HAOLIN ELECTRONICS

Apr 2009

HA9N90
900V N-Channel MOSFET

$BV_{DSS} = 900$ V

$R_{DS(on)\ typ} = 1.25\ \Omega$

$I_D = 9.0$ A

TO-3P

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 : 55 nC (Typ.)
- ❑ Extended Safe Operating Area
- ❑ Lower $R_{DS(ON)}$: 1.25 Ω (Typ.) @V_{GS}=10V
- ❑ 100% Avalanche Tested
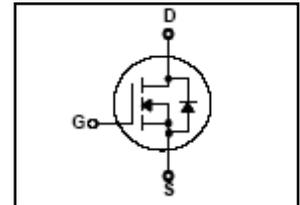
Absolute Maximum Ratings T_C=25℃ unless otherwise specified

Symbol	Parameter	Value	Units
V_{DSS}	Drain-Source Voltage	900	V
I_D	Drain Current – Continuous ($T_C = 25$℃)	9.0	A
	Drain Current – Continuous ($T_C = 100$℃)	5.7	A
I_{DM}	Drain Current – Pulsed (Note 1)	36	A
V_{GS}	Gate-Source Voltage	±30	V
E_{AS}	Single Pulsed Avalanche Energy (Note 2)	900	mJ
I_{AR}	Avalanche Current (Note 1)	9.0	A
E_{AR}	Repetitive Avalanche Energy (Note 1)	28	mJ
dv/dt	Peak Diode Recovery dv/dt (Note 3)	4.0	V/ns
P_D	Power Dissipation ($T_C = 25$℃)	280	W
	– Derate above 25℃	2.22	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	℃

Thermal Resistance Characteristics

Symbol	Parameter	Typ.	Max.	Units
$R_{\theta JC}$	Junction-to-Case	--	0.45	
$R_{\theta CS}$	Case-to-Sink	0.24	--	℃/W
$R_{\theta JA}$	Junction-to-Ambient	--	40	

Electrical Characteristics T_C=25 °C unless otherwise specified

Symbol	Parameter	Test Conditions	Min	Typ	Max	Units
On Characteristics						
V_{GS}	Gate Threshold Voltage	$V_{DS} = V_{GS}$, $I_D = 250 \mu A$	2.5	--	4.5	V
$R_{DS(ON)}$	Static Drain-Source On-Resistance	$V_{GS} = 10$ V, $I_D = 4.5$ A	--	1.25	1.4	Ω
Off Characteristics						
BV_{DSS}	Drain-Source Breakdown Voltage	$V_{GS} = 0$ V, $I_D = 250 \mu A$	900	--	--	V
$\Delta BV_{DSS}/\Delta T_J$	Breakdown Voltage Temperature Coefficient	$I_D = 250 \mu A$, Referenced to 25°C	--	0.99	--	V/°C
I_{DSS}	Zero Gate Voltage Drain Current	$V_{DS} = 900$ V, $V_{GS} = 0$ V	--	--	10	μA
		$V_{DS} = 720$ V, $T_C = 125$°C	--	--	100	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						
C_{iss}	Input Capacitance	$V_{DS} = 25$ V, $V_{GS} = 0$ V, f = 1.0 MHz	--	2550	3310	pF
C_{oss}	Output Capacitance		--	210	270	pF
C_{rss}	Reverse Transfer Capacitance		--	18	23	pF
Switching Characteristics						
$t_{d(on)}$	Turn-On Time	$V_{DS} = 450$ V, $I_D = 9.0$ A, $R_G = 25$ Ω	--	60	120	ns
t_r	Turn-On Rise Time		--	145	290	ns
$t_{d(off)}$	Turn-Off Delay Time		--	120	240	ns
t_f	Turn-Off Fall Time	(Note 4,5)	--	90	180	ns
Q_g	Total Gate Charge	$V_{DS} = 720$V, $I_D = 9.0$ A, $V_{GS} = 10$ V	--	55	70	nC
Q_{gs}	Gate-Source Charge		--	16	--	nC
Q_{gd}	Gate-Drain Charge	(Note 4,5)	--	21	--	nC
Source-Drain Diode Maximum Ratings and Characteristics						
I_S	Continuous Source-Drain Diode Forward Current		--	--	9.0	A
I_{SM}	Pulsed Source-Drain Diode Forward Current		--	--	36	
V_{SD}	Source-Drain Diode Forward Voltage	$I_S = 9.0$ A, $V_{GS} = 0$ V	--	--	1.4	V
trr	Reverse Recovery Time	$I_S = 9.0$ A, $V_{GS} = 0$ V	--	660	--	ns
Qrr	Reverse Recovery Charge	$di_F/dt = 100$ A/μs (Note 4)	--	7.8	--	μC

