Dec 2005

SemiHow
Know-How for Semiconductor

HFS11N40

400V N-Channel MOSFET

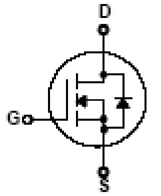
BV_{DSS} = 400 V

$R_{DS(on)\ typ}$ = 0.38 Ω

I_D = 11.4 A

TO-220F

1.Gate 2. Drain 3. Source



FEATURES

- ❑ Originative New Design
- ❑ Superior Avalanche Rugged Technology
- ❑ Robust Gate Oxide Technology
- ❑ Very Low Intrinsic Capacitances
- ❑ Excellent Switching Characteristics
- ❑ Unrivalled Gate Charge : 35 nC (Typ.)
- ❑ Extended Safe Operating Area
- ❑ Lower $R_{DS(ON)}$: 0.38 Ω (Typ.) @V_{GS}=10V
- ❑ 100% Avalanche Tested

Absolute Maximum Ratings

T_C=25℃ unless otherwise specified

Symbol	Parameter	Value	Units
V_{DSS}	Drain-Source Voltage	400	V
I_D	Drain Current – Continuous (T_C = 25℃)	11.4*	A
	Drain Current – Continuous (T_C = 100℃)	7.2*	A
I_{DM}	Drain Current – Pulsed (Note 1)	45.6*	A
V_{GS}	Gate-Source Voltage	±30	V
E_{AS}	Single Pulsed Avalanche Energy (Note 2)	520	mJ
I_{AR}	Avalanche Current (Note 1)	11.4	A
E_{AR}	Repetitive Avalanche Energy (Note 1)	14.7	mJ
dv/dt	Peak Diode Recovery dv/dt (Note 3)	4.5	V/ns
P_D	Power Dissipation (T_C = 25℃)	50	W
	– Derate above 25℃	0.4	W/℃
T_J, T_{STG}	Operating and Storage Temperature Range	-55 to +150	℃
T_L	Maximum lead temperature for soldering purposes, 1/8” from case for 5 seconds	300	℃

* Drain current limited by maximum junction temperature

Thermal Resistance Characteristics

Symbol	Parameter	Typ.	Max.	Units
$R_{\theta JC}$	Junction-to-Case	--	2.5	℃/W
$R_{\theta JA}$	Junction-to-Ambient	--	62.5	

Electrical Characteristics T_C=25 °C unless otherwise specified

Symbol	Parameter	Test Conditions	Min	Typ	Max	Units

On Characteristics

Symbol	Parameter	Test Conditions	Min	Typ	Max	Units
V_{GS}	Gate Threshold Voltage	$V_{DS} = V_{GS}$, I_D = 250 μA	2.5	--	4.5	V
$R_{DS(ON)}$	Static Drain-Source On-Resistance	V_{GS} = 10 V, I_D = 5.7 A	--	0.38	0.48	Ω

Off Characteristics

Symbol	Parameter	Test Conditions	Min	Typ	Max	Units
BV_{DSS}	Drain-Source Breakdown Voltage	V_{GS} = 0 V, I_D = 250 μA	400	--	--	V
ΔBV_{DSS} /ΔT_J	Breakdown Voltage Temperature Coefficient	I_D = 250 μA, Referenced to25℃	--	0.41	--	V/℃
I_{DSS}	Zero Gate Voltage Drain Current	V_{DS} = 400 V, V_{GS} = 0 V	--	--	1	μA
		V_{DS} = 320 V, T_C = 125℃	--	--	10	μA
I_{GSSF}	Gate-Body Leakage Current, Forward	V_{GS} = 30 V, V_{DS} = 0 V	--	--	100	nA
I_{GSSR}	Gate-Body Leakage Current, Reverse	V_{GS} = -30 V, V_{DS} = 0 V	--	--	-100	nA

