

## N-Channel Super Junction Power MOSFET

### General Description

The series of devices use advanced super junction technology and design to provide excellent  $R_{DS(ON)}$  with low gate charge. This super junction MOSFET fits the industry's AC-DC SMPS requirements for PFC, AC/DC power conversion, and industrial power applications.

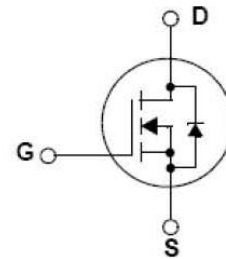
### Features

- New technology for high voltage device
- Low on-resistance and low conduction losses
- Small package
- Ultra Low Gate Charge cause lower driving requirements
- 100% Avalanche Tested
- ROHS compliant

### Application

- Power factor correction (PFC)
- Switched mode power supplies(SMPS)
- Uninterruptible Power Supply (UPS)

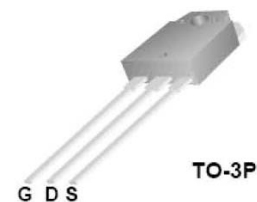
$V_{DS@T_{jmax}}$	650	V
$R_{DS(ON) MAX}$	70	mΩ
$I_D$	69	A



**Schematic diagram**

### Package Marking And Ordering Information

Device	Device Package	Marking
HMS47N60A	TO-3P	HMS47N60A



**Table 1. Absolute Maximum Ratings ( $T_c=25^\circ\text{C}$ )**

Parameter	Symbol	HMS21N60A	Unit
Drain-Source Voltage ( $V_{GS}=0V$ )	$V_{DS}$	600	V
Gate-Source Voltage ( $V_{DS}=0V$ )	$V_{GS}$	$\pm 30$	V
Continuous Drain Current at $T_c=25^\circ\text{C}$	$I_{D(DC)}$	47	A
Continuous Drain Current at $T_c=100^\circ\text{C}$	$I_{D(DC)}$	33	A
Pulsed drain current <sup>(Note 1)</sup>	$I_{DM(pluse)}$	141	A
Maximum Power Dissipation( $T_c=25^\circ\text{C}$ )	$P_D$	200	W
Derate above $25^\circ\text{C}$		1.6	W/ $^\circ\text{C}$
Single pulse avalanche energy <sup>(Note 2)</sup>	$E_{AS}$	690	mJ
Avalanche current <sup>(Note 1)</sup>	$I_{AR}$	7	A
Repetitive Avalanche energy , $t_{AR}$ limited by $T_{jmax}$ <sup>(Note 1)</sup>	$E_{AR}$	1	mJ

Parameter	Symbol	HMS21N60A	Unit
Drain Source voltage slope, $V_{DS} \leq 480V$ ,	dv/dt	50	V/ns
Reverse diode dv/dt, $V_{DS} \leq 480V, I_{SD} < I_D$	dv/dt	15	V/ns
Operating Junction and Storage Temperature Range	$T_J, T_{STG}$	-55...+150	°C

\* limited by maximum junction temperature

**Table 2. Thermal Characteristic**

Parameter	Symbol	HMS21N60A	Unit
Thermal Resistance, Junction-to-Case (Maximum)	$R_{thJC}$	0.62	°C /W
Thermal Resistance, Junction-to-Ambient (Maximum)	$R_{thJA}$	62.5	°C /W

