

## 600V/4.5A Power MOSFET (N-Channel)

### General Description

- MSU5N60 is a N-Channel enhancement mode power MOSFET with advanced technology. It is designed to have better characteristics, such as fast switching time, low gate charge, minimized on-state resistance and withstanding high energy pulse in the avalanche and commutation modes. These devices are well suited for high efficiency switching mode power supply applications.
- MSU5N60 are available in TO-220, TO-220F and DPAK packages.



TO-220



TO-220F



DPAK  
(TO-252)

### Features

- $R_{DS(ON)} \leq 2.5\Omega @ V_{GS}=10V$
- Ultra low gate charge (Typ.15nC)
- Low Crss (Typ.6.5pF)
- Fast switching capability
- 100% Avalanche energy tested
- Improved dv/dt capability, high ruggedness
- RoHS Compliance and Halogen free



HALOGEN  
**FREE**

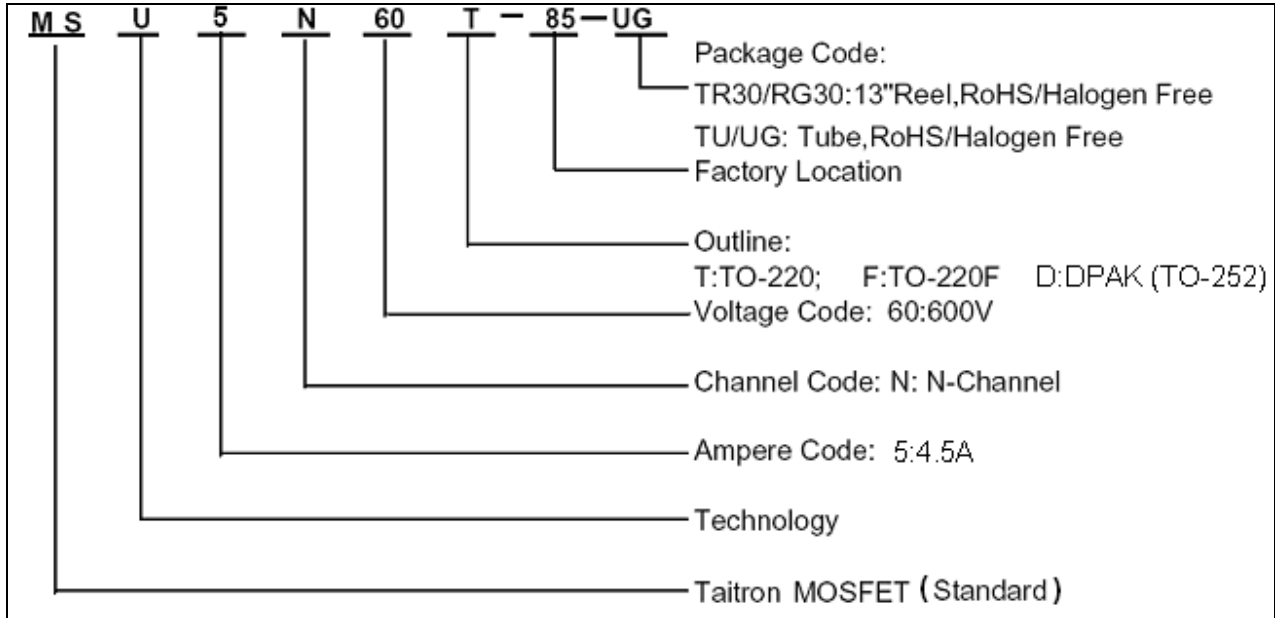
### Application

- DC to DC Converter
- Adapter
- SMPS Application.

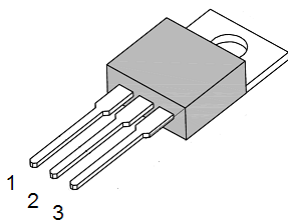
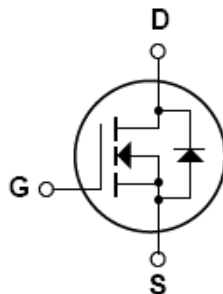
# 600V/4.5A POWER MOSFET (N-Channel)

## MSU5N60

### Ordering Information

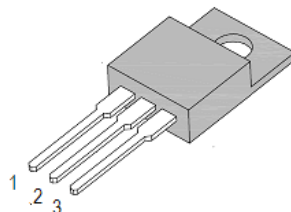


### Pin Configuration and Symbol



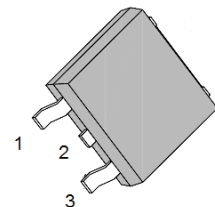
1: GATE 2: DRAIN 3: SOURCE

**TO-220**



1: GATE 2: DRAIN 3: SOURCE

**TO-220F**



1: GATE 2: DRAIN 3: SOURCE

**DPAK (TO-252)**

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## Absolute Maximum Ratings ( $T_C=25^\circ\text{C}$ unless otherwise specified, Note)

Symbol	Description		Ratings	Unit
<b>V<sub>DSS</sub></b>	Drain-Source Voltage		600	V
<b>V<sub>GSS</sub></b>	Gate-Source Voltage		± 30	V
<b>I<sub>D</sub></b>	Drain Current -Continuous		4.5	A
<b>I<sub>DM</sub></b>	Drain Current -Pulsed (note1)		18	A
<b>E<sub>AS</sub></b>	Avalanche Energy	Single Pulsed (Note2)	210	mJ
<b>E<sub>AR</sub></b>		Repetitive (Note1)	10	
<b>I<sub>AR</sub></b>	Avalanche Current (note1)		4.5	A
<b>dv/dt</b>	Peak Diode Recovery dv/dt (note3)		4.5	V/ns
<b>P<sub>D</sub></b>	Power Dissipation	TO-220	100	W
		TO-220F	33	
		DPAK	54	
<b>R<sub>θJA</sub></b>	Thermal Resistance (Junction-to-Ambient)	TO-220/ TO-220F	62.5	°C/ W
		DPAK	83	
<b>R<sub>θJC</sub></b>	Thermal Resistance (Junction-to-Case)	TO-220	1.25	°C/ W
		TO-220F	3.79	
		DPAK	2.3	
<b>T<sub>J</sub></b>	Junction Temperature		+150	° C
<b>T<sub>STG</sub></b>	Storage Temperature Range		-55 to +150	° C

Note: Absolute maximum ratings indicate limits beyond which damage to the device may occur.  
 For guarantee specification and test conditions, see the Electrical Characteristics.  
 The guaranteed specification apply only for the test conditions listed.