Dynamic Characteristics

Symbol	Parameter	Test Conditions	Min	Typ	Max	Units
C_{iss}	Input Capacitance	V_{DS} = 25 V, V_{GS} = 0 V, f = 1.0 MHz	--	1350	1750	pF
C_{oss}	Output Capacitance		--	180	240	pF
C_{rss}	Reverse Transfer Capacitance		--	30	39	pF

Switching Characteristics

Symbol	Parameter	Test Conditions	Min	Typ	Max	Units
$t_{d(on)}$	Turn-On Time	V_{DS} = 200 V, I_D = 11.4 A, R_G = 25 Ω (Note 4,5)	--	35	70	ns
t_r	Turn-On Rise Time		--	120	240	ns
$t_{d(off)}$	Turn-Off Delay Time		--	80	160	ns
t_f	Turn-Off Fall Time		--	80	160	ns
Q_g	Total Gate Charge	V_{DS} = 320 V, I_D = 11.4 A, V_{GS} = 10 V (Note 4,5)	--	35	45	nC
Q_{gs}	Gate-Source Charge		--	7	--	nC
Q_{gd}	Gate-Drain Charge		--	17	--	nC

Source-Drain Diode Maximum Ratings and Characteristics

Symbol	Parameter	Test Conditions	Min	Typ	Max	Units
I_S	Continuous Source-Drain Diode Forward Current		--	--	11.4	A
I_{SM}	Pulsed Source-Drain Diode Forward Current		--	--	45.6	
V_{SD}	Source-Drain Diode Forward Voltage	I_S = 11.4 A, V_{GS} = 0 V	--	--	1.5	V
trr	Reverse Recovery Time	I_S = 11.4 A, V_{GS} = 0 V di_F/dt = 100 A/μs (Note 4)	--	310	--	ns
Qrr	Reverse Recovery Charge		--	2.3	--	μC

Notes ;

1. Repetitive Rating : Pulse width limited by maximum junction temperature
2. L=7mH, I_{AS}=11.4A, V_{DD}=50V, R_G=25Ω, Starting T_J =25°C
3. I_{SD}≤11.4A, di/dt≤200A/μs, V_{DD}≤BV_{DSS} , Starting T_J =25 °C
4. Pulse Test : Pulse Width ≤ 300μs, Duty Cycle ≤ 2%
5. Essentially Independent of Operating Temperature

