

**NPB9N20ES**

N-Channel Enhancement Mode Power MOSFET



**VOLTAGE:** 200 Volts

**CURRENT:** 9 Amperes

**Package:** TO-251

**Marking And Polarity**

**FEATURES**

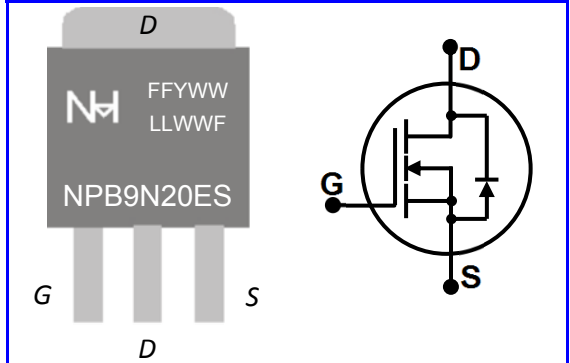
- Low  $R_{DS(ON)}$  For High Efficiency
- Low Gate Charge For High Speed Swithing
- High EAS For High Reliability
- 100% UIS And RG Tested

**TYPICAL APPLICATIONS**

- DC/DC Converter And Synchronous Rectification
- High-Frequency Circuits And Battery Management System(BMS)
- The Motor Drives And Printed Circuit Board Control
- Automotive Electronics And UPS (Uninterruptible Power Supplies)
- Weight:App. 0.361 Grams (0.01273 Ounce)

**PRODUCT SUMMARY**

VDS Min.@Tj	200	V
I <sub>D</sub> Min.@Ta	9	A
RDS(ON) Type@10V	220.00	mΩ



Remark:

- ①. NH=Nihang Trademark
- ②. FF=Product Line Code,According To Actual Changes  
YWW=Date Code,According To Actual Changes  
LLWWF=Inernal Code,According To Actual Changes
- ③. NPB9N20ES=Model

**Absolute Maximum Ratings (Ta=25°C Unless Otherwise Specified)**

Parameter	Test Conditions	Symbol	Ratings	Unit
Drain-Source Voltage		$V_{DS}$	200	V
Gate-Source Voltage		$V_{GS}$	±30	V
Continuous Drain Current (Note 1)	Ta= 25 °C	$I_D$	9	A
	Ta= 100 °C		6	
Drain Current-Pulsed (Note 1)	T <sub>J</sub> < 150 °C	$I_{DM}$	36	A
Maximum Power Dissipation Power	Ta= 25 °C	$P_D$	75	W
Dissipation Derating Factor Above 25°C	Ta= 100 °C		30	
Derating Factor		$D_F$	0.60	W/°C
Junction Temperature		$T_J$	-55 to 150	°C
Storage Temperature Range		$T_{STD}$	-55 to 150	°C
Avalanche Current,Single Pulse (Note 1)	L= 0.5 mH	$I_{AS}$	25	A
Single Pulse Avalanche Energy (Note 1) Test Circuit & Waveform See Fig.16	L= 0.5 mH,VDD= 100 V IAS= 24.5 A,RG= 10 Ω Starting Tj=25 °C,VG = 10 V	$E_{AS}$	150	mJ

**Thermal Characteristics (Ta=25°C Unless Otherwise Specified)**

Parameter	Test Conditions	Symbol	Typ.	Unit
Thermal Resistance Junction To Ambient	Still Air Environment With Ta =25°C	$R_{\theta JA}$	100.0	°C/W
Thermal Resistance Junction-Case	Device Mounted On 1 in <sup>2</sup> FR-4 Board With 2oz	$R_{\theta JC}$	1.7	

Notes: 1. Pulse Width Limited By Max. Junction Temperature. (See Fig. 13).

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**Electrical Characteristics** (Ta=25°C Unless Otherwise Specified)

