

# FML13N60ES

FUJI POWER MOSFET

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

## N-CHANNEL SILICON POWER MOSFET

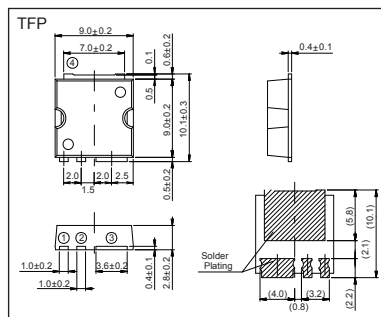
## ■ Features

- 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

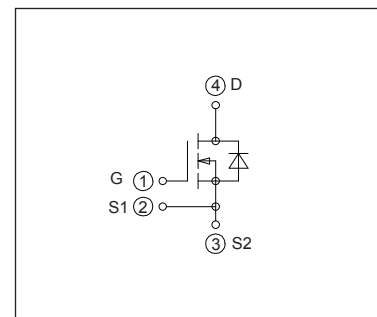
## ■ Applications

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

### ■ Outline Drawings [mm]



### ■ Equivalent circuit schematic



### Maximum Ratings and Characteristics

● Absolute Maximum Ratings at Tc=25°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	$I_D$	±13	A	
Pulsed Drain Current	$I_{DP}$	±52	A	
Gate-Source Voltage	$V_{GS}$	±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/ $\mu s$	Note*4
Peak Diode Recovery $-di/dt$	$-di/dt$	100	A/ $\mu s$	Note*5
Maximum Power Dissipation	$P_D$	1.44	W	$T_a=25^{\circ}C$
		225		$T_c=25^{\circ}C$
Operating and Storage Temperature range	$T_{ch}$	150	$^{\circ}C$	
	$T_{sto}$	-55 to +150	$^{\circ}C$	

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

Description	Symbol	Conditions	min.	typ.	max.	Unit
Drain-Source Breakdown Voltage	BV <sub>DSS</sub>	I <sub>D</sub> =250μA, V <sub>GS</sub> =0V	600	-	-	V
Gate Threshold Voltage	V <sub>GS</sub> (th)	I <sub>D</sub> =250μA, V <sub>DS</sub> =V <sub>GS</sub>	3.7	4.2	4.7	V
Zero Gate Voltage Drain Current	I <sub>DSS</sub>	V <sub>DS</sub> =600V, V <sub>GS</sub> =0V	-	-	25	μA
		V <sub>DS</sub> =480V, V <sub>GS</sub> =0V	-	-	250	
Gate-Source Leakage Current	I <sub>GSS</sub>	V <sub>GS</sub> =±30V, V <sub>DS</sub> =0V	-	10	100	nA
Drain-Source On-State Resistance	R <sub>DS</sub> (on)	I <sub>D</sub> =6.5A, V <sub>GS</sub> =10V	-	0.50	0.58	Ω
Forward Transconductance	g <sub>fs</sub>	I <sub>D</sub> =6.5A, V <sub>DS</sub> =25V	5	10	-	S
Input Capacitance	C <sub>iss</sub>	V <sub>DS</sub> =25V	-	1700	2550	pF
Output Capacitance	C <sub>oss</sub>	V <sub>GS</sub> =0V	-	190	285	
Reverse Transfer Capacitance	C <sub>rss</sub>	f=1MHz	-	10	15	
Turn-On Time	td(on)	V <sub>cc</sub> =300V	-	38	57	ns
	tr	V <sub>GS</sub> =10V	-	24	36	
Turn-Off Time	td(off)	I <sub>D</sub> =6.5A	-	86	129	
	tf	R <sub>G</sub> =18Ω	-	16	24	
Total Gate Charge	Q <sub>G</sub>	V <sub>cc</sub> =300V	-	48	56	nC
Gate-Source Charge	Q <sub>GS</sub>	I <sub>D</sub> =13A	-	16	24	
Drain-Source Crossover Charge	Q <sub>SW</sub>	V <sub>GS</sub> =10V	-	7	10.5	
Gate-Drain Charge	Q <sub>GD</sub>		-	16	24	
Avalanche Capability	I <sub>AV</sub>	L=2.36mH, T <sub>ch</sub> =25°C	13	-	-	A
Diode Forward On-Voltage	V <sub>SD</sub>	I <sub>F</sub> =13A, V <sub>GS</sub> =0V, T <sub>ch</sub> =25°C	-	0.90	1.08	V
Reverse Recovery Time	trr	I <sub>F</sub> =13A, V <sub>GS</sub> =0V	-	0.7	-	μS
Reverse Recovery Charge	Q <sub>rr</sub>	-di/dt=100A/μs, T <sub>ch</sub> =25°C	-	8	-	μC