Typical Characteristics

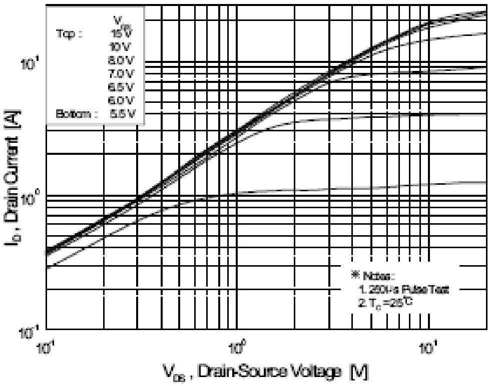


Figure 1. On Region Characteristics

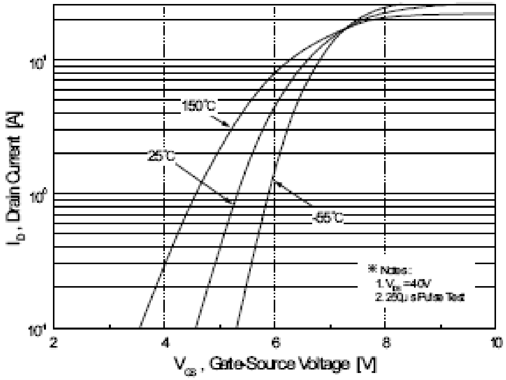


Figure 2. Transfer Characteristics

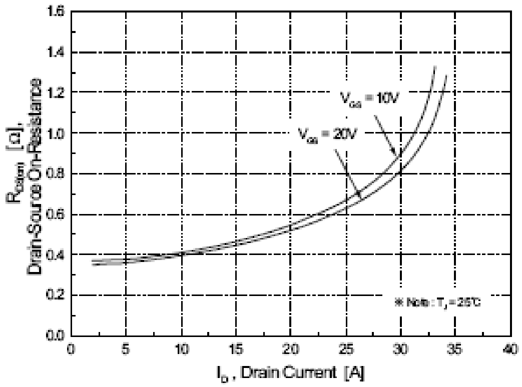


Figure 3. On Resistance Variation vs Drain Current and Gate Voltage

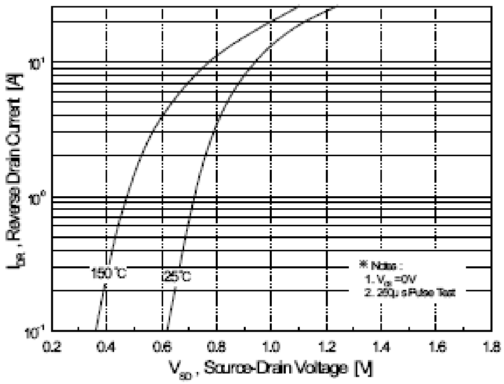


Figure 4. Body Diode Forward Voltage Variation with Source Current and Temperature

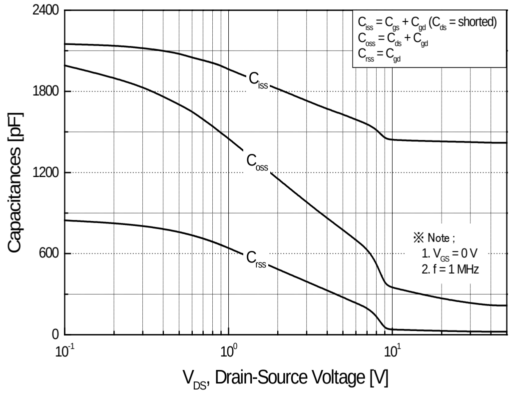


Figure 5. Capacitance Characteristics

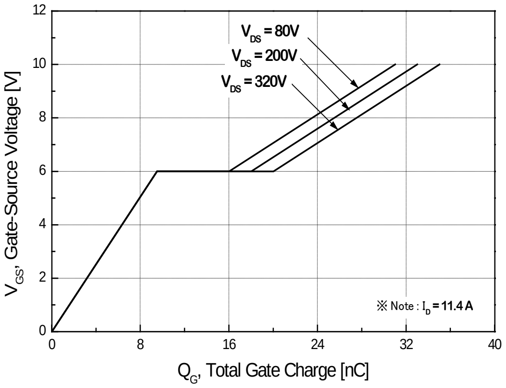
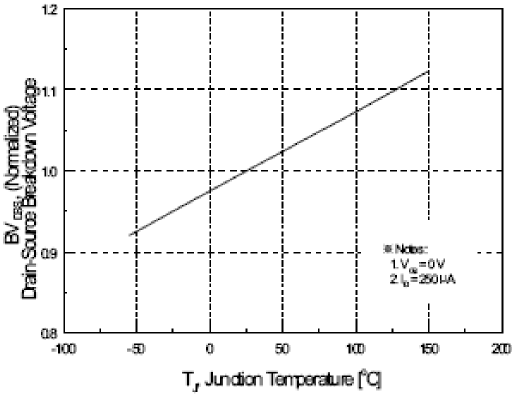


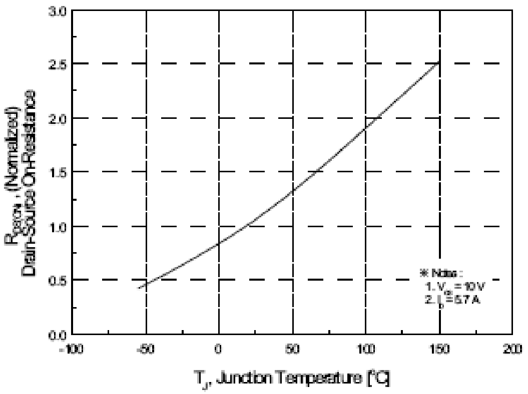
Figure 6. Gate Charge Characteristics

Typical Characteristics (continued)