Notes ;
1. Repetitive Rating : Pulse width limited by maximum junction temperature
2. L=21mH, I_{AS}=9.0A, V_{DD}=50V, R_G=25Ω, Starting T_J=25°C
3. I_{SD}≤9.0A, 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
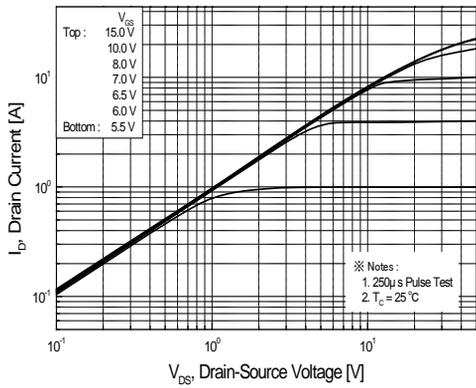
**Figure 1. On Region Characteristics**
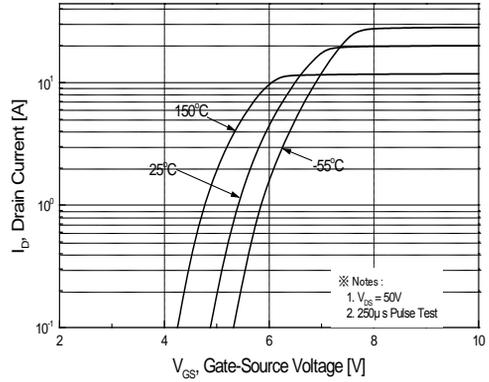
**Figure 2. Transfer Characteristics**
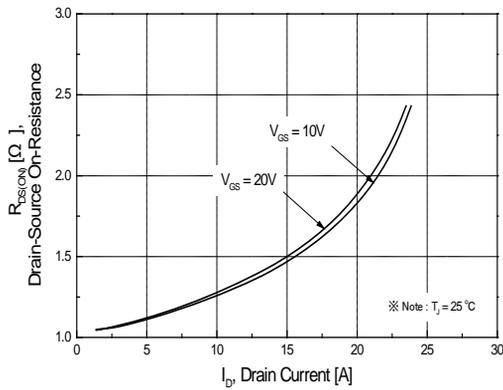
Figure 3. On Resistance Variation vs Drain Current and Gate Voltage
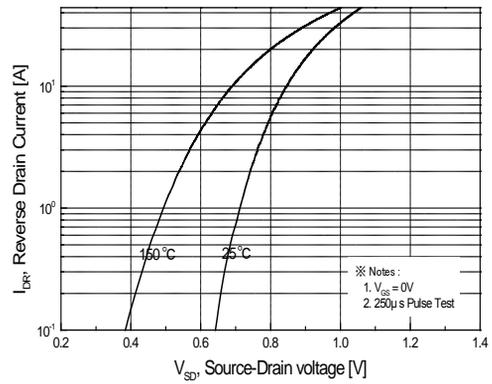

**Figure 4. Body Diode Forward Voltage Variation with Source Current and Temperature**
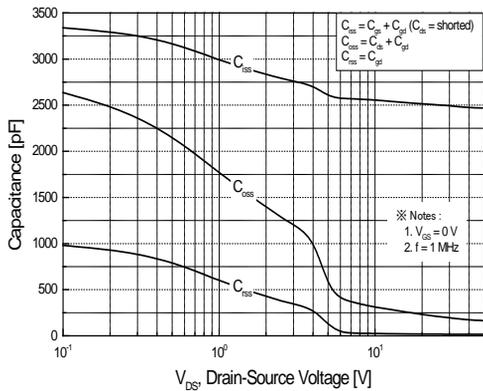