Parameter	Test Conditions	Symbol	Min.	Typ.	Max.	Unit
<b>Static off Characteristics</b>						
Drain-Source Breakdown Voltage	VGS=0V, ID=250uA	$BV_{DSS}$	200	--	--	V
Bvdss Temperature Coefficient	ID=250uA, Reference 25°C	$\Delta BV_{DSS}/\Delta T_J$	--	0.229	--	V/°C
Drain-Source Leakage Current	VDS= 200 V, VGS=0V	$I_{DSS}$	--	--	1	uA
Gate-Body Leakage Current	VGS= ±30 V, VDS=0V	$I_{GSS}$	--	--	±100	nA
Forward Transconductance	ID= 5 A, VDS= 5 V	$g_{fs}$	--	5.0	--	S
<b>Static on Characteristics</b>						
Gate Threshold Voltage	VGS= VDS ID=250uA	$V_{GS(TH)}$	1.0	2.0	3.0	V
Drain-Source On Resistance	ID= 5 A, VGS= 10 V	$R_{DS(ON)}$	--	220.00	280.00	mΩ
	ID= 5 A, VGS= 4.5 V		--	253.00	375.20	
<b>Dynamic Characteristics</b>						
Gate Resistance	VGS=0V, VDS=0V, Freq.=1MHz	$R_g$	--	2.7	--	Ω
Input Capacitance	VDS= 100 V	$C_{iss}$	--	675.0	--	pF
Output Capacitance	VGS= 0 V	$C_{oss}$	--	85.0	--	pF
Reverse Transfer Capacitance	F= 1 MHz	$C_{rss}$	--	5.0	--	pF
<b>Switching Paramters (Test Circuit &amp; Waveform See Fig.14)</b>						
Turn-On Delay Time	VDS= 100 V	$t_{d(on)}$	--	9.0	--	ns
Turn-On Rise Time	VGS= 10 V	$t_r$	--	3.5	--	ns
Turn-Off Delay Time	RL= 1.2 Ω	$t_{d(off)}$	--	27.5	--	ns
Turn-Off Rise Time	RG= 10 Ω	$t_f$	--	4.0	--	ns
<b>Gate Charge Paramters (Test Circuit &amp; Waveform See Fig.15)</b>						
Total Gate Charge	VDS= 100 V	$Q_g$	--	15.1	--	nC
Gate-Source Charge	VGS= 10 V	$Q_{gs}$	--	2.5	--	nC
Gate-Drain Charge	ID= 5 A	$Q_{gd}$	--	5.0	--	nC
<b>Drain-Source Diode Characteristics And Maximum Ratings (Test Circuit &amp; Waveform See Fig.17)</b>						
Max. Diode Forward Current		$I_S$	--	--	9	A
Max. Pulsed Forward Current		$I_{SM}$	--	--	32	A
Diode Forward Voltage	ID= 5 A, VGS=0V	$V_{SD}$	--	1.08	1.5	V
Reverse Recovery Time	ID= 5 A, di/dt= 100 A/us	$t_{rr}$	--	105	--	ns
Reverse Recovery Charge	VGS= 10 V, VDS= 100 V	$Q_{rr}$	--	405.0	--	nC

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Typical Characteristics Curves