Note1: Repetitive Rating: Pulse width limited by maximum junction temperature  
 2: L=18.9mH, I<sub>AS</sub>=4.5A, V<sub>DD</sub>=50V, R<sub>G</sub>=25Ω, Starting T<sub>J</sub>=25°C  
 3: I<sub>sd</sub>≤4.5A, di/dt≤200A/us, V<sub>DD</sub>≤V<sub>BR(DSS)</sub>, Starting T<sub>J</sub>=25°C

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## MSU5N60

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

Symbol	Description	Min.	Typ.	Max.	Unit	Conditions	
<b>OFF CHARACTERISTICS</b>							
$V_{(BR)DSS}$	Drain-Source Breakdown Voltage	600	-	-	V	$V_{GS}=0V, I_D=250\mu A$	
$\Delta V_{(BR)DSS} / \Delta T_J$	Breakdown Voltage Temperature Coefficient	-	0.6	-	V/°C	$I_D=250\mu A$ , referenced to $25^\circ\text{C}$	
$I_{DSS}$	Drain-Source leakage Current	-	-	1	$\mu A$	$V_{DS}=600V, V_{GS}=0V$	
$I_{GSS}$	Gate-Source leakage Current	Forward	-	-	100	nA	$V_{GS}=30V, V_{DS}=0V$
		Reverse	-	-	-100	nA	$V_{GS}=-30V, V_{DS}=0V$
<b>ON CHARACTERISTICS</b>							
$V_{GS(th)}$	Gate-Source Threshold Voltage	2.0	-	4.0	V	$V_{DS}=V_{GS}, I_D=250\mu A$	
$R_{DS(on)}$	Static Drain-Source On-State Resistance	-	2.0	2.5	$\Omega$	$V_{GS}=10.0V, I_D=2.25A$	
<b>DYNAMIC CHARACTERISTICS</b>							
$C_{iss}$	Input Capacitance	-	515	670	pF	$V_{DS}=25V, V_{GS}=0V, f=1.0\text{MHz}$	
$C_{oss}$	Output Capacitance	-	55	72	pF		
$C_{rss}$	Reverse Transfer Capacitance	-	6.5	8.5	pF		
<b>SWITCHING CHARACTERISTICS</b>							
$t_d(on)$	Turn-on Delay Time	-	10	30	nS	$V_{DD}=300V, I_D=4.5A, R_G=25\Omega$ (Note 4, 5)	
$t_r$	Turn-on Rise Time	-	42	90	nS		
$t_d(off)$	Turn-off Delay Time	-	38	85	nS		
$t_f$	Turn-off Fall Time	-	46	100	nS		
$Q_g$	Total Gate Charge	-	15	19	nC	$V_{DS}=480V, I_D=4.5A, V_{GS}=10V$ (Note 4, 5)	
$Q_{gs}$	Gate-Source Charge	-	2.5	-	nC		
$Q_{gd}$	Gate-Drain Charge	-	6.6	-	nC		
<b>DRAIN-SOURCE DIODE CHARACTERISTICS AND MAXIMUM RATINGS</b>							
$V_{SD}$	Drain-Source Diode Forward Voltage	-	-	1.4	V	$V_{GS}=0V, I_S=4.5A$	
$I_S$	Maximum Continuous Drain-Source Diode Forward Current	-	-	4.5	A	-	
$I_{SM}$	Maximum Pulse Drain-Source Diode Forward Current	-	-	18	A	-	
$t_{rr}$	Reverse Recovery Time	-	300	-	nS	$V_{GS}=0V, I_S=4.5A, di_F/dt=100A/\mu s$ (Note4)	
$Q_{rr}$	Reverse Recovery Charge	-	2.2	-	$\mu C$		

Note 4: Pulse test: Pulse width  $\leq 300\mu s$ , Duty cycle  $\leq 2\%$

5: Essentially independent of operating temperature

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## Typical Characteristics Curves