Figure 5. Capacitance Characteristics
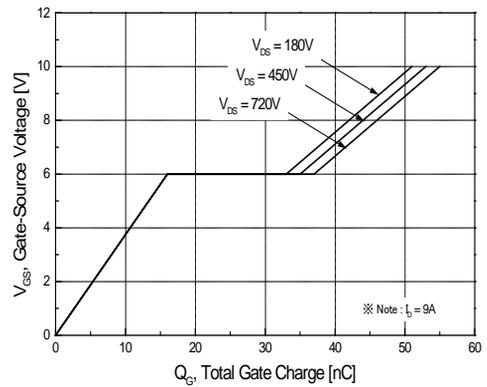
Figure 6. Gate Charge Characteristics

# Typical Characteristics   (continued)
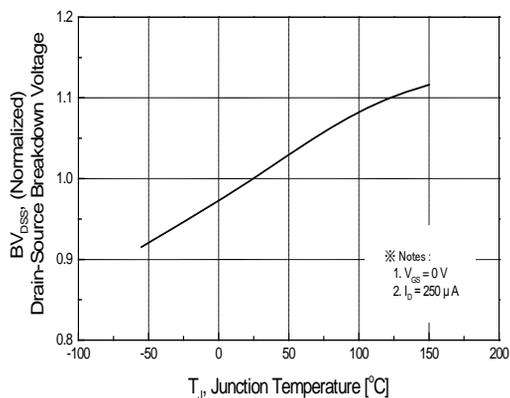
**Figure 7. Breakdown Voltage Variation
vs Temperature**
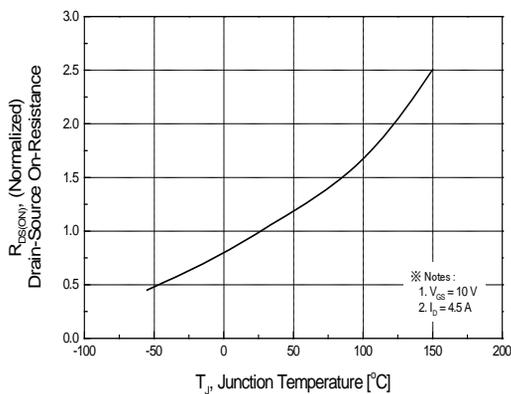

**Figure 8. On-Resistance Variation
vs Temperature**
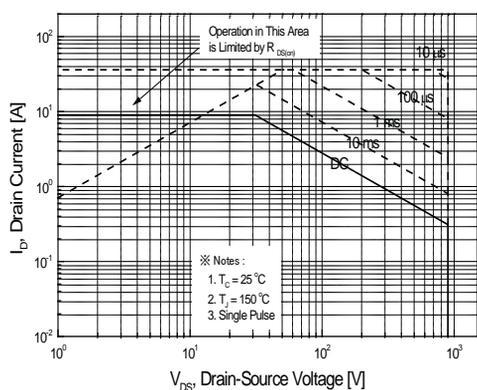

Figure 9. Maximum Safe Operating Area
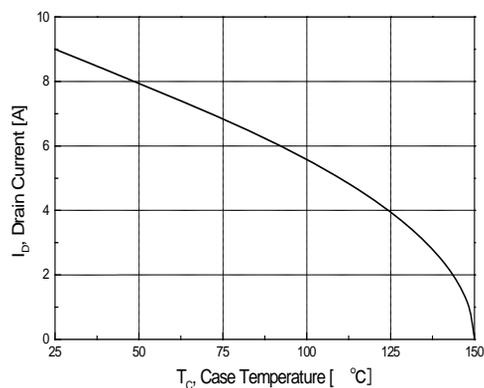

**Figure 10. Maximum Drain Current
vs Case Temperature**
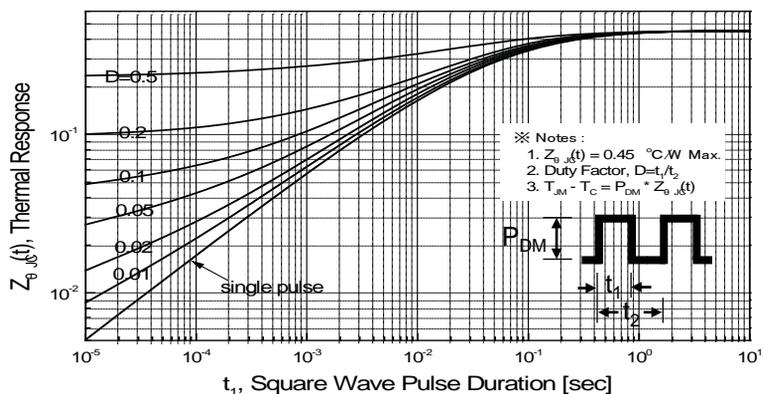
Figure 11. Transient Thermal Response Curve