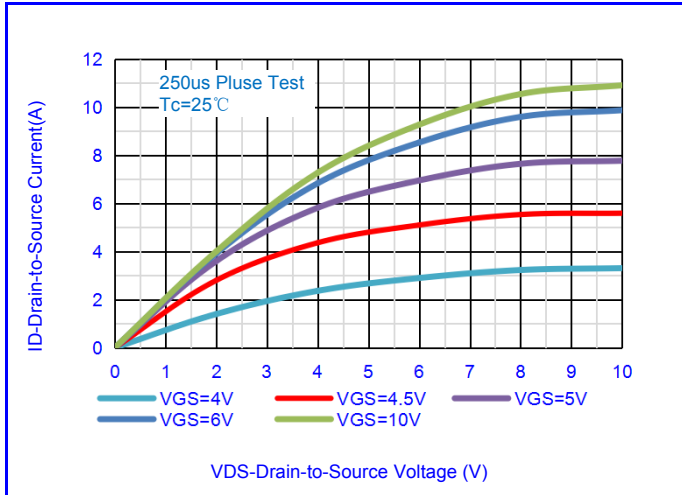


Fig.1-Output Characteristics

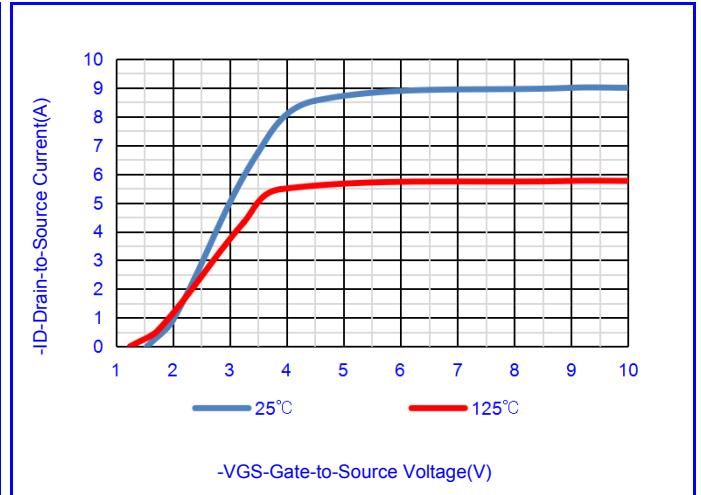


Fig.2- Transfer Characteristics

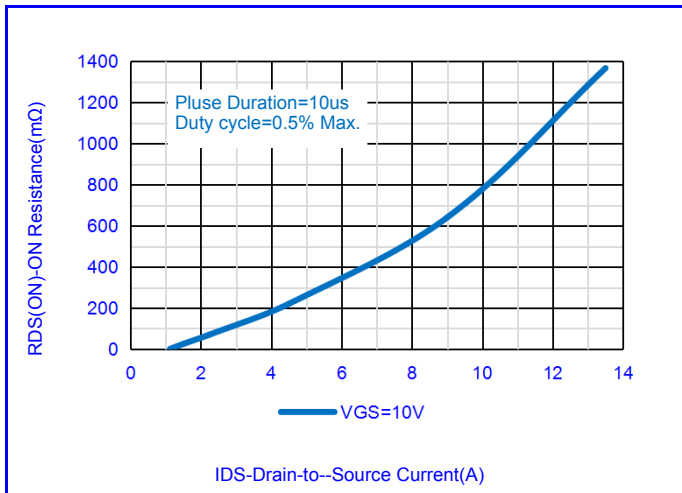


Fig.3- On Resistance vs. Drain Current

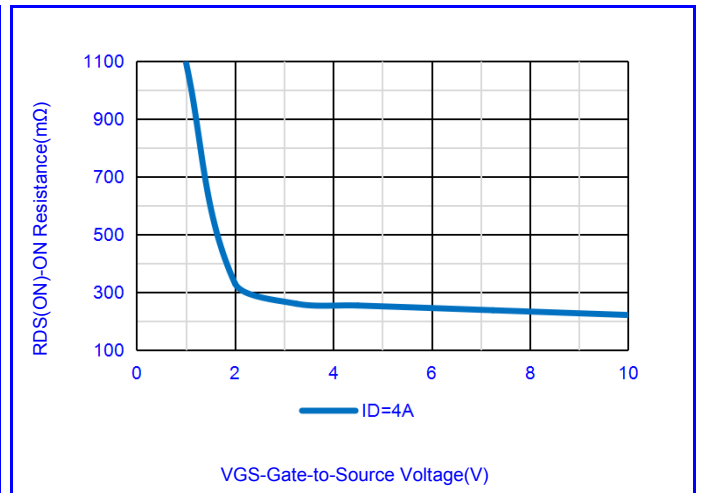


Fig.4- On Resistance vs. Gate Source Voltage

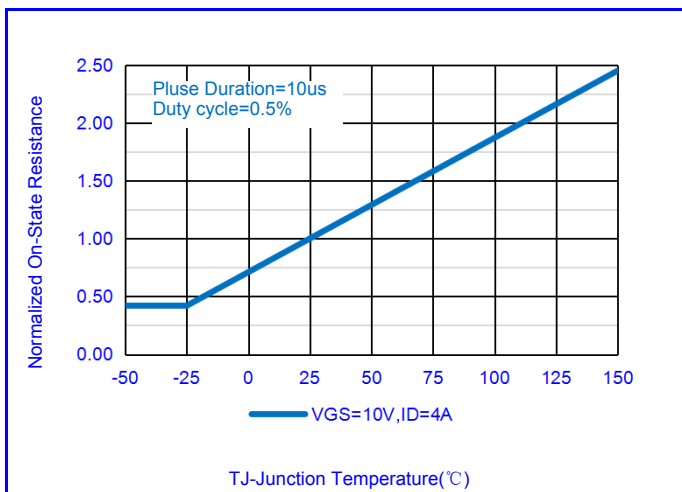


Fig.5- On Resistance vs. Junction Temperature

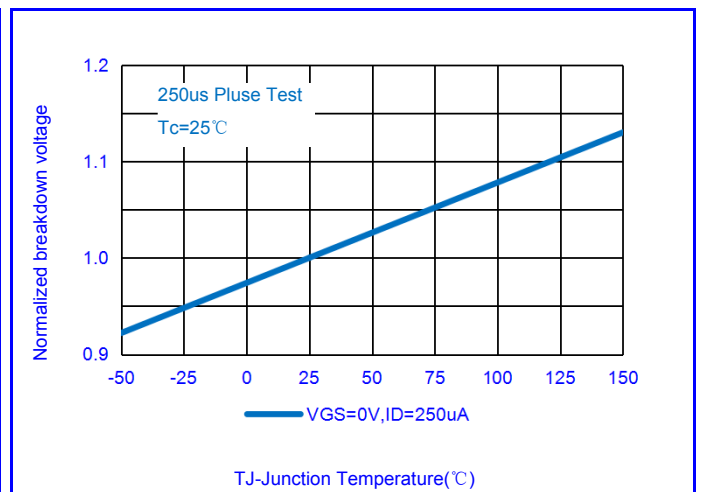


Fig.6- Breakdown Voltage vs. Junction Temperature

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Typical Characteristics Curves