**Table 3. Electrical Characteristics (TA=25°C unless otherwise noted)**

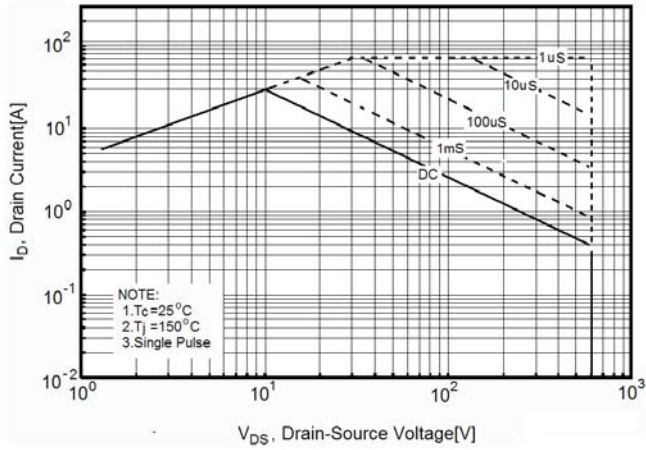
Parameter	Symbol	Condition	Min	Typ	Max	Unit
<b>On/off states</b>						
Drain-Source Breakdown Voltage	$BV_{DSS}$	$V_{GS}=0V, I_D=250\mu A$	600			V
Zero Gate Voltage Drain Current( $T_C=25^\circ C$ )	$I_{DSS}$	$V_{DS}=600V, V_{GS}=0V$		0.05	1	$\mu A$
Zero Gate Voltage Drain Current( $T_C=125^\circ C$ )	$I_{DSS}$	$V_{DS}=600V, V_{GS}=0V$			100	$\mu A$
Gate-Body Leakage Current	$I_{GSS}$	$V_{GS}=\pm 30V, V_{DS}=0V$			$\pm 100$	nA
Gate Threshold Voltage	$V_{GS(th)}$	$V_{DS}=V_{GS}, I_D=250\mu A$	2.6	3.5	4.4	V
Drain-Source On-State Resistance	$R_{DS(ON)}$	$V_{GS}=10V, I_D=10.5A$		69	70	m $\Omega$
<b>Dynamic Characteristics</b>						
Forward Transconductance	$g_{FS}$	$V_{DS} = 20V, I_D = 10.5A$		17.5		S
Input Capacitance	$C_{iss}$	$V_{DS}=50V, V_{GS}=0V,$ $F=1.0MHz$		1950		PF
Output Capacitance	$C_{oss}$			150		PF
Reverse Transfer Capacitance	$C_{rss}$			5		PF
Total Gate Charge	$Q_g$		$V_{DS}=480V, I_D=47A,$ $V_{GS}=10V$		45	70
Gate-Source Charge	$Q_{gs}$			9		nC
Gate-Drain Charge	$Q_{gd}$			18		nC
Intrinsic gate resistance	$R_G$	$f = 1 MHz$ open drain		1		$\Omega$
<b>Switching times</b>						
Turn-on Delay Time	$t_{d(on)}$	$V_{DD}=380V, I_D=11A,$ $R_G=4\Omega, V_{GS}=10V$		11		nS
Turn-on Rise Time	$t_r$			6		nS
Turn-Off Delay Time	$t_{d(off)}$			61	100	nS
Turn-Off Fall Time	$t_f$			4.5	12	nS
<b>Source- Drain Diode Characteristics</b>						
Source-drain current(Body Diode)	$I_{SD}$	$T_C=25^\circ C$			47	A
Pulsed Source-drain current(Body Diode)	$I_{SDM}$				141	A
Forward on voltage	$V_{SD}$	$T_J=25^\circ C, I_{SD}=47A, V_{GS}=0V$		0.9	1.3	V
Reverse Recovery Time	$t_{rr}$	$T_J=25^\circ C, I_F=47A, di/dt=100A/\mu s$		310		nS
Reverse Recovery Charge	$Q_{rr}$				5	$\mu C$
Peak Reverse Recovery Current	$I_{rrm}$				28	A

Notes 1. Repetitive Rating: Pulse width limited by maximum junction temperature

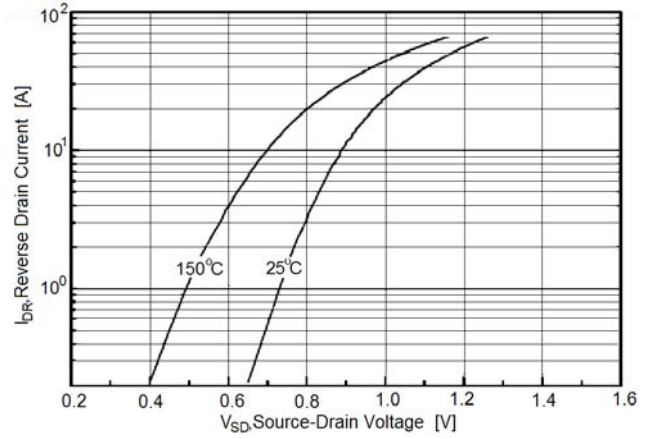
2.  $T_J=25^\circ C, V_{DD}=50V, V_G=10V, R_G=25\Omega$

## TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS (curves)

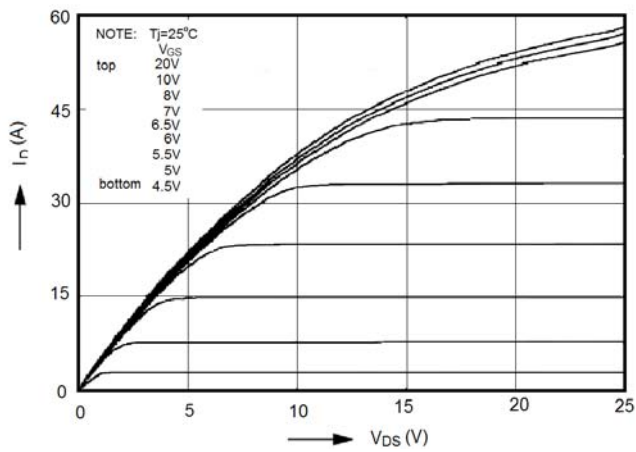
**Figure1. Safe operating area**



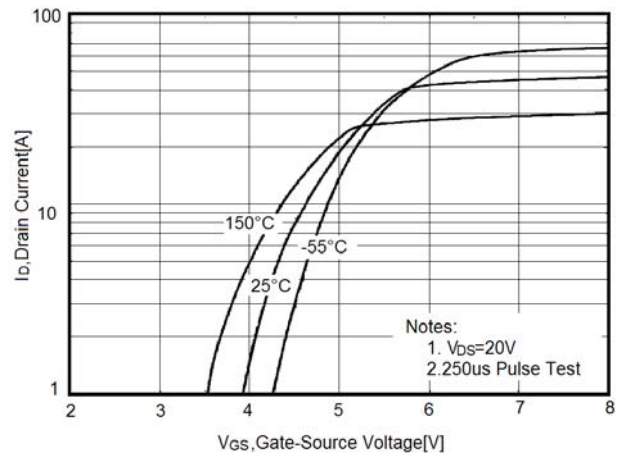
**Figure3. Source-Drain Diode Forward Voltage**



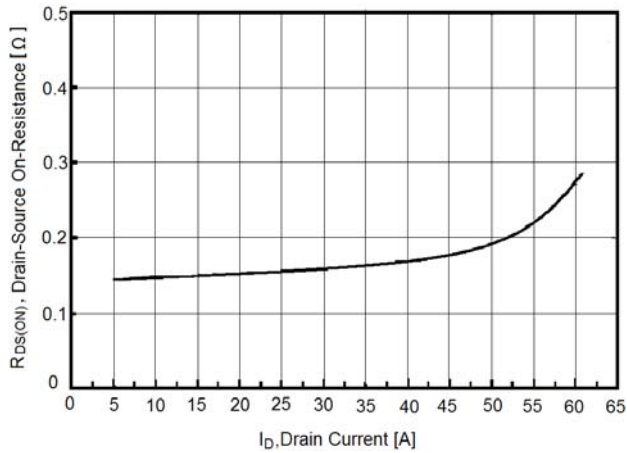
**Figure4. Output characteristics**



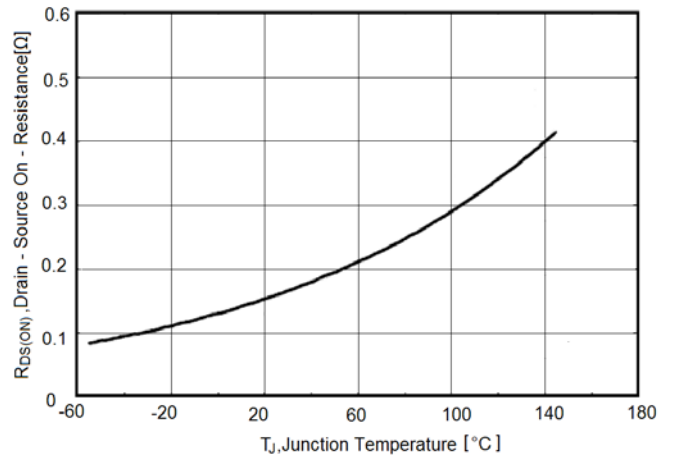
**Figure5. Transfer characteristics**



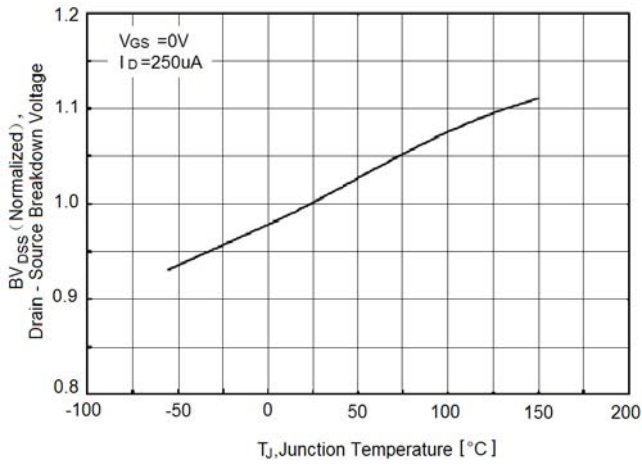
**Figure6. Static drain-source on resistance**