Fig.1- On-Region Characteristics

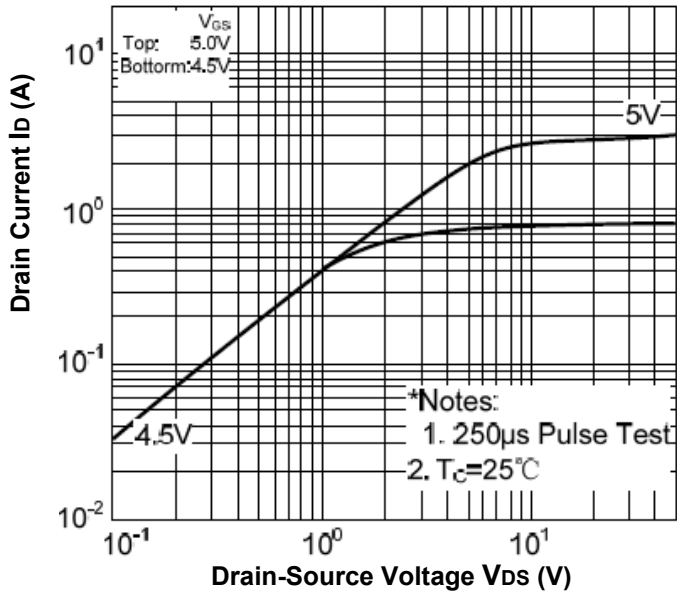


Fig.2- Transfer Characteristics

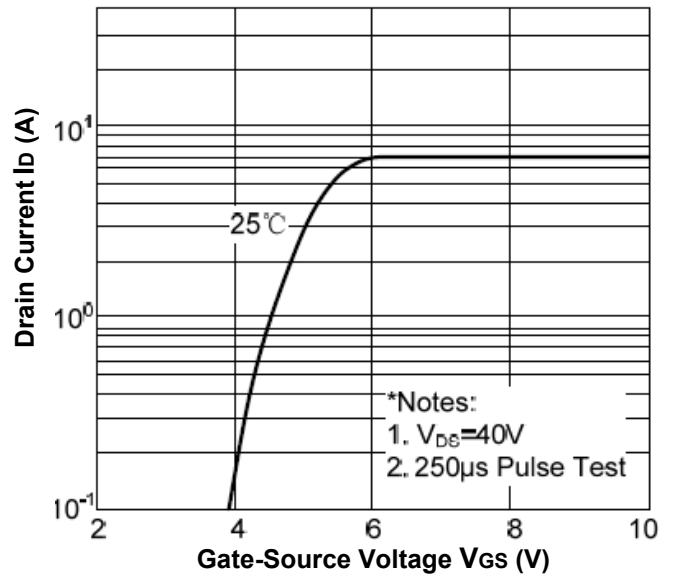


Fig.3- On-Resistance Variation Vs. Drain Current and Gate Voltage

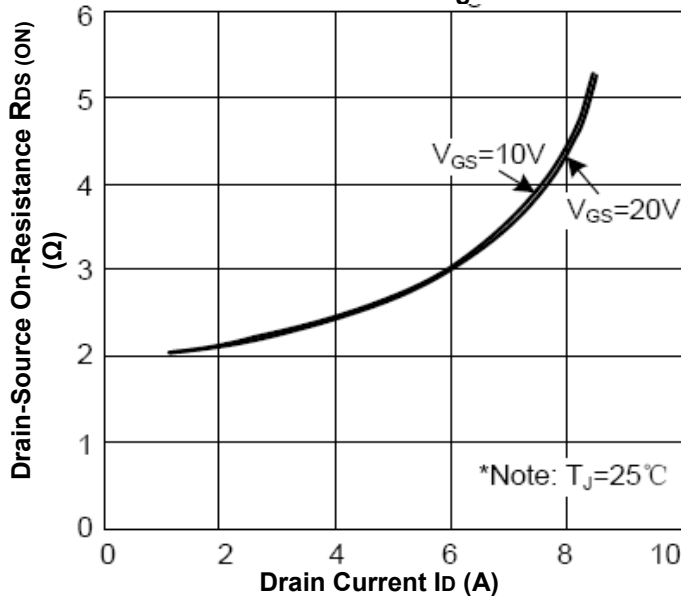
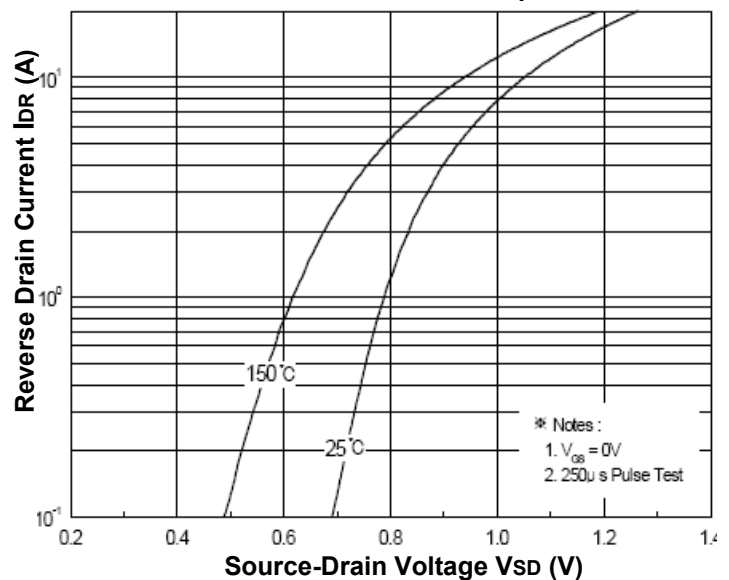


Fig.4- Body Diode Forward Voltage Variation Vs. Source Current and Temperature



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Fig.5- Capacitance Characteristics