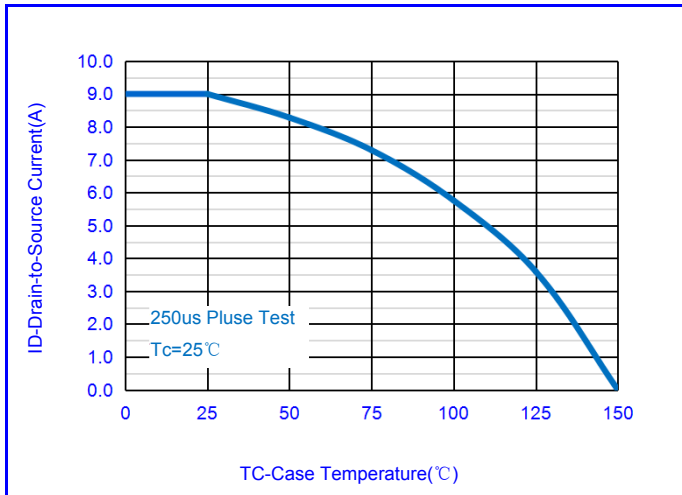


Fig.7-Maximum Continuous Drain Current vs. Case Temperature

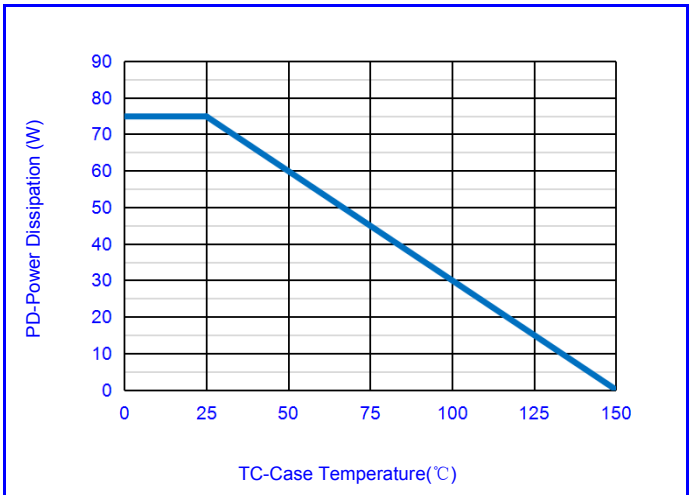


Fig.8-Maximum Power Dissipation vs. Case Temperature

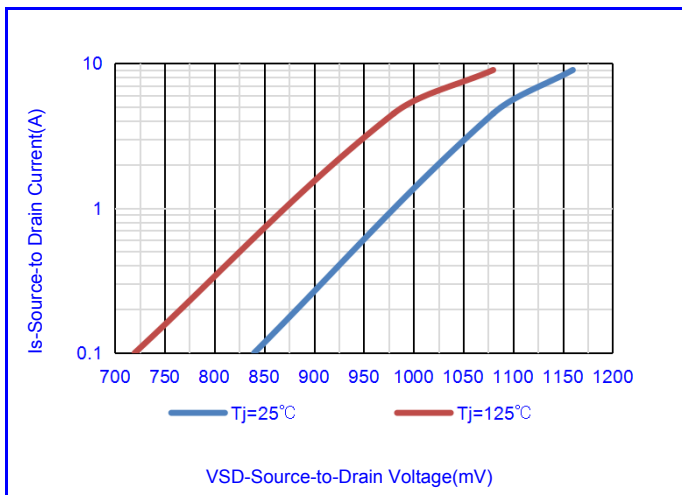


Fig.9- Source-Drain Diode Forward Voltage

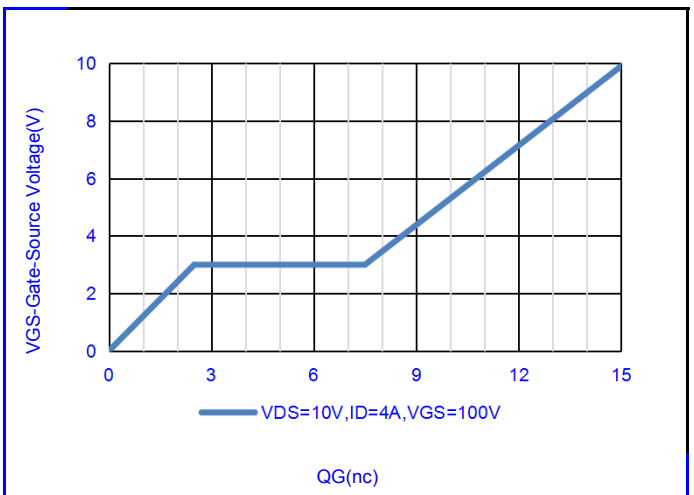


Fig.10- Gate Charge Waveform

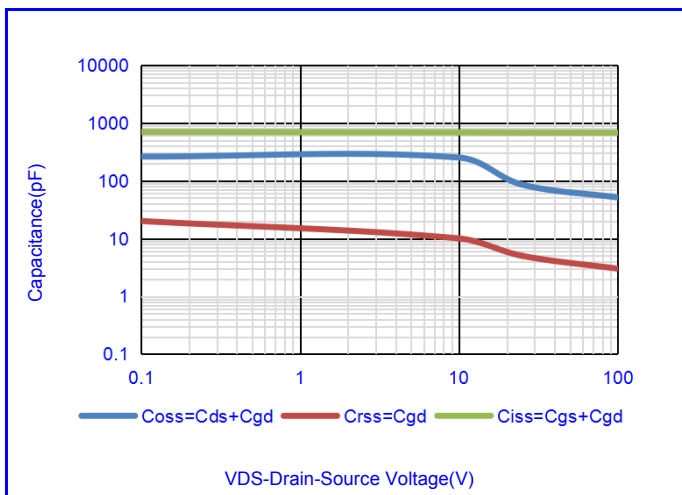


Fig.11- Gate-Source Voltage-VGS(V)

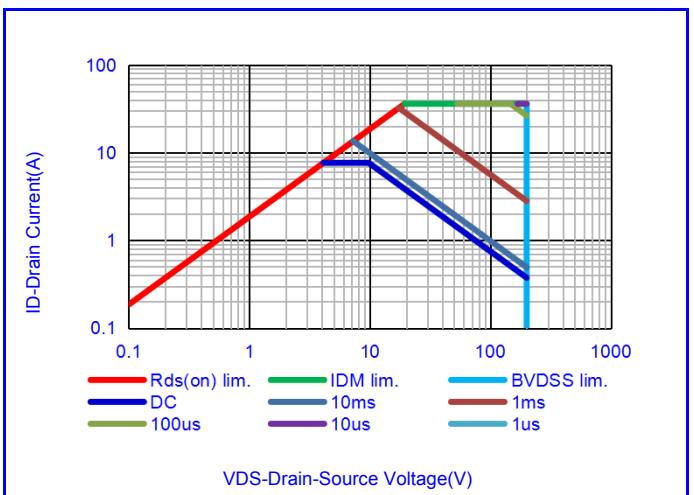


Fig.12-Maximum Safe Operating Area(SOA)

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Typical Characteristics Curves