### ● Thermal Characteristics

Description	Symbol	Test Conditions	min.	typ.	max.	Unit
Thermal resistance	Rth (ch-c)	Channel to case			0.56	°C/W
	Rth (ch-a)	Channel to Ambient			87	°C/W
	Rth (ch-a)	Channel to Ambient Note*6			52	°C/W

Note \*1 : Tch≤150°C

Note \*2 : Stating Tch=25°C, IAS=5A, L=33.8mH, Vcc=50V, RG=10Ω.

EAS limited by maximum channel temperature and avalanche current.

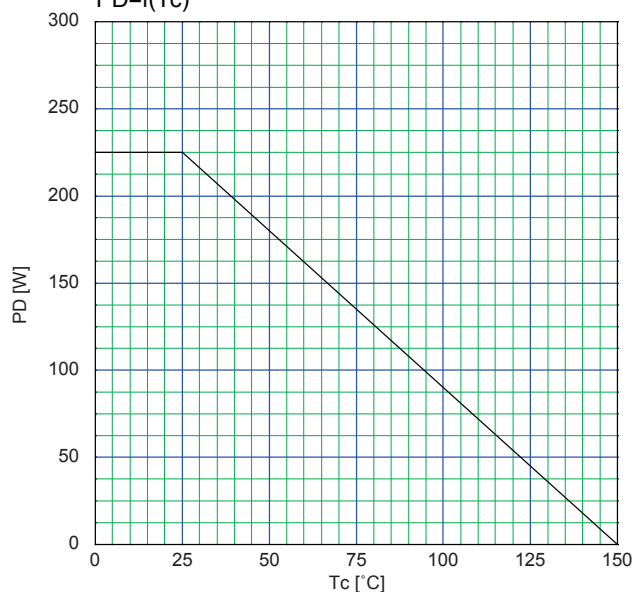
Note \*3 : Repetitive rating : Pulse width limited by maximum channel temperature.

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

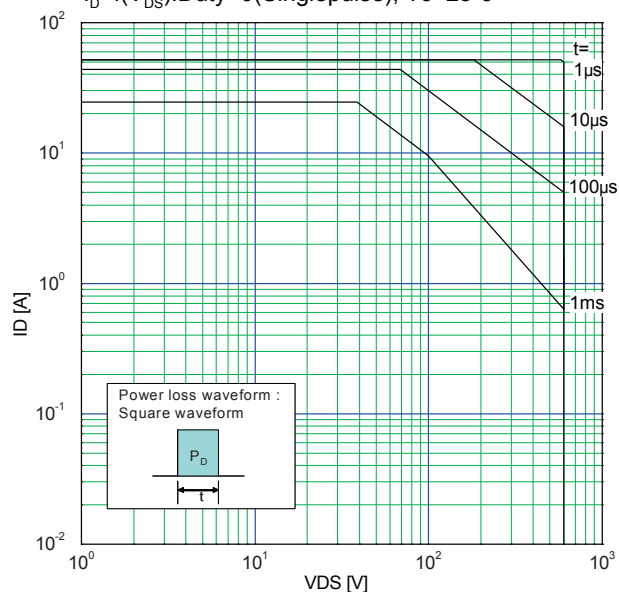
Note \*5 :  $I_F \leq -I_D$ ,  $dv/dt = 6.3 \text{ kV}/\mu\text{s}$ ,  $V_{CC} \leq BV_{DSS}$ ,  $T_{ch} \leq 150^\circ\text{C}$