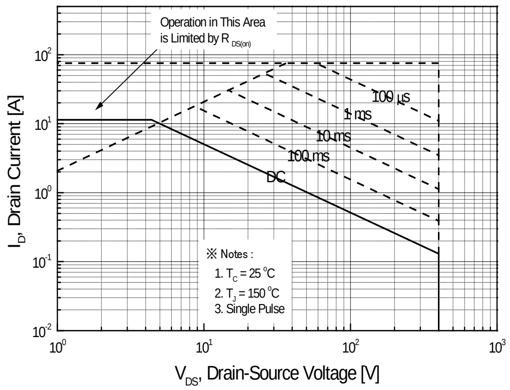
※ Notes :
1. V$_{GS}$ = 0 V
2. I$_D$ = 250 μA

Figure 7. Breakdown Voltage Variation vs Temperature



※ Notes :
1. V$_{GS}$ = 10 V
2. I$_D$ = 5.7 A

Figure 8. On-Resistance Variation vs Temperature



※ Notes :
1. T$_C$ = 25 °C
2. T$_J$ = 150 °C
3. Single Pulse

Figure 9. Maximum Safe Operating Area

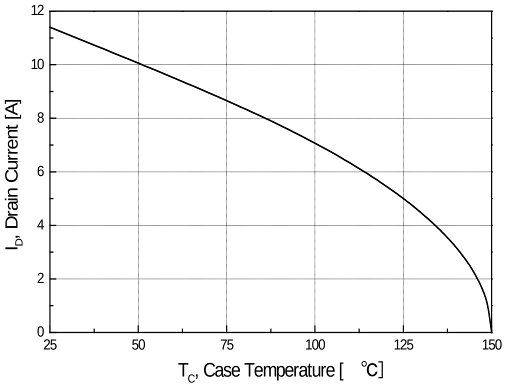
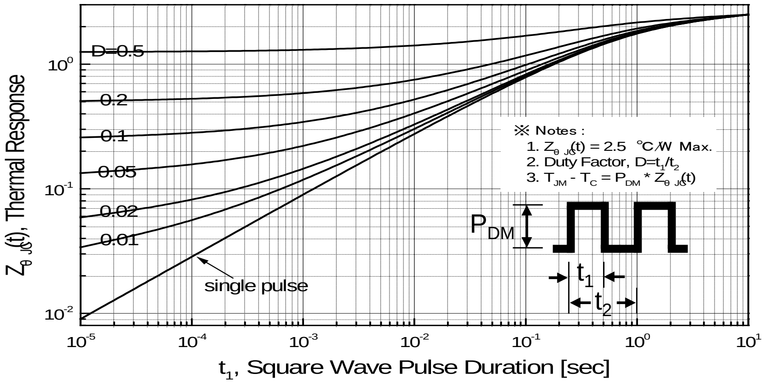


Figure 10. Maximum Drain Current vs Case Temperature



※ Notes :
1. $Z_{\theta JC}(t) = 2.5$ °C/W Max.
2. Duty Factor, $D = t_1/t_2$
3. $T_{JM} - T_C = P_{DM} * Z_{\theta JC}(t)$