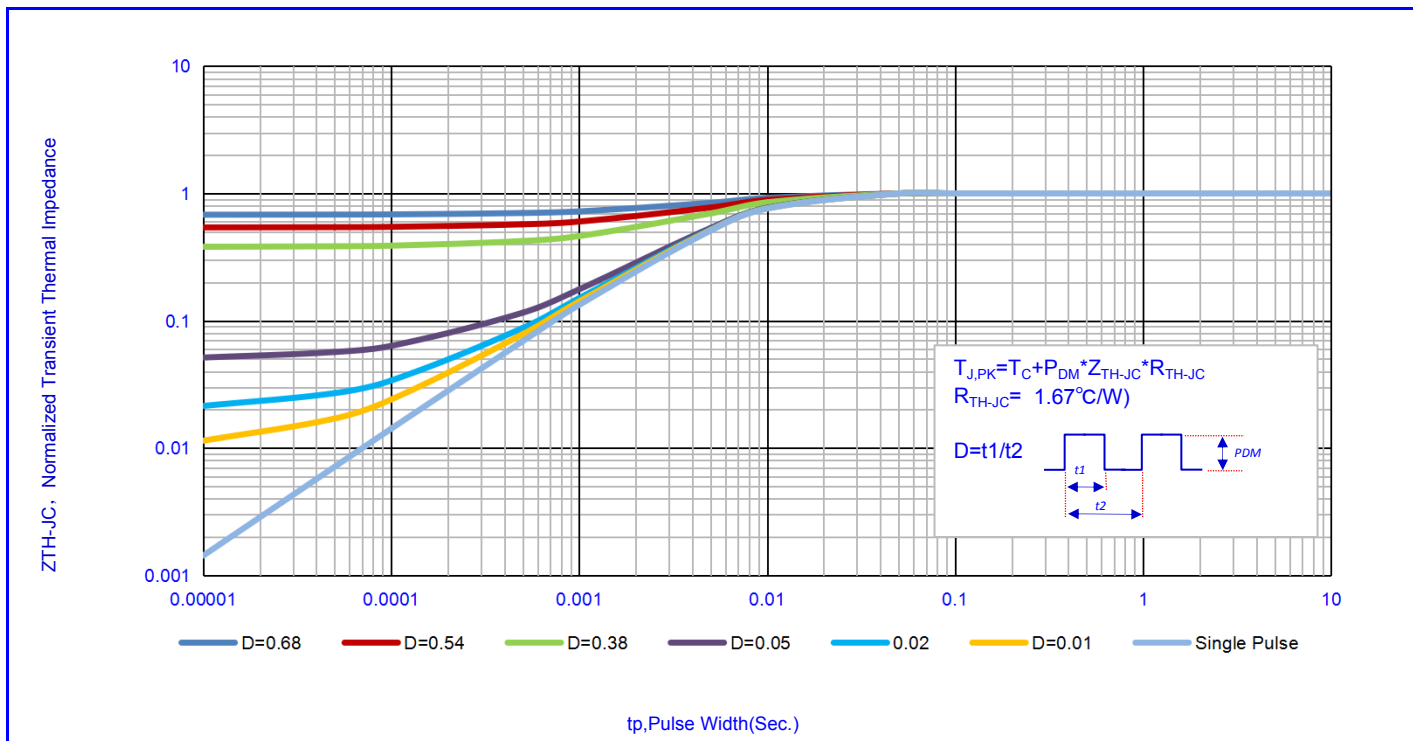


Fig.13- Normalized Maximum Transient Thermal Impedance vs.Pulse Width

Test Circuit & Waveform

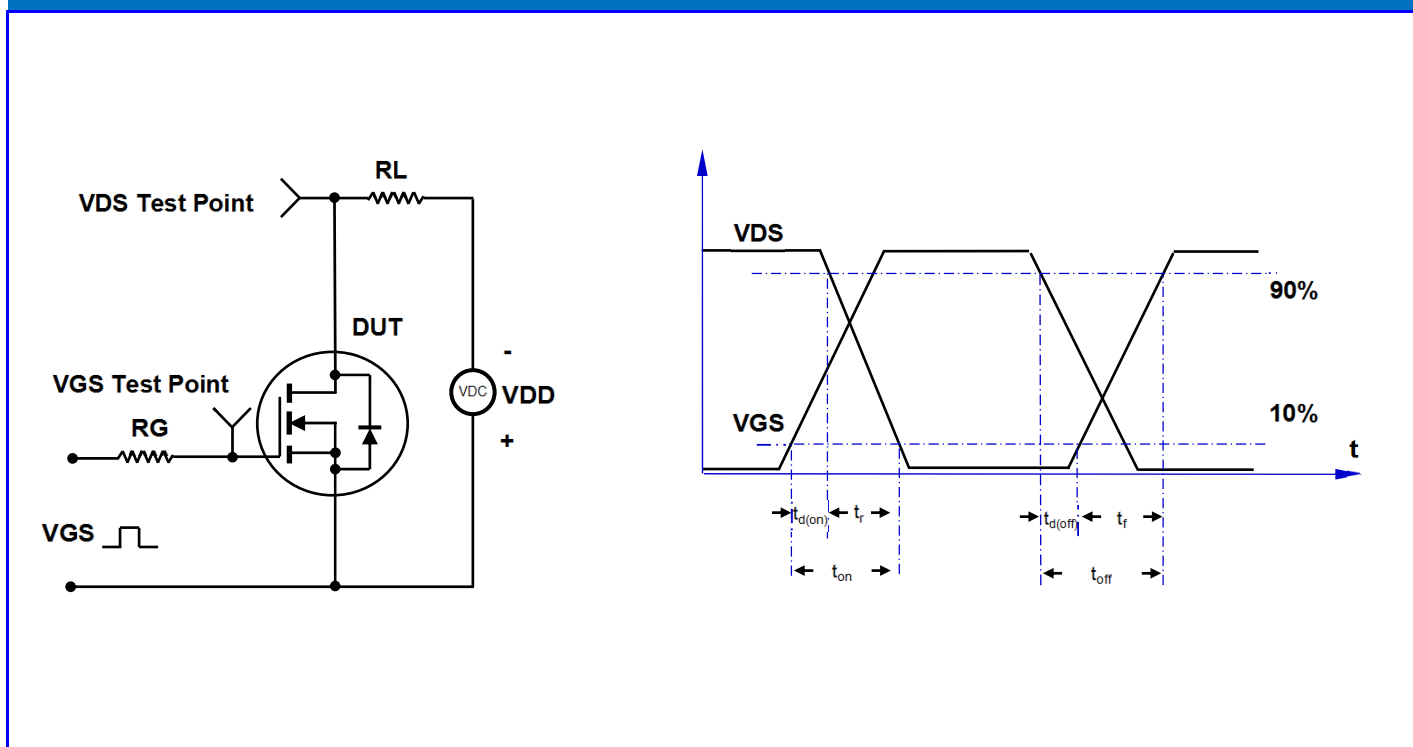


Fig.14- Resistive Switching Test Circuit & Waveform