Note \*6 : Surface mounted on 1000mm<sup>2</sup>, t=1.6mm FR-4 PCB (Drain pad area : 500mm<sup>2</sup>)

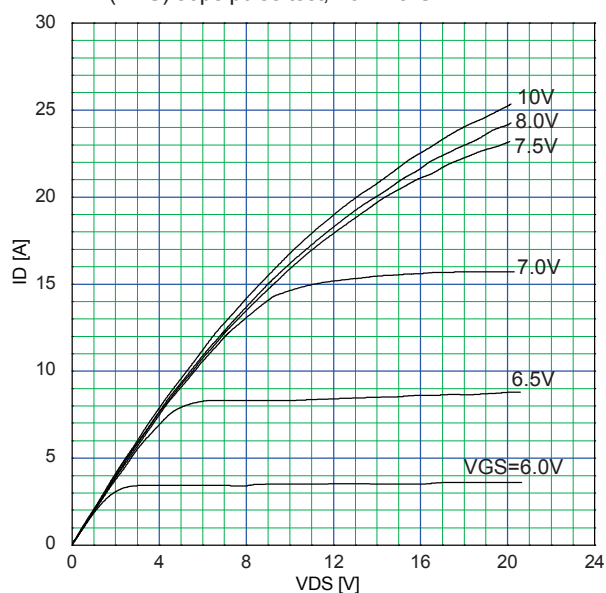
Allowable Power Dissipation  
 $P_D = f(T_c)$



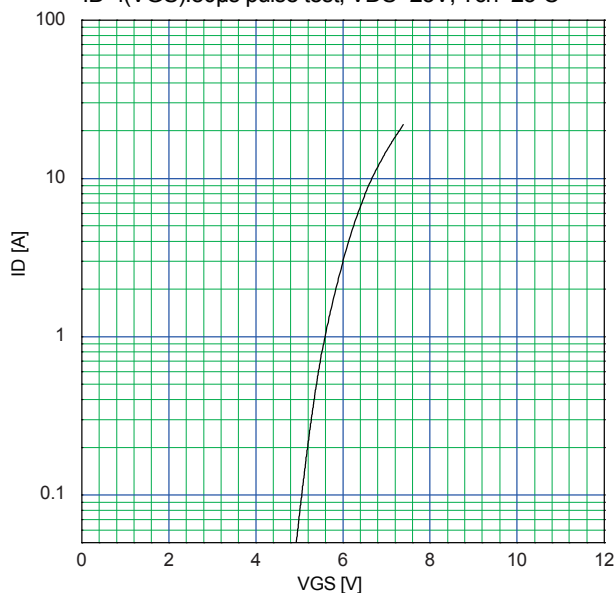
Safe Operating Area  
 $I_D = f(V_{DS})$ : Duty=0 (Single pulse),  $T_c = 25^\circ\text{C}$



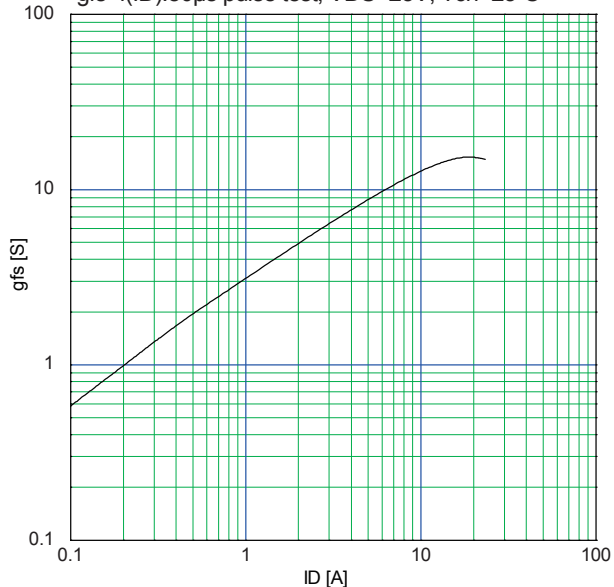
Typical Output Characteristics  
 $I_D = f(V_{DS})$ : 80μs pulse test,  $T_{ch} = 25^\circ\text{C}$



