V$	-	0.92	-	$\mu s$
Reverse Recovery Charge	$Q_{rr}$	$-di/dt=100A/\mu s, T_{ch}=25^\circ C$	-	14	-	$\mu C$

#### Thermal Characteristics

Description	Symbol	Test Conditions	min.	typ.	max.	Unit
Thermal resistance	$R_{th(ch-c)}$	Channel to case			0.313	$^\circ C/W$
	$R_{th(ch-a)}$	Channel to ambient			50.0	$^\circ C/W$

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

Note \*2 : Stating  $T_{ch}=25^\circ C, I_{AS}=10A, L=18.9mH, V_{cc}=60V, R_G=50\Omega$   
 $E_{AS}$  limited by maximum channel temperature and avalanche current.  
 See to 'Avalanche Energy' graph.

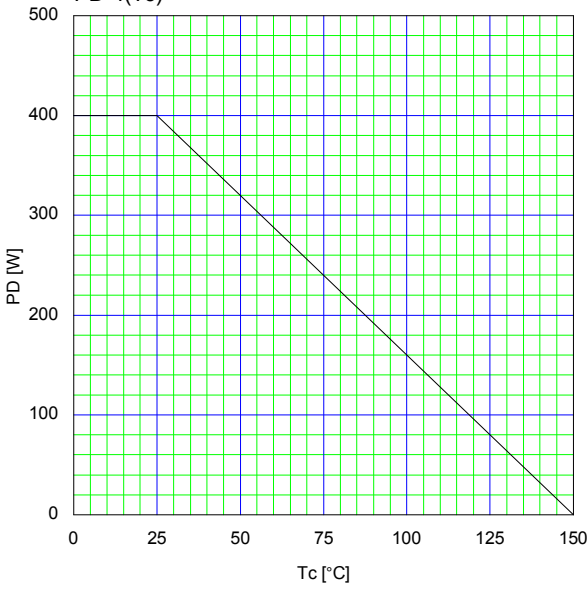
Note \*3 : Repetitive rating : Pulse width limited by maximum channel temperature.

See to the 'Transient Thermal Impedance' graph.

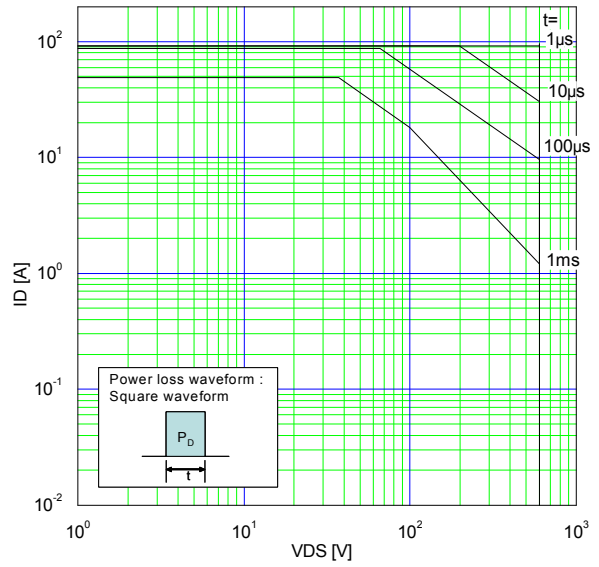
Note \*4 :  $I_F \leq I_D, -di/dt=100A/\mu s, V_{ccs}=BV_{DSS}, T_{ch} \leq 150^\circ C$ .

