

650V N-Channel Planar MOSFET

MOSFET

Metal Oxide Semiconductor Field Effect Transistor

650V N-Channel Planar MOSFET

650V N-Channel Planar MOSFET Power Transistor

HRH20N65ANx Data Sheet

Rev. 2023 V1.1



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Description

650V N-Channel Planar MOSFET

HRH20N65ANx is HRM high voltage MOSFET family based on advanced planar stripe DMOS technology. This advanced MOSFET family has optimized on-state resistance, and also provides superior switching performance and higher avalanche energy strength. This device family is suitable for high efficiency switch mode power supplies.

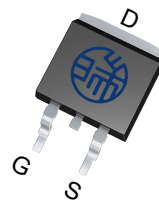
Features

- $R_{DS(on)}=0.3\Omega$ @ $V_{gs}=10V$, $I_d=10A$
- Low gate Charge(typical 73nC)
- Low C_{rss} (typical 12pF)
- Fast switching capability
- 100% avalanche tested
- Improved dv/dt capability

Applications

- Switch Mode Power Supply
- Uninterruptible Power Supply (UPS)
- TV Power
- A dapter/Charger

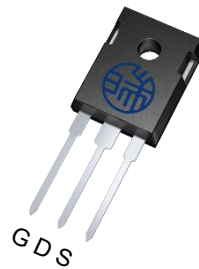
TO-263



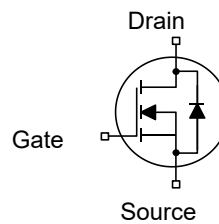
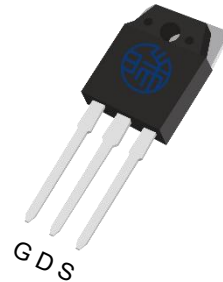
TO-220F



TO-247



TO-3P



Key Performance Parameters

Parameter	Value	Unit
V_{DS}	650	V
$R_{DS(on),typ}$	0.3	Ω
$Q_{g,typ}$	73	nC
I_D	20	A
$I_{D,pulse}$	80	A

Device Marking and Package Information

Device	Package	Marking
HRH20N65ANF	TO-220F	H20N65ANF
HRH20N65ANF	TO-220F	H20N65ANFT
HRH20N65ANB	TO-263	H20N65ANB
HRH20N65ANV	TO-3P	H20N65ANV
HRH20N65ANW	TO-247	H20N65ANW

Absolute Maximum Ratings T _C = 25°C, unless otherwise noted				
Parameter		Symbol	Value	Unit
Drain-Source Voltage(V _{GS} =0V)		V _{DS}	650	V
Continuous Drain Current ¹⁾	T _C = 25°C	I _D	20	A
	T _C = 100°C		12.5	
Pulsed Drain Current ²⁾		I _{D,pulse}	80	A
Gate-Source Voltage		V _{GS}	±30	V
Single Pulse Avalanche Energy ³⁾		E _{AS}	1600	mJ
Peak Diode Recovery dv/dt ⁴⁾		dv/dt	5	V/ns
Power Dissipation For TO-220F		P _D	113	W
Power Dissipation For TO-3P/247/263			284	
Continuous Diode Forward Current		I _S	20	A
Diode Pulsed Current ²⁾		I _{S,pulse}	80	
Operating Junction and Storage Temperature Range		T _J , T _{stg}	-55~+150	°C

Thermal Resistance For TO-220F			
Parameter	Symbol	Value	Unit
Thermal Resistance, Junction-to-Case	R_{thJC}	1.1	$^\circ\text{C/W}$
Thermal Resistance, Junction-to-Ambient	R_{thJA}	80	

Thermal Resistance For TO-3P/247/263			
Parameter	Symbol	Value	Unit
Thermal Resistance, Junction-to-Case	R_{thJC}	0.44	$^\circ\text{C/W}$
Thermal Resistance, Junction-to-Ambient	R_{thJA}	62	

Notes

- 1) Limited by maximum junction temperature.
- 2) Repetitive Rating: Pulse width limited by maximum junction temperature.
- 3) $L=8\text{mH}$, $I_D=20\text{A}$, $R_G=25\Omega$, $V_{DD}=100\text{V}$, Start $T_J=25^\circ\text{C}$.
- 4) $I_{SD} \leq 20\text{A}$, $di/dt \leq 100\text{A}/\mu\text{s}$, $V_{DD} \leq BV_{DSS}$, Start $T_J=25^\circ\text{C}$.