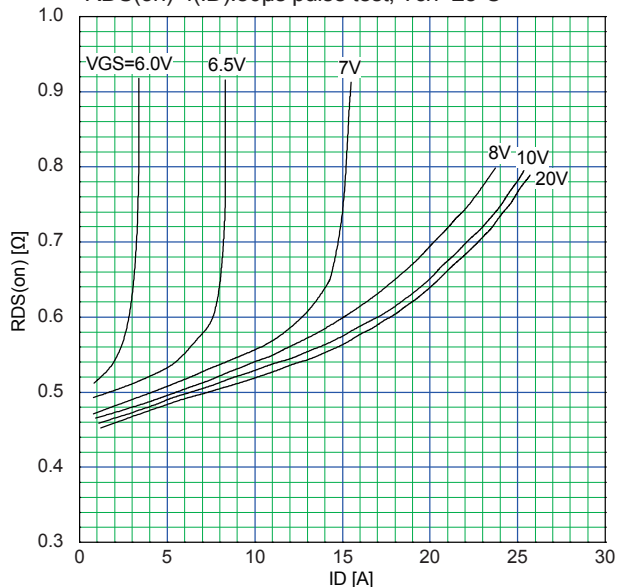
Typical Transfer Characteristic  
 $I_D = f(V_{GS})$ : 80μs pulse test,  $V_{DS} = 25\text{V}$ ,  $T_{ch} = 25^\circ\text{C}$



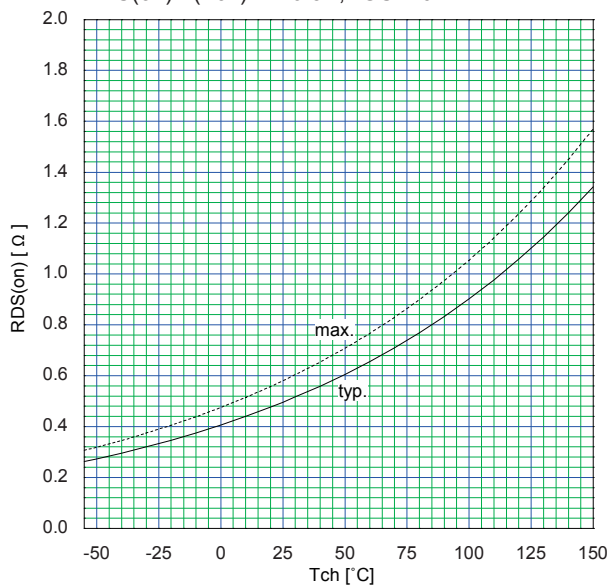
Typical Transconductance  
 $g_{fs} = f(I_D)$ : 80μs pulse test,  $V_{DS} = 25\text{V}$ ,  $T_{ch} = 25^\circ\text{C}$



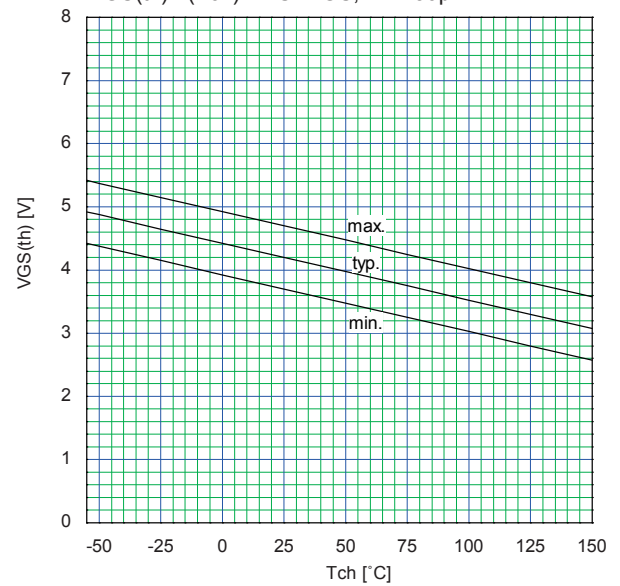
Typical Drain-Source on-state Resistance  
 $R_{DS(on)} = f(I_D)$ : 80μs pulse test,  $T_{ch} = 25^\circ\text{C}$