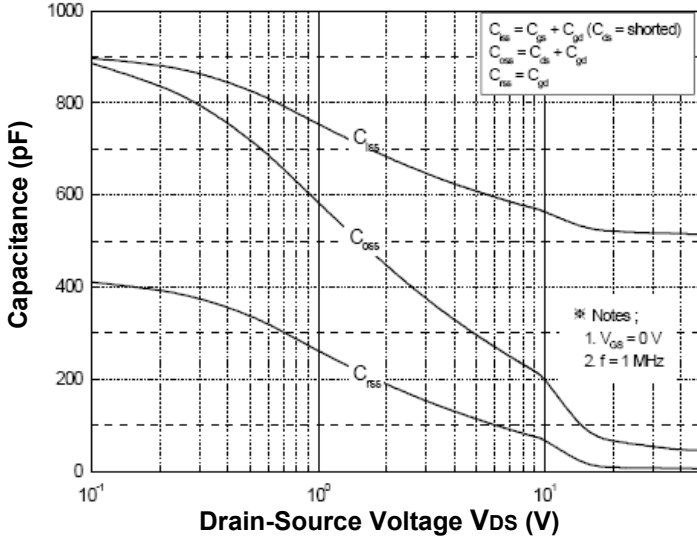


Fig.6- Gate Charge Characteristics

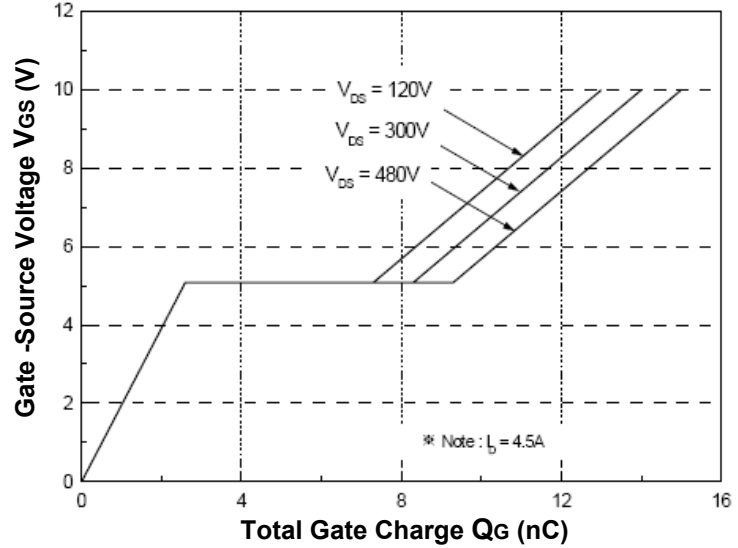


Fig.7- Breakdown Voltage Variation Vs. Temperature

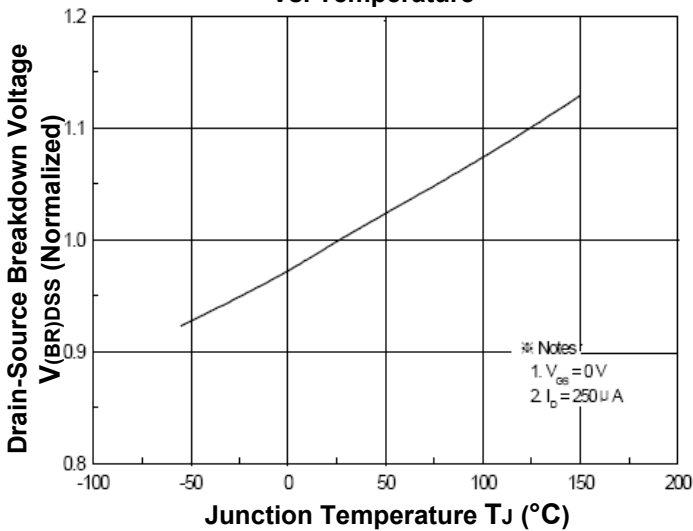
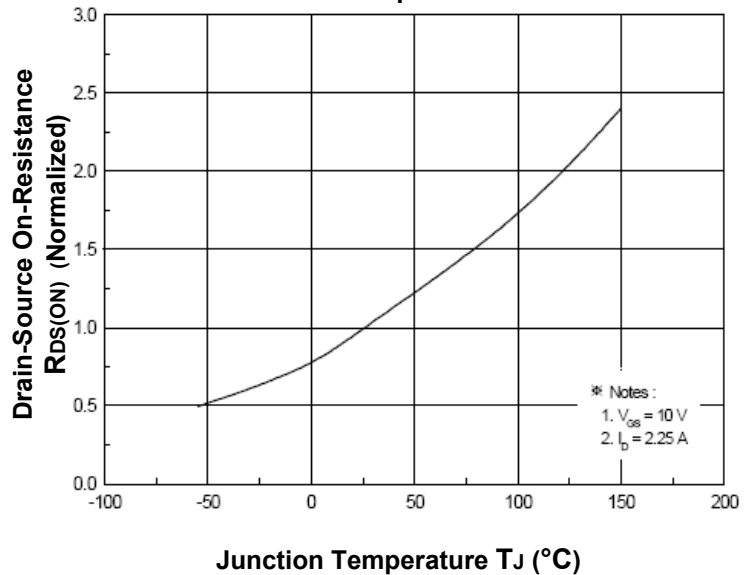


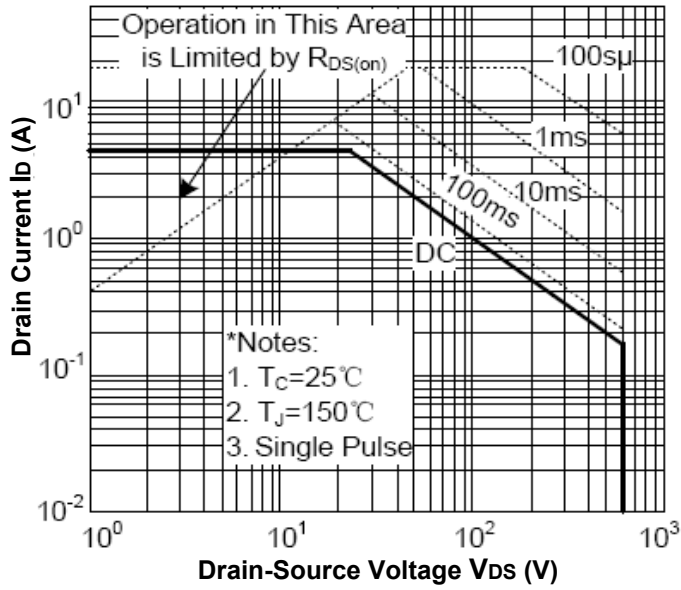
Fig.8- On Resistance Variation Vs. Temperature



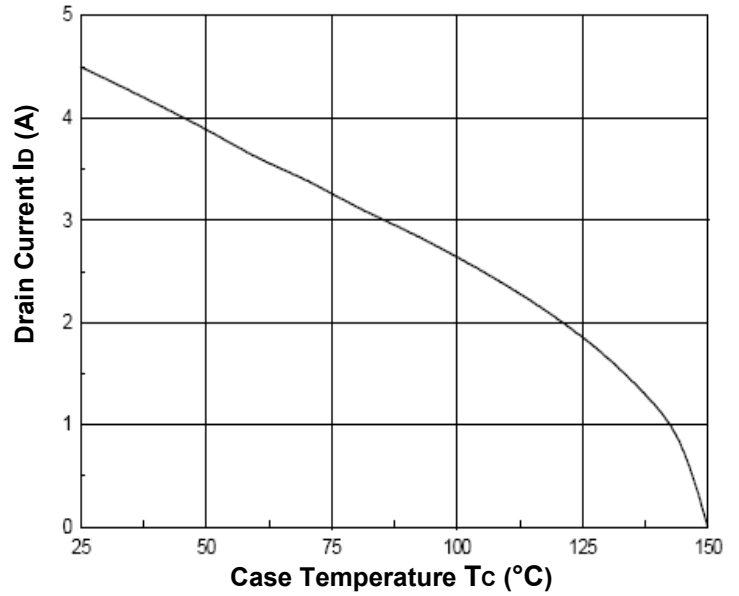
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**Fig.9- Max. Safe Operation Area  
Vs. Temperature (TO-220)**