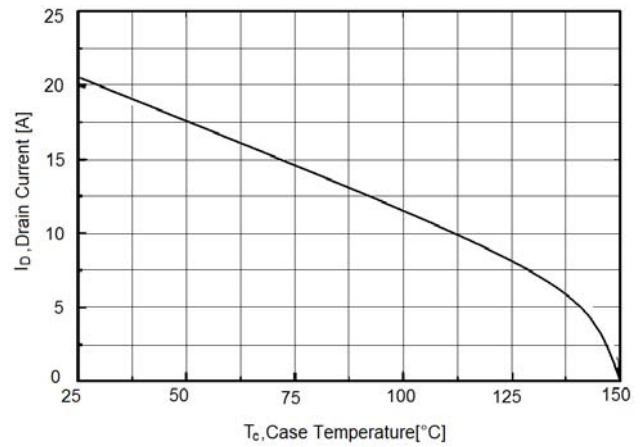
**Figure7.  $R_{DS(ON)}$  vs Junction Temperature**



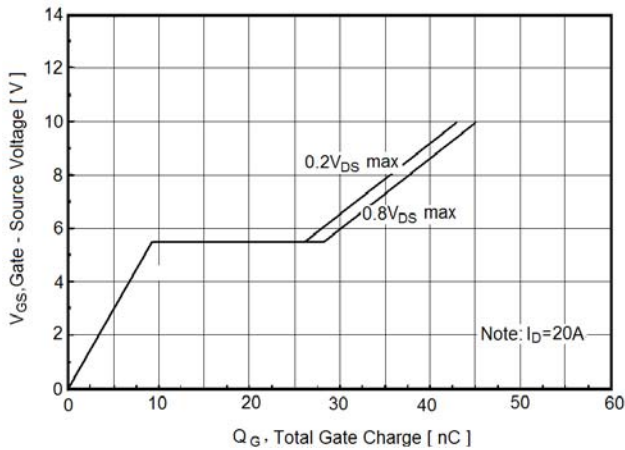
**Figure8.  $V_{DS}$  vs Junction Temperature**



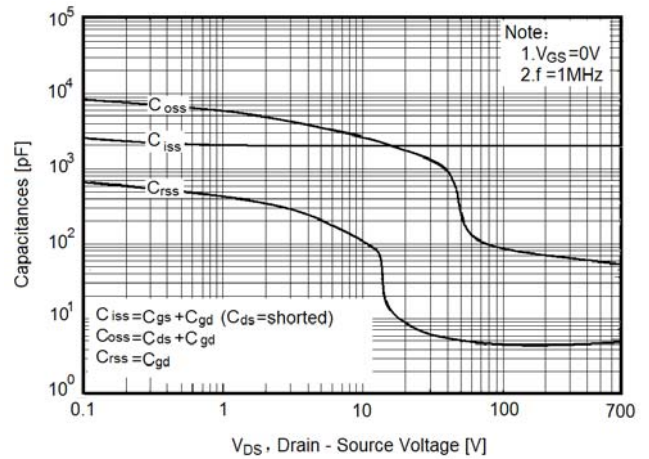
**Figure9. Maximum  $I_D$  vs Junction Temperature**