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

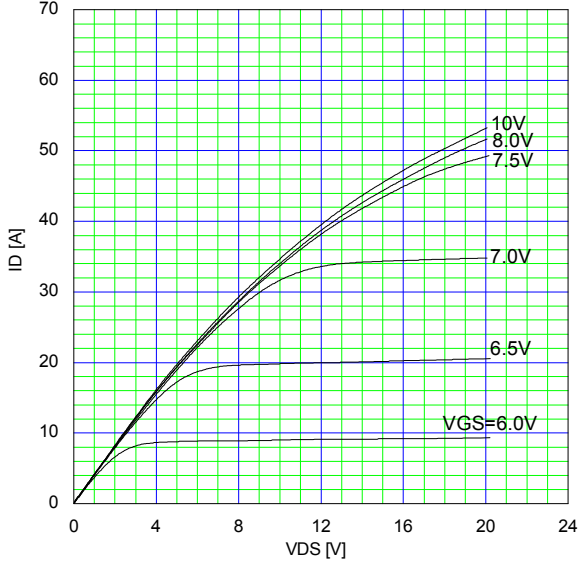
Allowable Power Dissipation  
 $PD=f(T_c)$



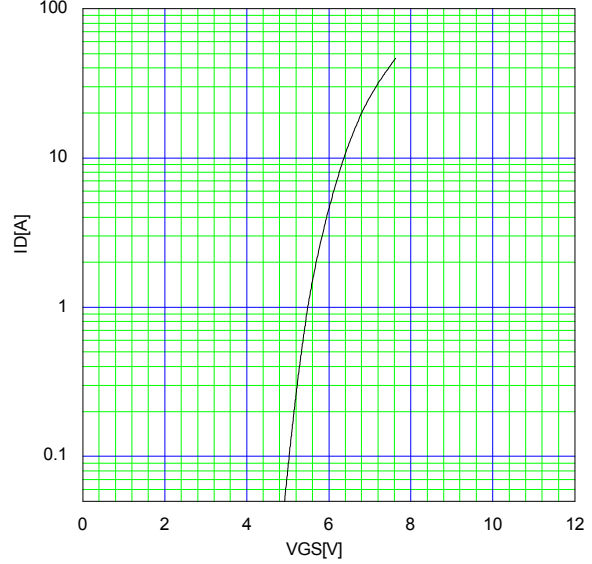
Safe Operating Area  
 $I_D=f(V_{DS}): \text{Duty}=0(\text{Single pulse}), T_c=25^\circ\text{C}$



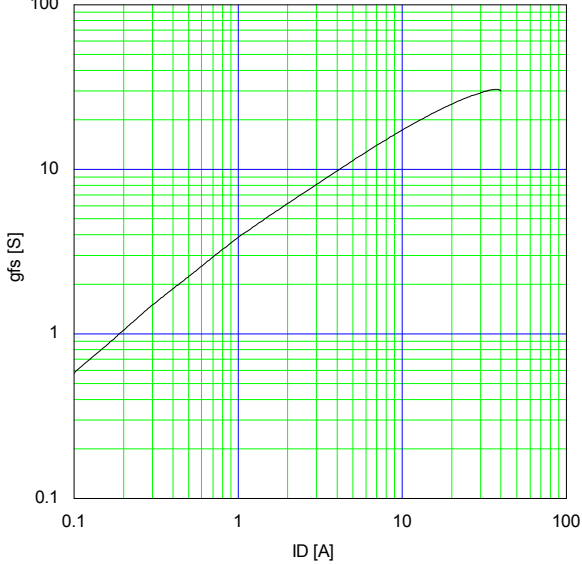
Typical Output Characteristics  
 $I_D=f(V_{DS}): 80\ \mu\text{s pulse test}, T_{ch}=25^\circ\text{C}$