**Fig.10- Max. Drain Current  
Vs. Case Temperature**



TEST CIRCUIT AND WAVEFORMS

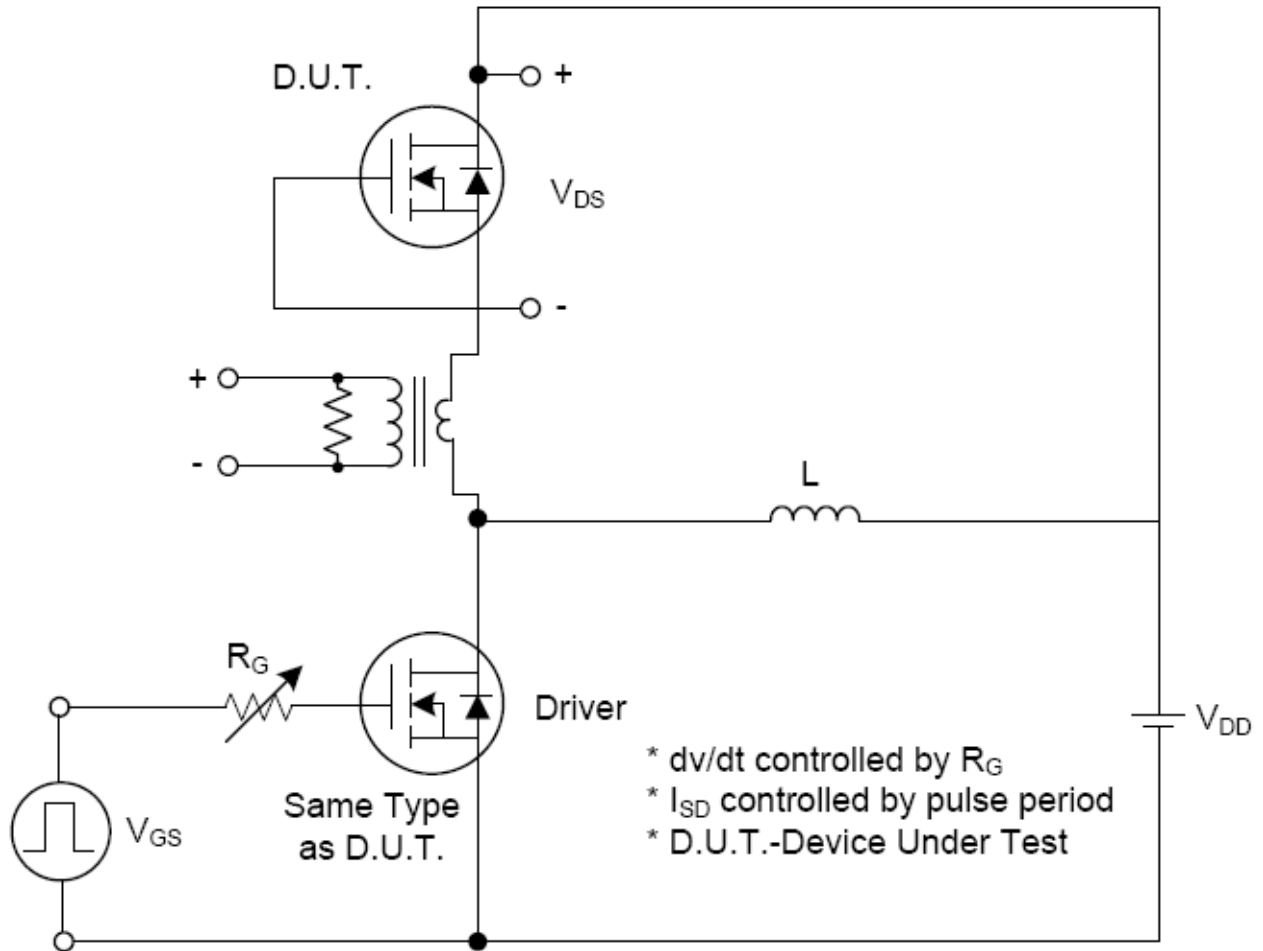


Fig.12- Peak Diode Recovery  $dv/dt$  Test Circuit



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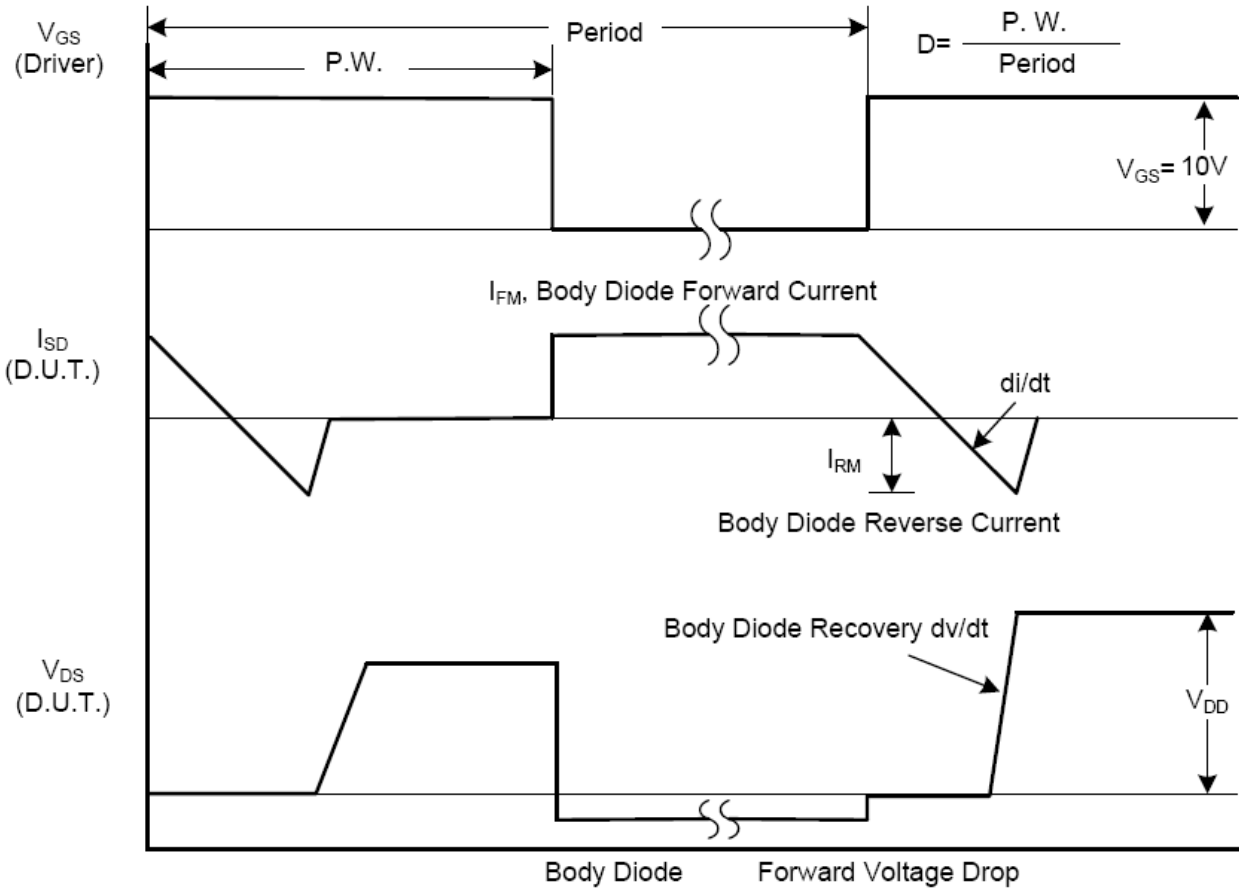