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Test Circuit & Waveform

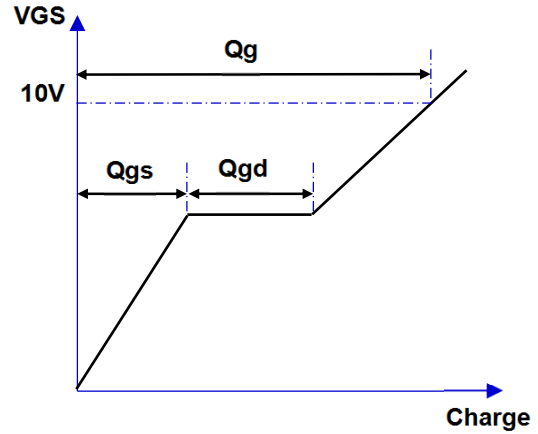
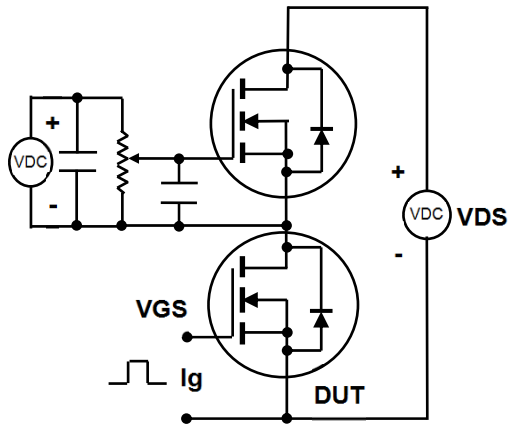


Fig.15-Gate Charge Test Circuit & Waveform