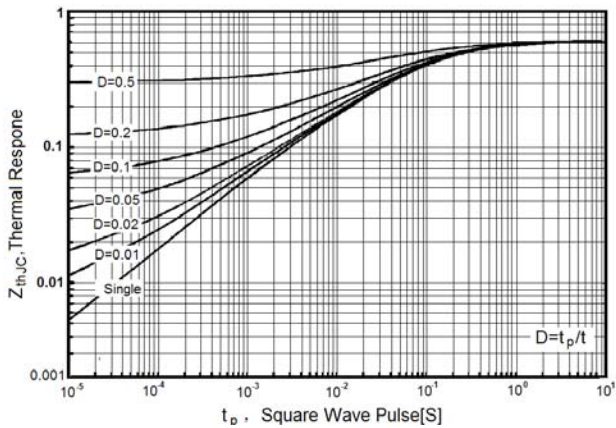
**Figure10. Gate charge waveforms**



**Figure11. Capacitance**

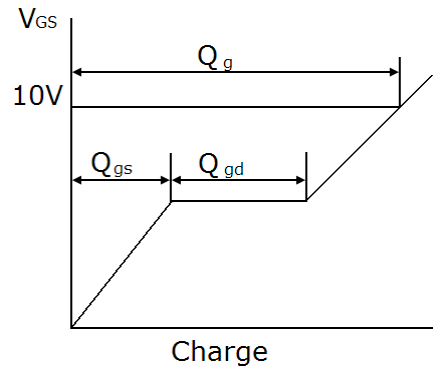
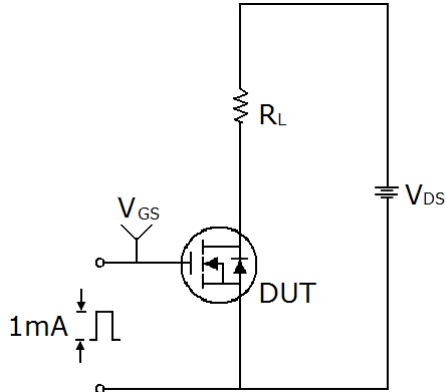


**Figure12. Transient Thermal Impedance**

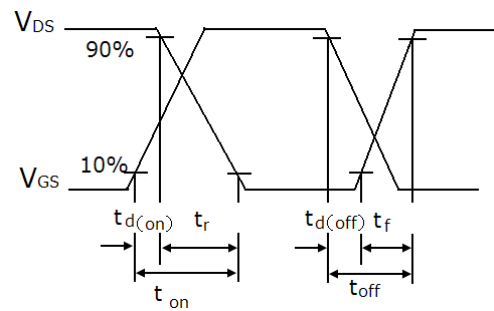
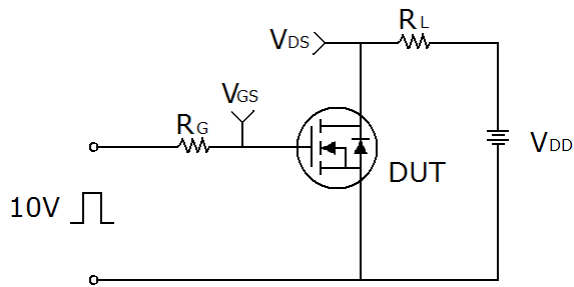


## Test circuit

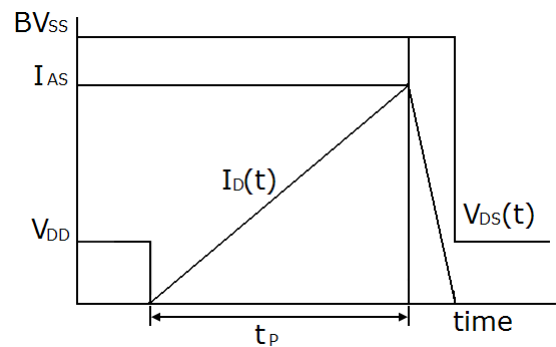
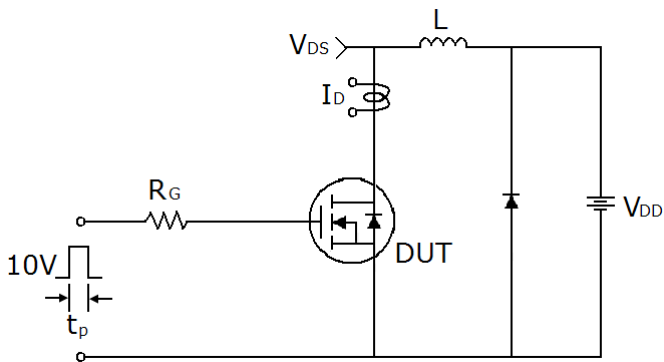
### 1) Gate charge test circuit & Waveform