Fig.11- Peak diode Recovery  $dv/dt$  Waveform

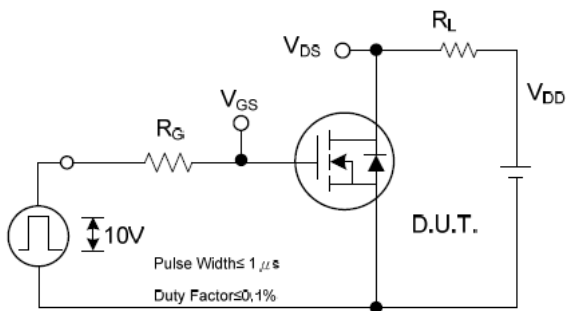


Fig.12- Switching Test Circuit

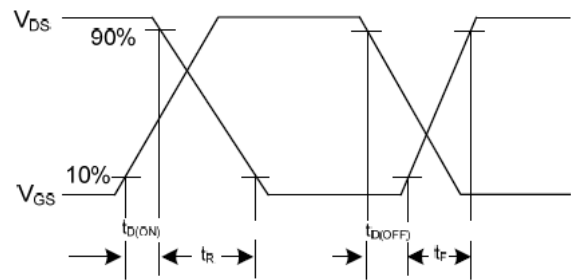


Fig.13- Switching Waveform

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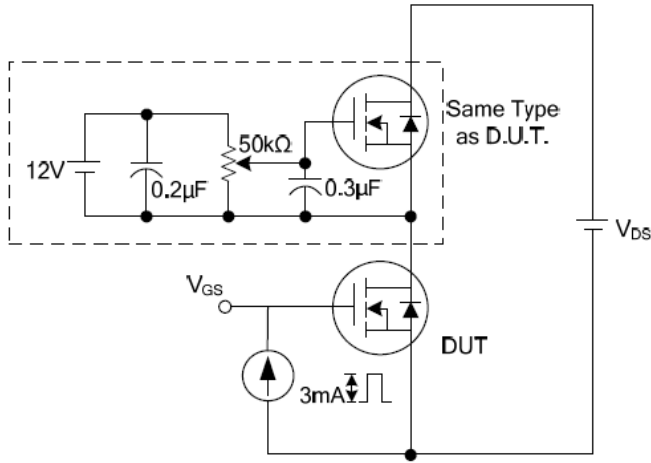