Figure 11. Transient Thermal Response Curve

Fig 12. Gate Charge Test Circuit & Waveform

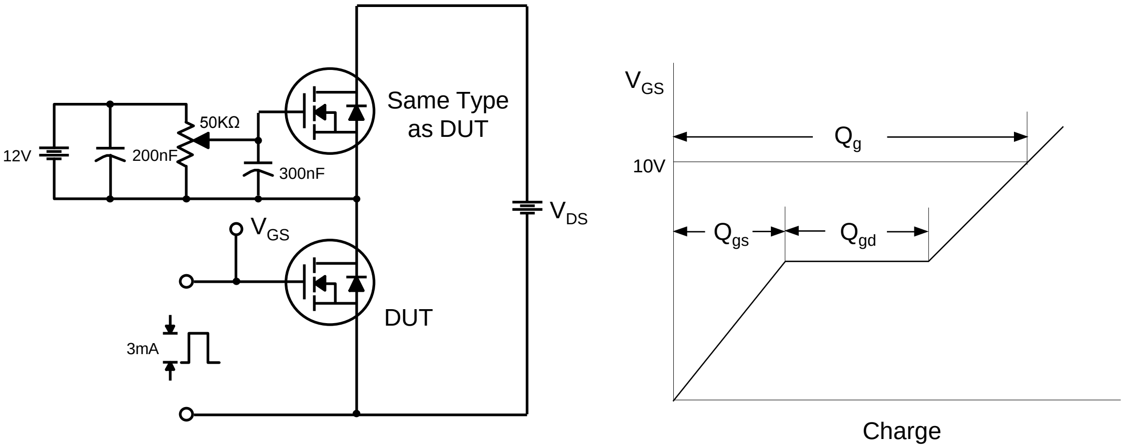


Fig 13. Resistive Switching Test Circuit & Waveforms

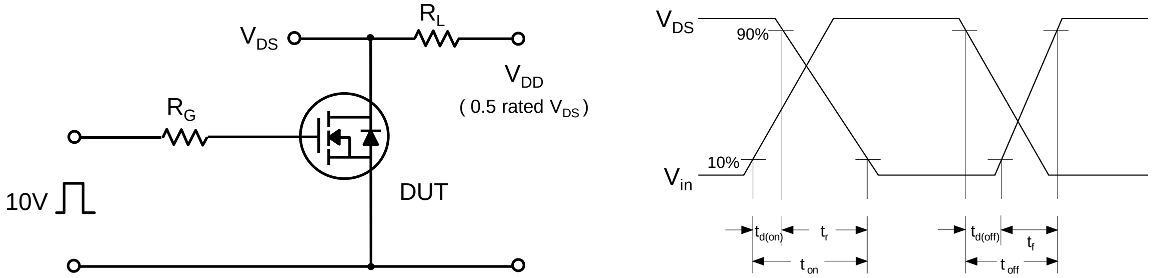


Fig 14. Unclamped Inductive Switching Test Circuit & Waveforms