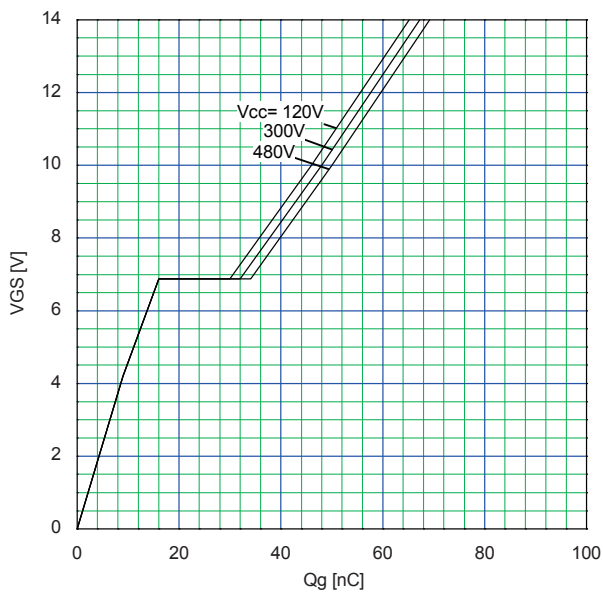
Drain-Source On-state Resistance  
 $R_{DS(on)} = f(T_{ch}): I_D = 6.5A, V_{GS} = 10V$



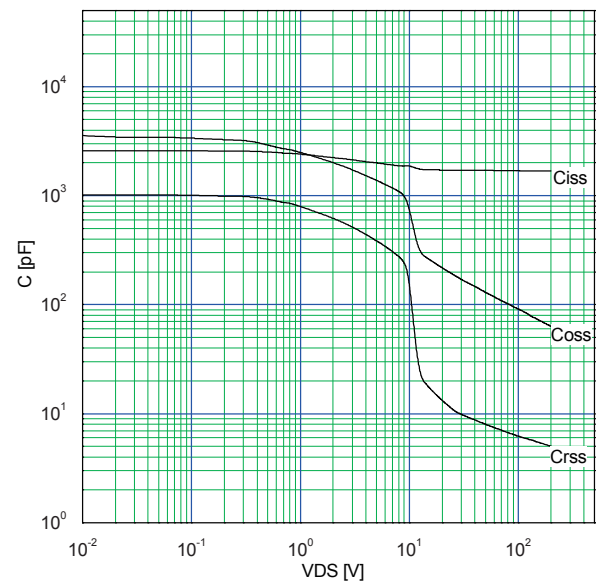
Gate Threshold Voltage vs.  $T_{ch}$   
 $V_{GS(th)} = f(T_{ch}): V_{DS} = V_{GS}, I_D = 250\mu A$



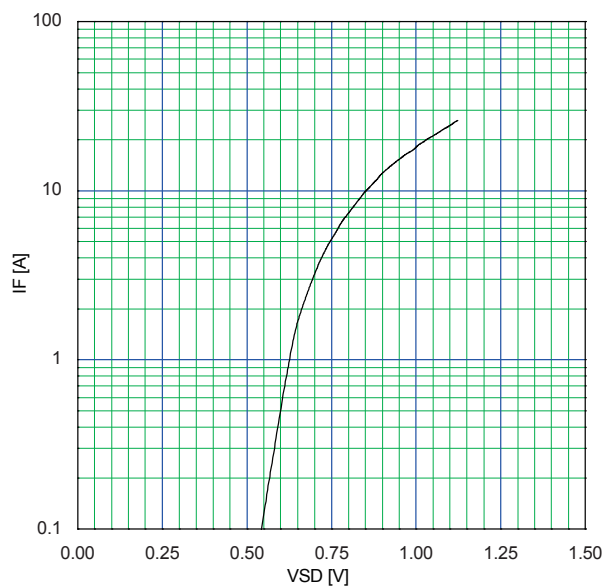
Typical Gate Charge Characteristics  
 $V_{GS} = f(Q_g): I_D = 13A, T_{ch} = 25^{\circ}C$