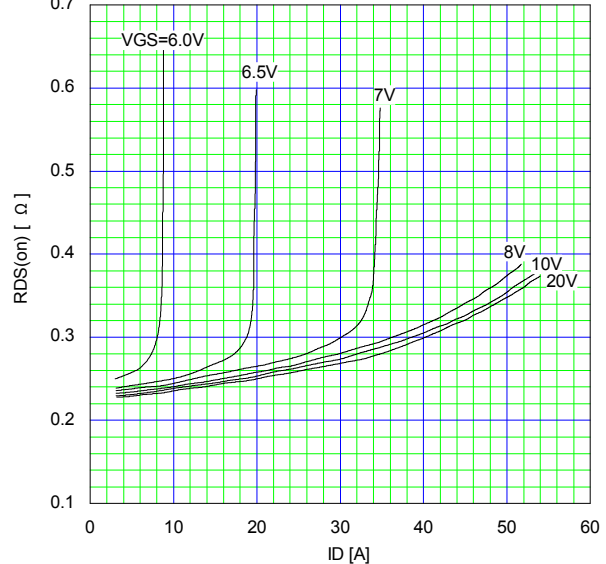
Typical Transfer Characteristic  
 $I_D=f(V_{GS}): 80\ \mu\text{s pulse test}, V_{DS}=25\text{V}, T_{ch}=25^\circ\text{C}$



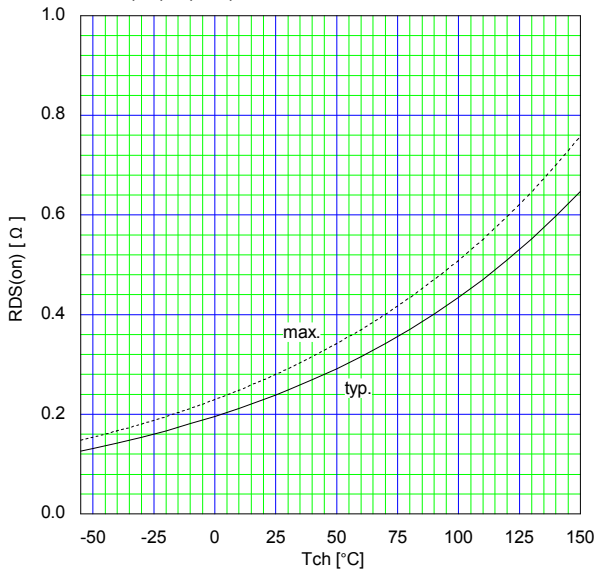
Typical Transconductance  
 $g_{fs}=f(I_D): 80\ \mu\text{s pulse test}, V_{DS}=25\text{V}, T_{ch}=25^\circ\text{C}$



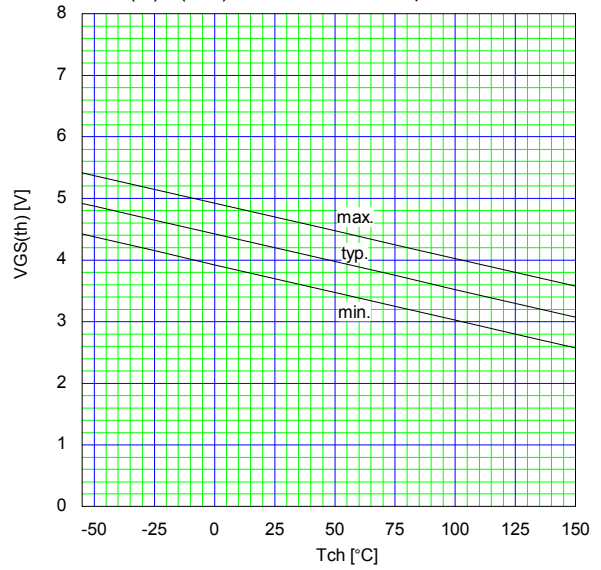
Typical Drain-Source on-state Resistance  
 $R_{DS(on)}=f(I_D): 80\ \mu\text{s pulse test}, T_{ch}=25^\circ\text{C}$