Fig.14- Gate Charge Test Circuit

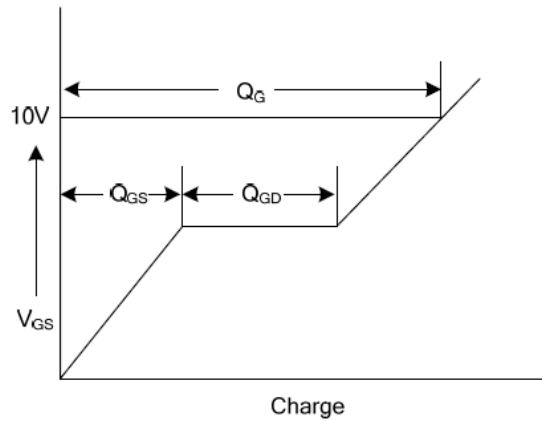


Fig.15- Gate Charge Waveform

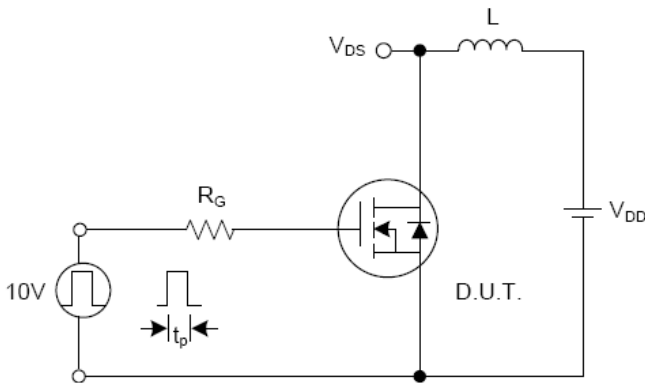


Fig.16- Unclamped Inductive Switching Test Circuit

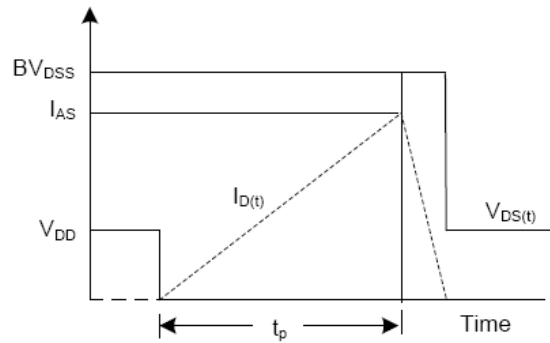
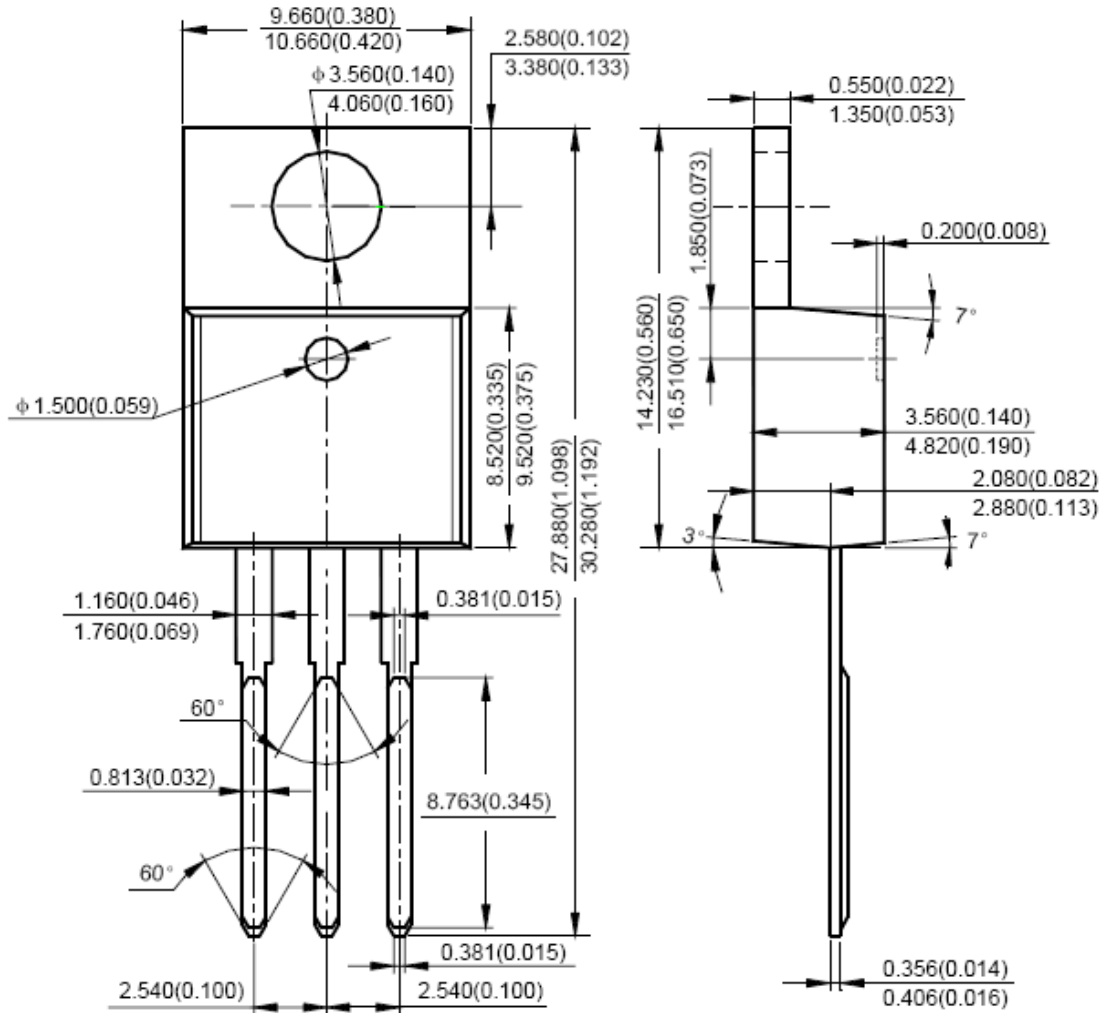