Fig 12. Gate Charge Test Circuit & Waveform

Same Type as DUT

12V 200nF 50KΩ 300nF V_{GS} DUT 3mA V_{DS}

V_{GS} 10V Q_g Q_{gs} Q_{gd} Charge
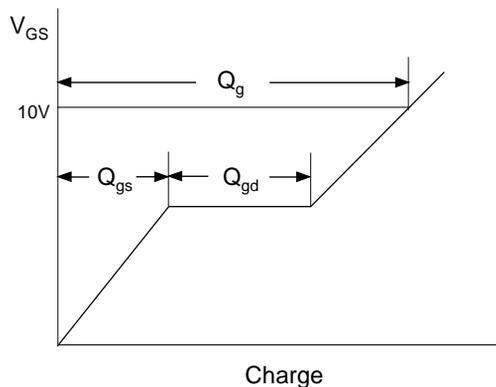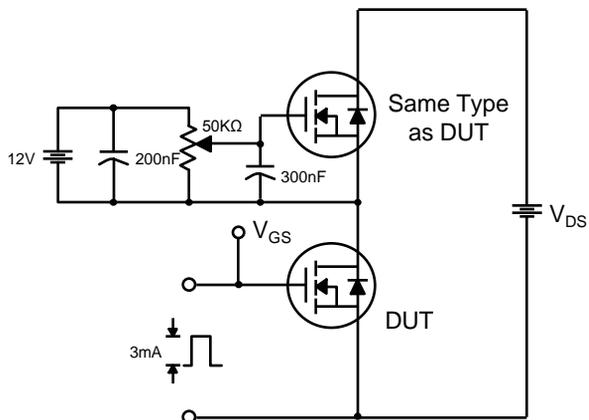
Fig 13. Resistive Switching Test Circuit & Waveforms

V_{DS} R_L V_{DD} (0.5 rated V_{DS}) R_G 10V DUT

V_{DS} 90% V_{in} 10% $t_{d(on)}$ t_r t_{on} $t_{d(off)}$ t_f t_{off}
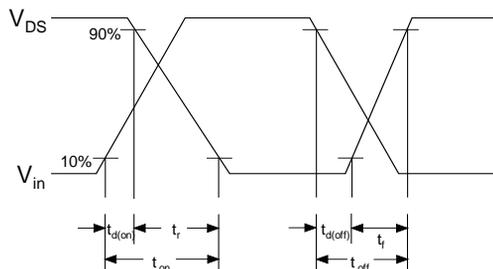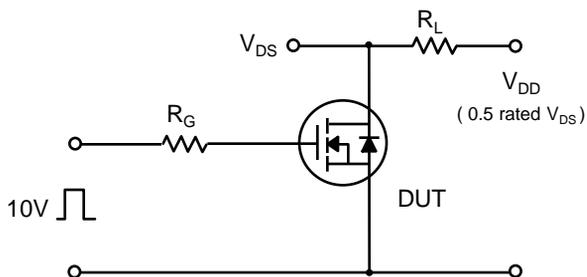
Fig 14. Unclamped Inductive Switching Test Circuit & Waveforms

V_{DS} L V_{DD} I_D R_G 10V DUT

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

BV_{DSS} I_{AS} $I_D(t)$ V_{DD} $V_{DS}(t)$ t_p Time

5
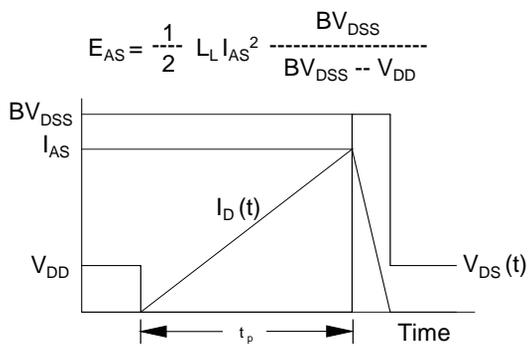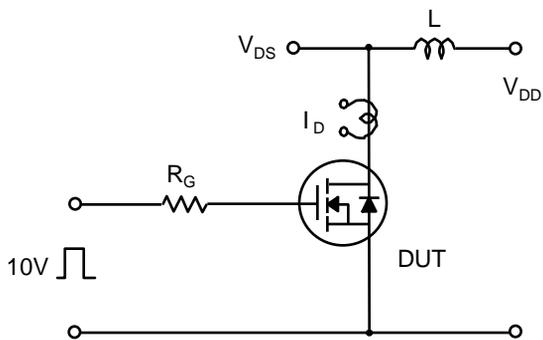
Fig 15. Peak Diode Recovery dv/dt Test Circuit & Waveforms