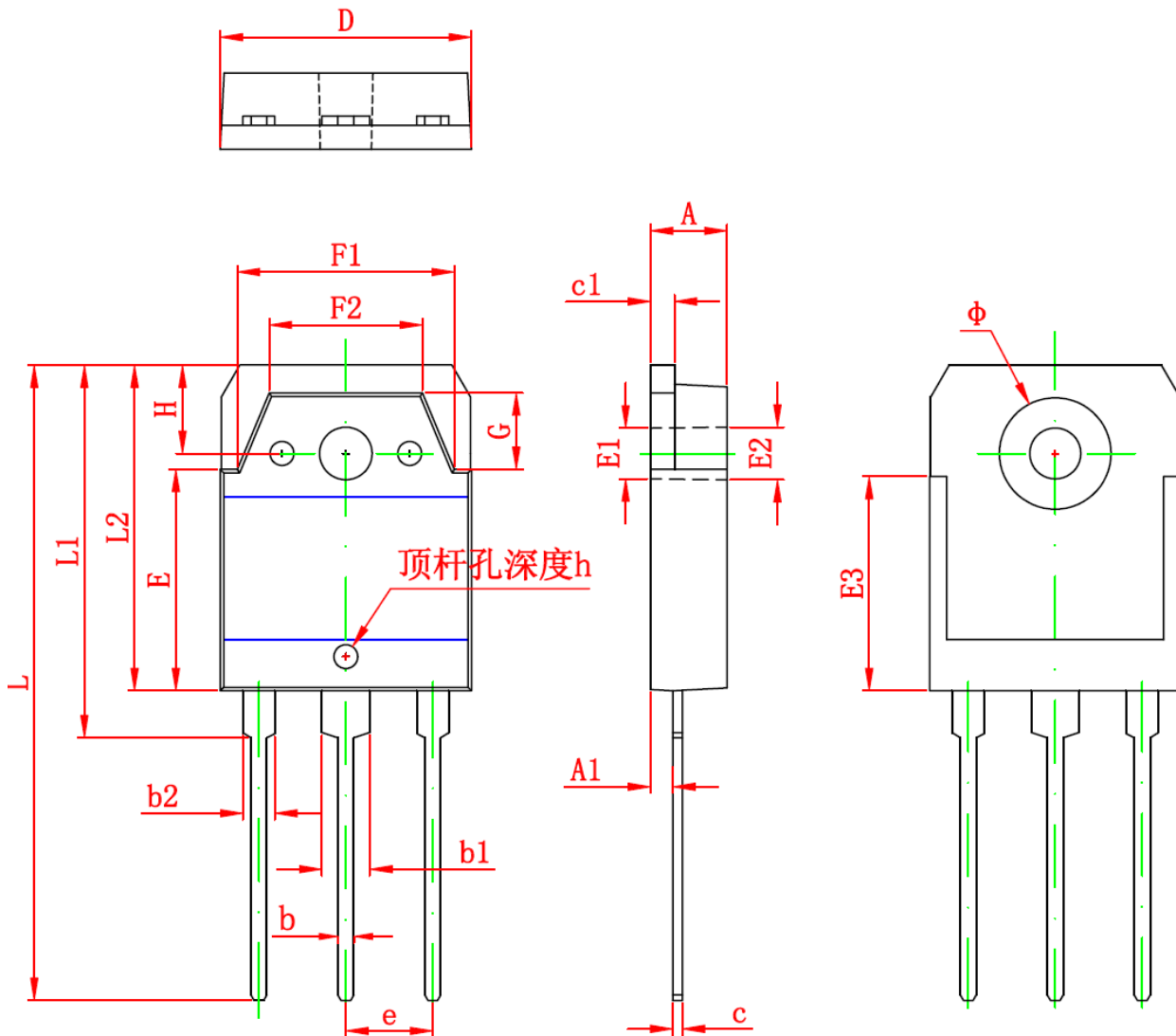
### 2) Switch Time Test Circuit:



### 3) Unclamped Inductive Switching Test Circuit & Waveforms



## TO-3P PACKAGE OUTLINE DIMENSIONS



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	4.600	5.000	0.181	0.197
A1	1.200	1.600	0.047	0.063
b	0.800	1.200	0.031	0.047
b1	2.800	3.200	0.110	0.126
b2	1.800	2.200	0.071	0.087
c	0.500	0.700	0.020	0.028
c1	1.450	1.650	0.057	0.065
D	15.450	15.850	0.606	0.622
E	13.700	14.100	0.539	0.555
E1	3.200 REF		0.126 REF	
E2	3.300 REF		0.130 REF	
E3	13.450 REF		0.530 REF	
F1	13.400	13.800	0.528	0.543
F2	9.400	9.800	0.370	0.386
L	39.900	40.300	1.571	1.587
L1	23.200	23.600	0.913	0.929
L2	20.300	20.600	0.799	0.811
Φ	6.900	7.100	0.272	0.280
G	5.150	5.550	0.203	0.219
e	5.450 TYP		0.215 TYP	
H	5.000 REF		0.197 REF	
h	0.000	0.300	0.000	0.012

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