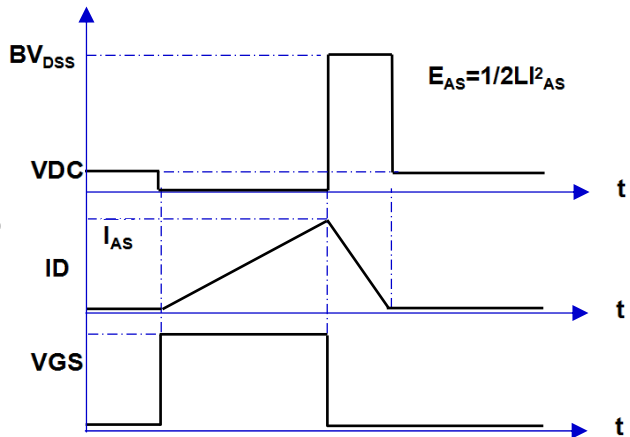
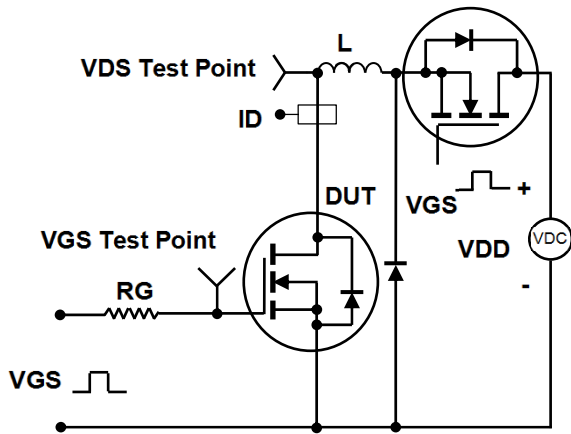


Fig.16- EAS Test Circuit & Waveform

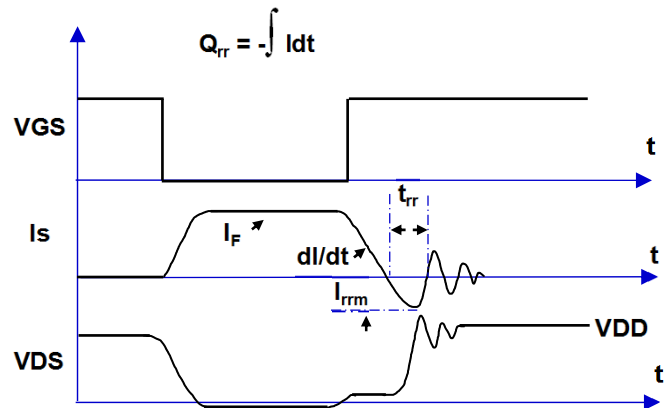
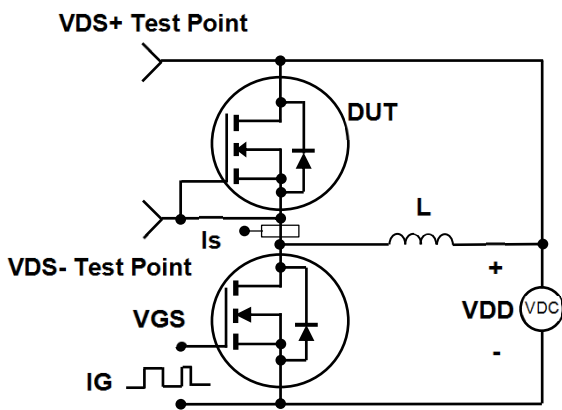