DUT

V_{DS}

+

−

I_S

L

Driver

R_G

Same Type
as DUT

V_{GS}

V_{DD}

• dv/dt controlled by R_G
• I_S controlled by pulse period

V_{GS}
(Driver)

$$D = \frac{\text{Gate Pulse Width}}{\text{Gate Pulse Period}}$$

10V

I_S
(DUT)

I_{FM} , Body Diode Forward Current

di/dt

I_{RM}

Body Diode Reverse Current

V_{DS}
(DUT)

Body Diode Recovery dv/dt

V_f

V_{DD}

Body Diode
Forward Voltage Drop

Package Dimension

TO-3P

A
15.6±0.2
B
9.6±0.2
C
19.9±0.2
D
2.0±0.1
E
20.3±0.2
I
3±0.1
J
3.5±0.2
H
1±0.1
G
5.45±0.2
K
4,8±0.1
L
1.5±0.1
M
1,4±0.1
N
0.6±0.1
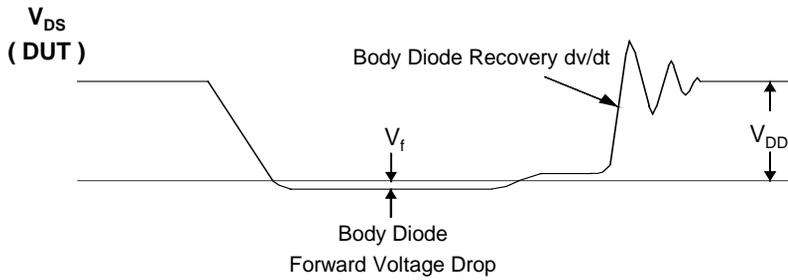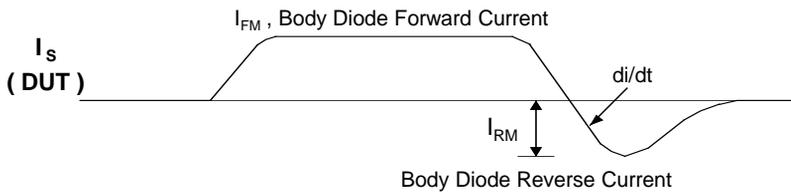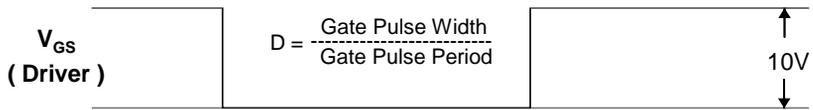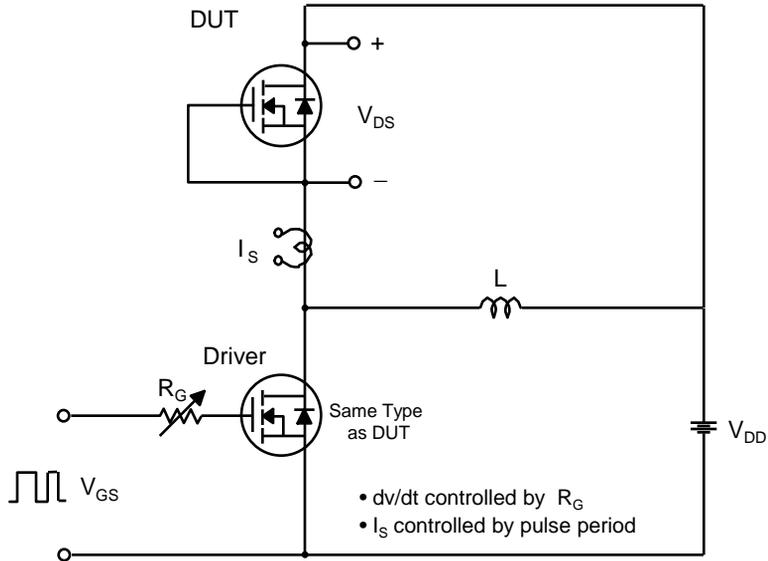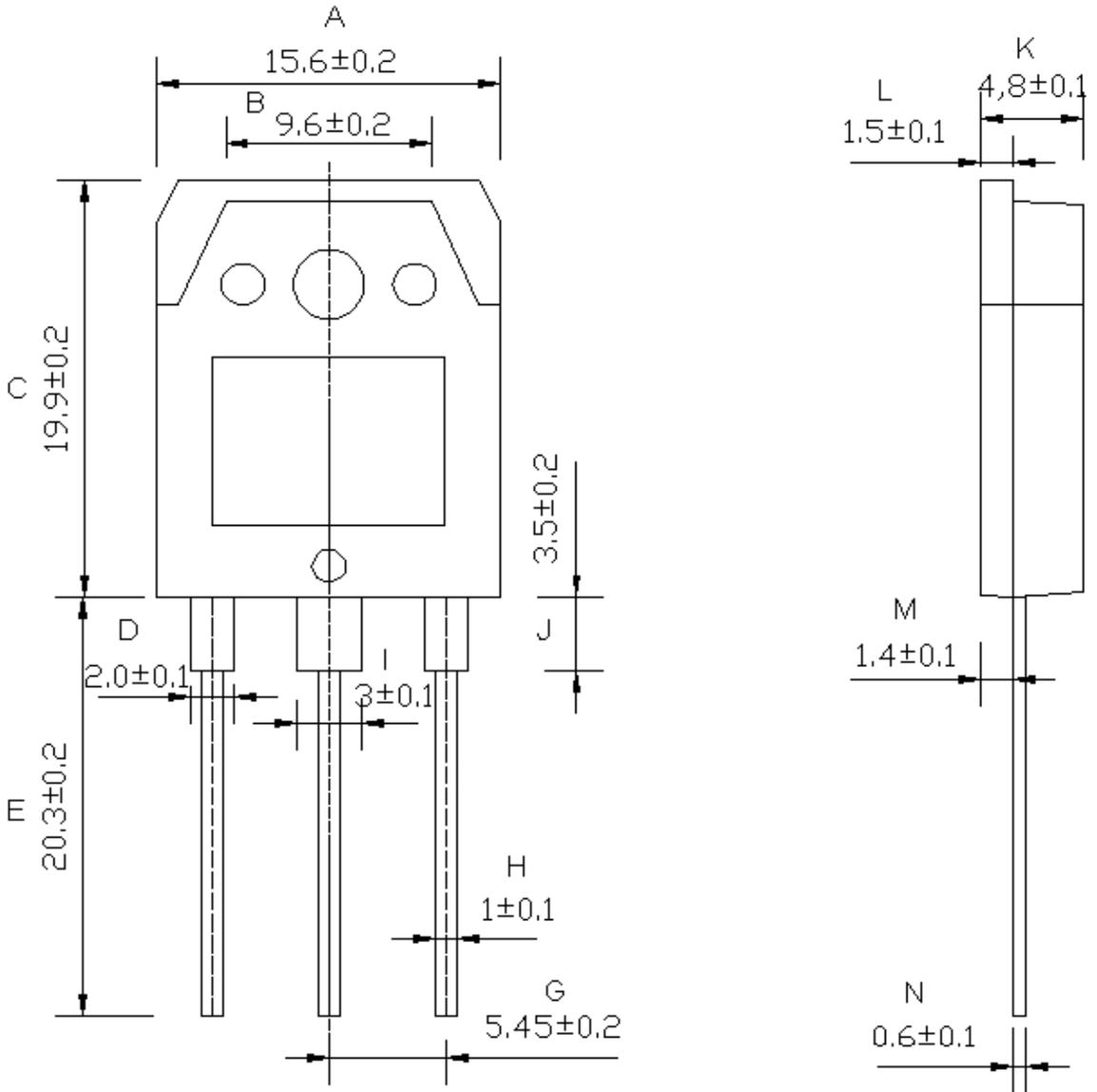
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