Fig.17- Unclamped Inductive Switching Waveform

# 600V/4.5A POWER MOSFET (N-Channel)

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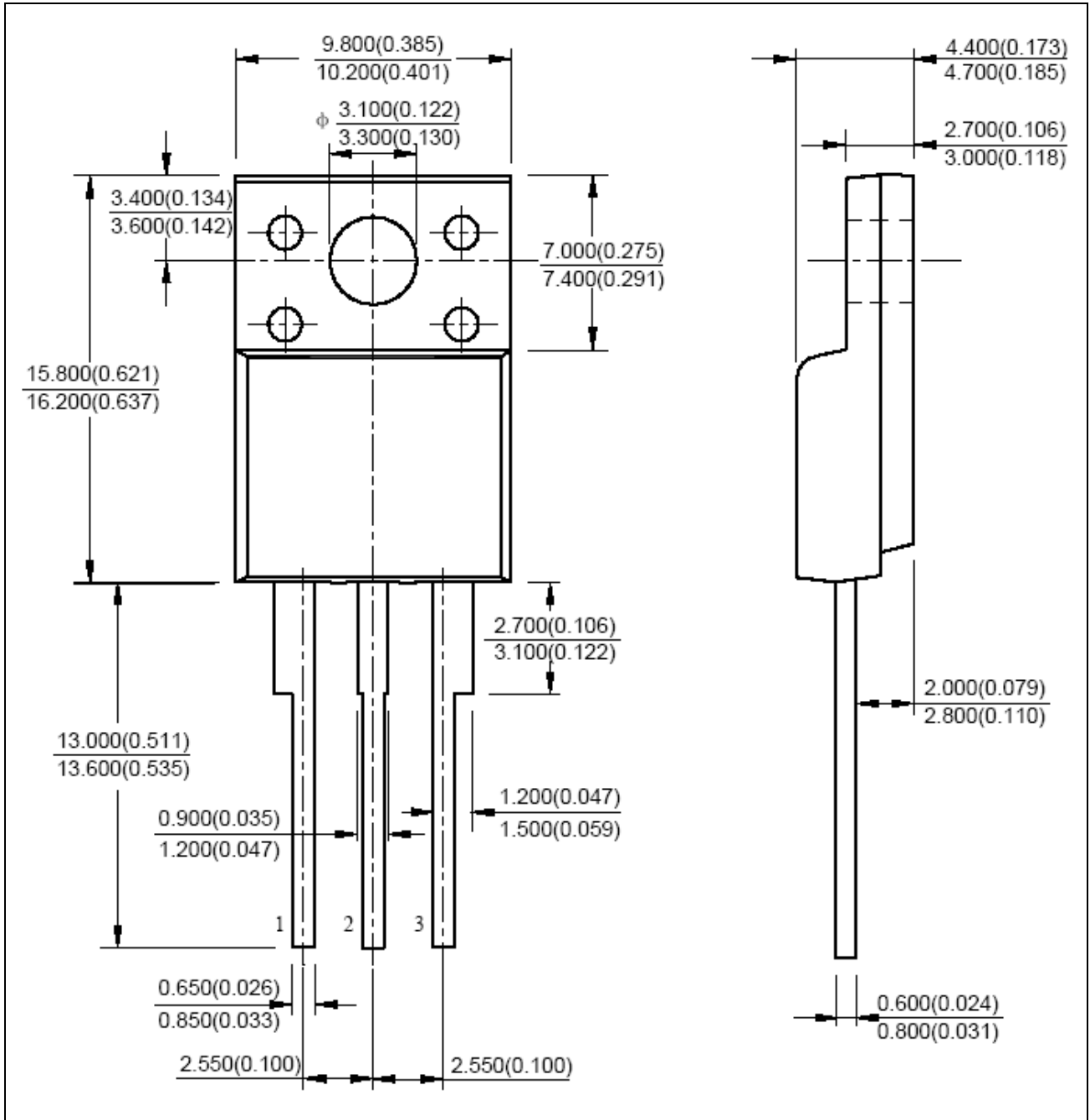
### Dimensions in mm ( inch)



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# 600V/4.5A POWER MOSFET (N-Channel)

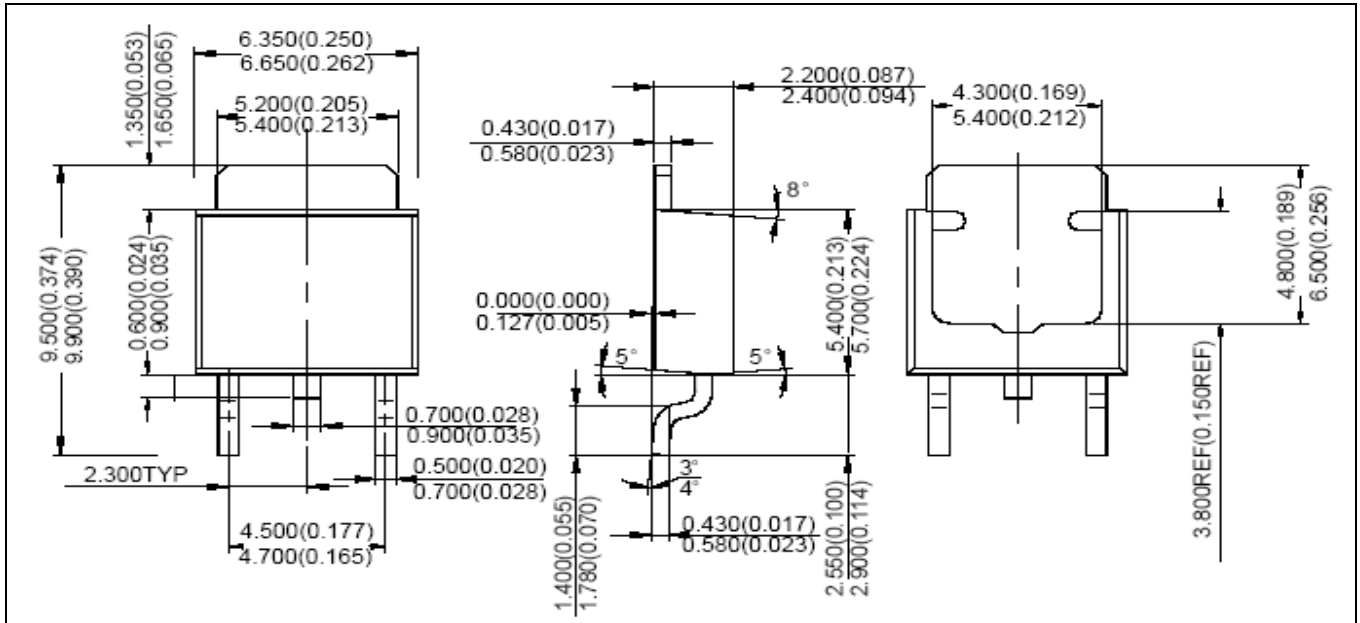
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# 600V/4.5A POWER MOSFET (N-Channel)

## MSU5N60



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DPAK (TO-252)

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