Fig.17- Diode Recovery Test Circuit & Waveform

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OUTLINE DRAWINGS		TO-251				
		<b>OUTLINE DIMENSIONS</b>				
Dim.	Milimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A	6.100	-	7.100	0.240	-	0.280
B	4.800	-	5.800	0.189	-	0.228
C	1.950	-	2.550	0.077	-	0.100
D	0.350	-	0.750	0.014	-	0.030
E	14.500	-	16.000	0.571	-	0.630
F	5.600	-	6.600	0.220	-	0.260
G	9.000	-	9.600	0.354	-	0.378
H	0.450	-	0.850	0.018	-	0.033
J	2.100	-	2.500	0.083	-	0.098
M	0.350	-	0.750	0.014	-	0.030

OUTLINE DRAWINGS		TO-251				
		<b>OUTLINE DIMENSIONS</b>				
Dim.	Milimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A	-	6.09	-	-	0.24	-
B	-	7.57	-	-	0.298	-
C	-	6.64	-	-	0.261	-
D	-	2.3	-	-	0.091	-
E	-	2.76	-	-	0.109	-
F	-	1.42	-	-	0.056	-

PACKING INFORMATION					
Package Code	Package Method	Inner Box Size L×W×H(mm)	Quantity (Pcs/Inner Box)	Outer Carton Size L×W×H(mm)	Quantity (Pcs/Carton)
TO-251	Tube Packaging	565×155×5	4000	580×285×180	20000

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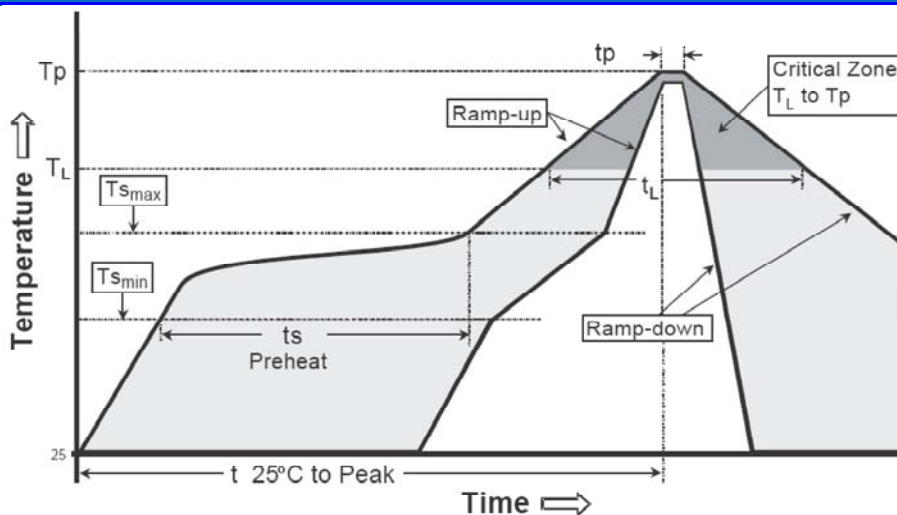
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**Recommended wave soldering condition**

Product	Peak Temperature	Soldering Time
Pb-free devices	260 +0/-5 °C	5 +1/-1 seconds

**Recommended temperature profile for IR reflow**



Profile feature	Sn-Pb eutectic Assembly	Pb-free Assembly
Average ramp-up rate (T <sub>smax</sub> to T <sub>p</sub> )	3°C/second max.	3°C/second max.
Preheat -Temperature Min(T <sub>S min</sub> ) -Temperature Max(T <sub>S max</sub> ) -Time(t <sub>s min</sub> to t <sub>s max</sub> )	100°C 150°C 60-120 seconds	150°C 200°C 60-180 seconds
Time maintained above: -Temperature (T <sub>L</sub> ) - Time (t <sub>L</sub> )	183°C 60-150 seconds	217°C 60-150 seconds
Peak Temperature(T <sub>P</sub> )	240 +0/-5 °C	260 +0/-5 °C
Time within 5°C of actual peak temperature(tp)	10-30 seconds	20-40 seconds
Ramp down rate	6°C/second max.	6°C/second max.
Time 25 °C to peak temperature	6 minutes max.	8 minutes max.

Note : All temperatures refer to topside of the package, measured on the package body surface.



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