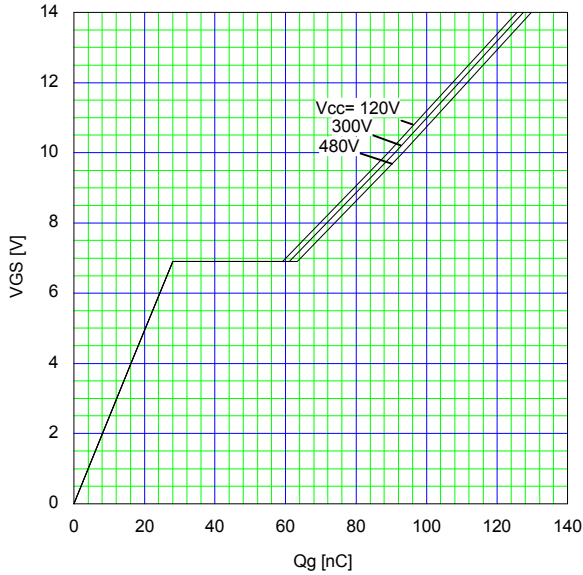
Drain-Source On-state Resistance  
 $R_{DS(on)}=f(T_{ch}):I_D=11.5A, V_{GS}=10V$



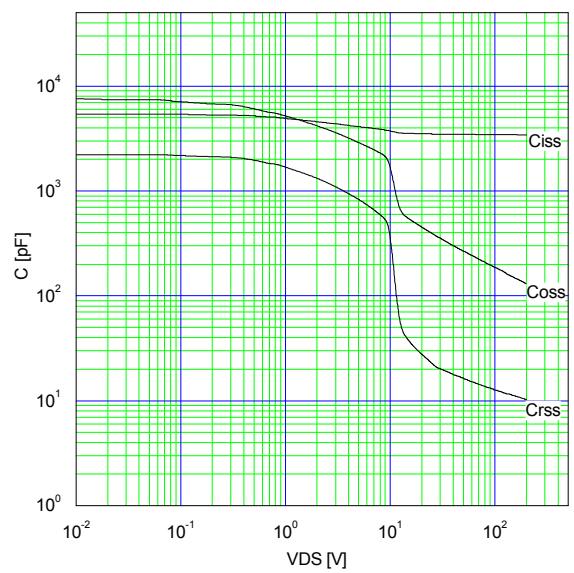
Gate Threshold Voltage vs. T<sub>ch</sub>  
 $V_{GS(th)}=f(T_{ch}):V_{DS}=V_{GS}, I_D=250\mu A$



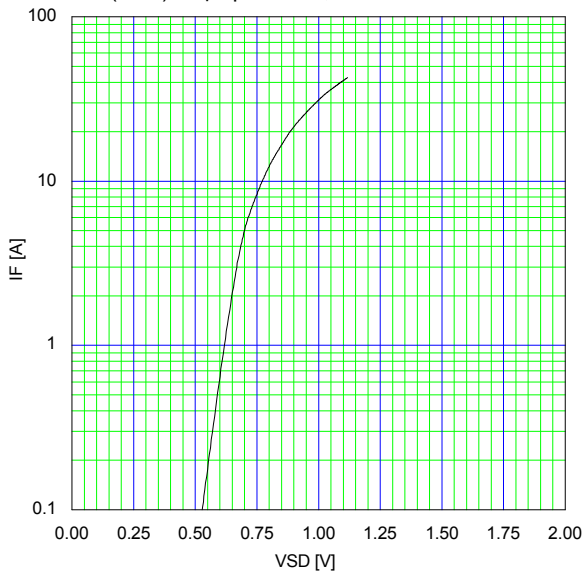
Typical Gate Charge Characteristics  
 $V_{GS}=f(Q_g):I_D=23A, T_{ch}=25\text{ °C}$