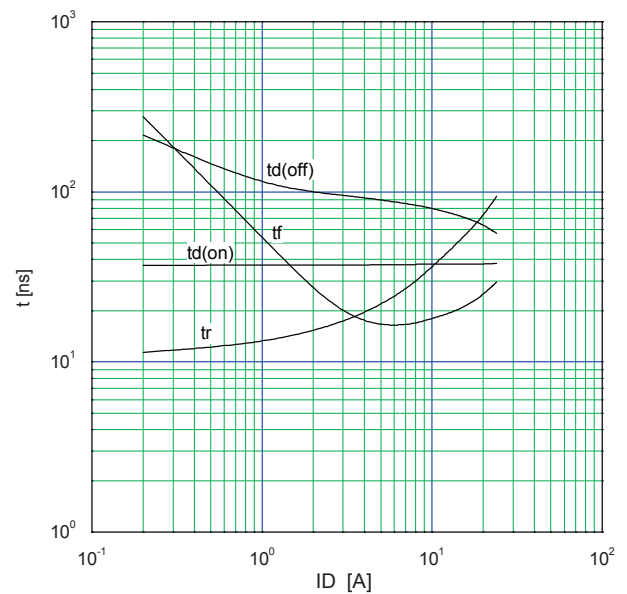
Typical Capacitance  
 $C = f(V_{DS}): V_{GS} = 0V, f = 1MHz$

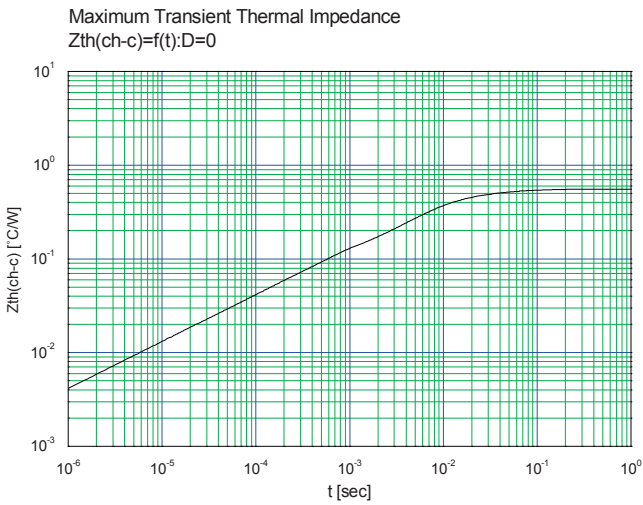
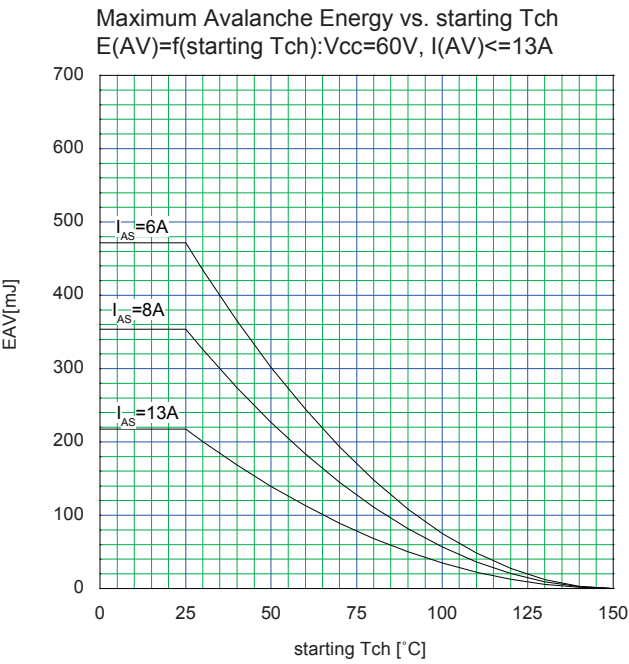


Typical Forward Characteristics of Reverse Diode  
 $I_F = f(V_{SD}): 80\mu s$  pulse test,  $T_{ch} = 25^{\circ}C$



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





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