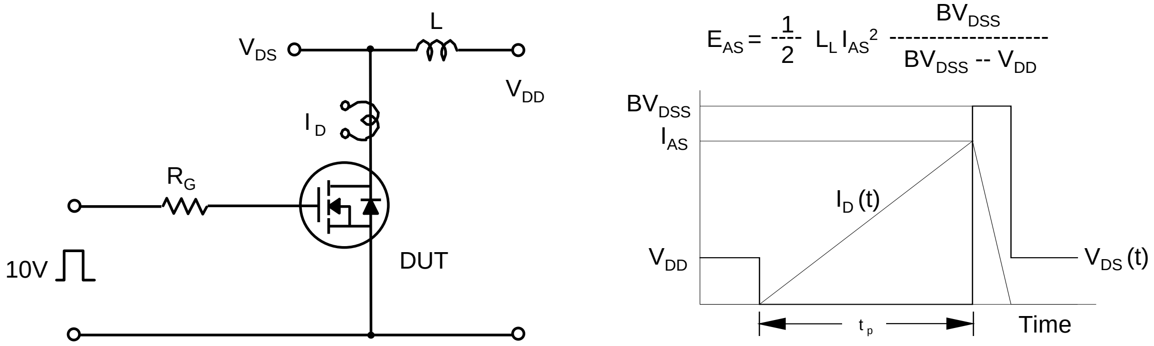
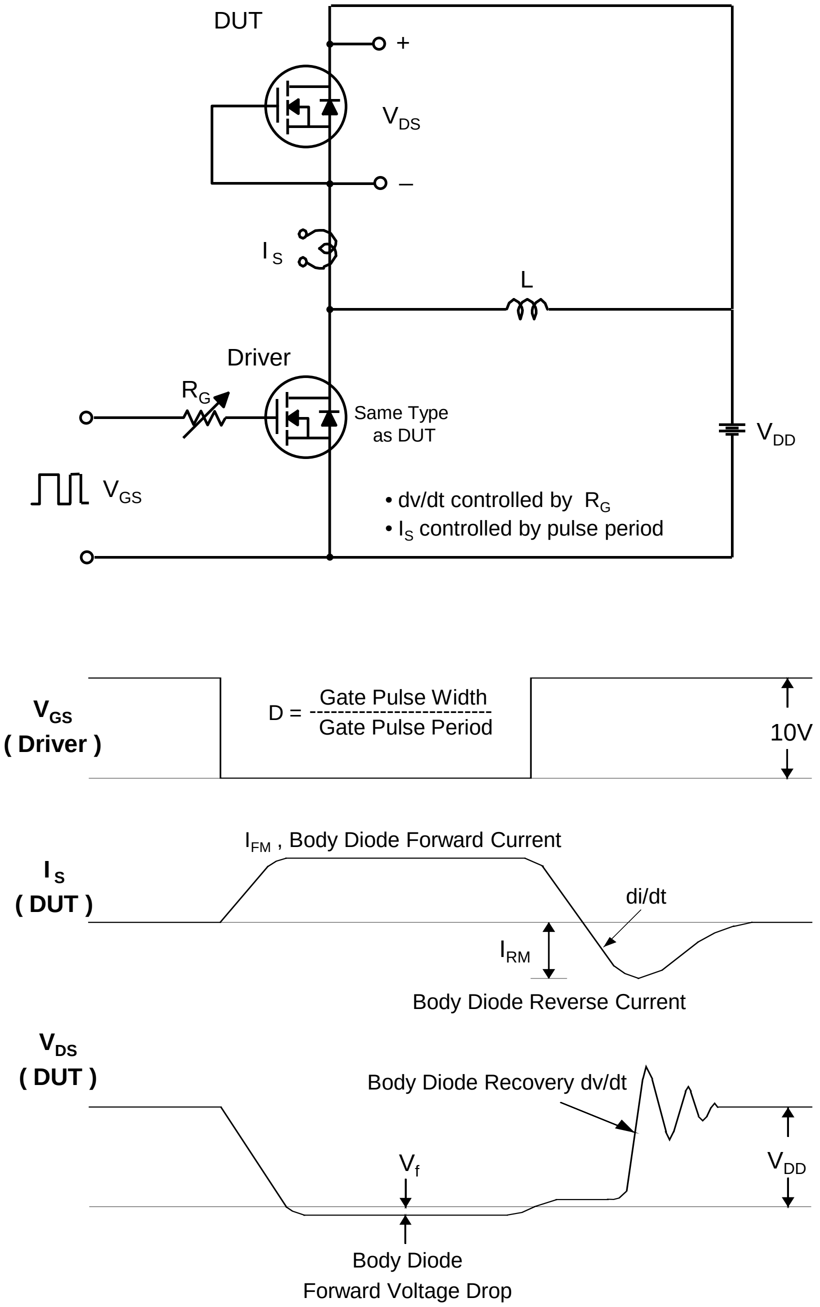

$$E_{AS} = \frac{1}{2} L_L I_{AS}^2 \frac{BV_{DSS}}{BV_{DSS} - V_{DD}}$$

Fig 15. Peak Diode Recovery dv/dt Test Circuit & Waveforms



Package Dimension

TO-220F