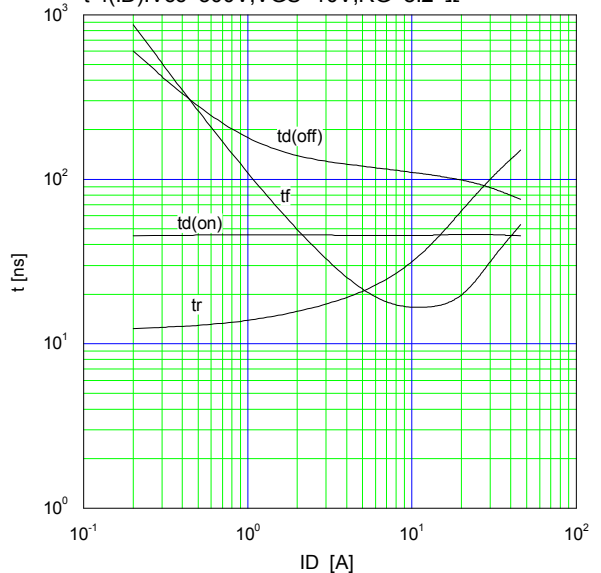
Typical Capacitance  
 $C=f(V_{DS}):V_{GS}=0V, f=1MHz$

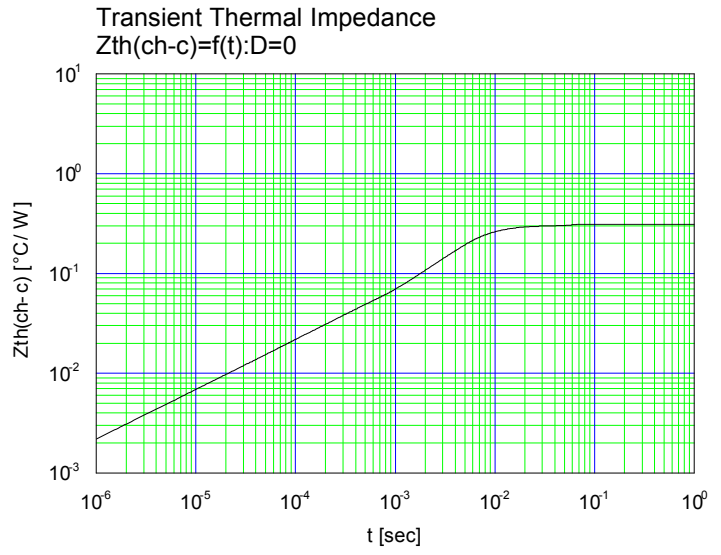
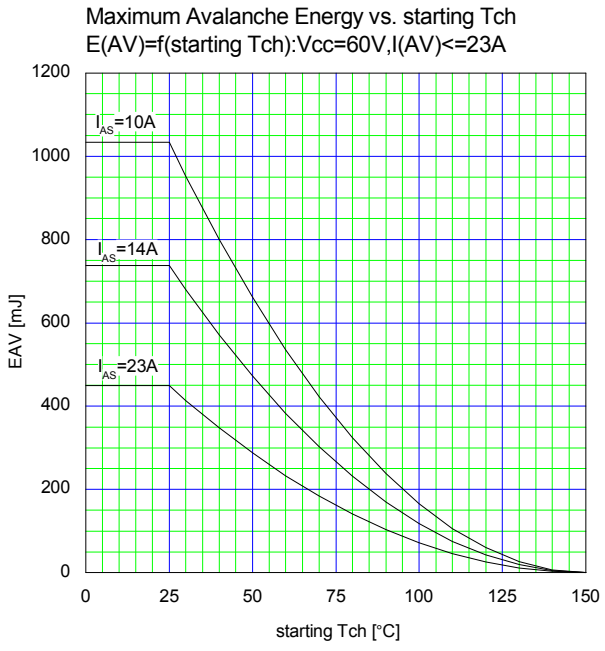


Typical Forward Characteristics of Reverse Diode  
 $I_F=f(V_{SD}):80\text{ }\mu s\text{ pulse test}, T_{ch}=25\text{ °C}$



Typical Switching Characteristics vs. I<sub>D</sub>  
 $t=f(I_D):V_{cc}=300V, V_{GS}=10V, R_G=8.2\text{ }\Omega$





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