Electrical Characteristics T _J = 25°C, unless otherwise noted						
Parameter	Symbol	Test Conditions	Value			Unit
			Min.	Typ.	Max.	
Static Characteristics						
Drain-Source Breakdown Voltage	V _{(BR)DSS}	V _{GS} = 0V, I _D = 250μA	650	--	--	V
Zero Gate Voltage Drain Current	I _{DSS}	V _{DS} = 650V V _{GS} = 0V, T _J = 25°C	--	--	1	μA
		V _{DS} = 650V, V _{GS} = 0V, T _J = 150°C	--	--	100	
Gate-Source Leakage Current	I _{GSS}	V _{GS} = ±30V	--	--	±100	nA
Gate-Source Threshold Voltage	V _{GS(th)}	V _{DS} = V _{GS} , I _D = 250μA	2	--	4	V
Drain-Source On-State-Resistance	R _{DS(on)}	V _{GS} = 10V, I _D = 10A	--	0.3	0.42	Ω
Gate Resistance	R _G	f = 1.0MHz open drain	--	1.2	--	Ω
Dynamic Characteristics						
Input Capacitance	C _{iss}	V _{GS} = 0V, V _{DS} = 25V f = 1.0MHz	--	4348	--	pF
Output Capacitance	C _{oss}		--	287	--	
Reverse Transfer Capacitance	C _{rss}		--	12	--	
Total Gate Charge	Q _g	V _{DD} = 520V, I _D = 20A V _{GS} = 10V	--	73	--	nC
Gate-Source Charge	Q _{gs}		--	23	--	
Gate-Drain Charge	Q _{gd}		--	20	--	
Gate Plateau Voltage	V _{Plateau}		--	5.35	--	V
Turn-on Delay Time	t _{d(on)}	V _{DD} = 325V, I _D = 20A R _G = 10Ω, V _{GS} = 10V	--	30	--	ns
Turn-on Rise Time	t _r		--	61	--	
Turn-off Delay Time	t _{d(off)}		--	60	--	
Turn-off Fall Time	t _f		--	51	--	
Drain-Source Body Diode Characteristics						
Body Diode Forward Voltage	V _{SD}	T _J = 25°C, I _{SD} = 20A V _{GS} = 0V	--	--	1.2	V
Reverse Recovery Time	t _{rr}	V _R = 400V I _F = 20A, di _F /dt = 100A/μs	--	924	--	ns
Reverse Recovery Charge	Q _{rr}		--	11.6	--	μC

Typical Characteristics $T_J = 25^\circ\text{C}$, unless otherwise noted

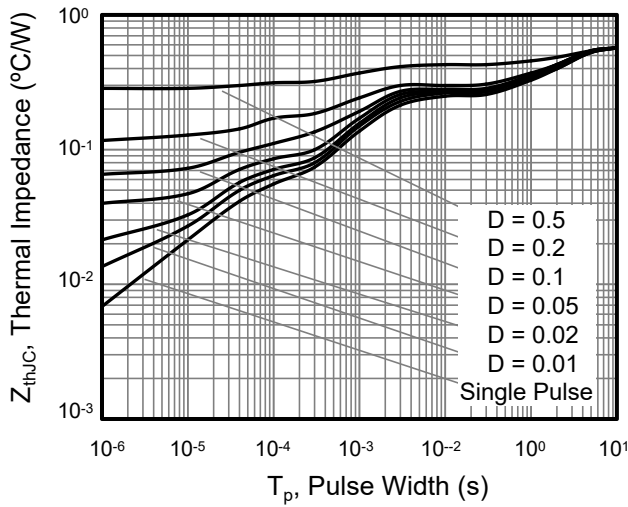


Figure 1. Transient Thermal Impedance For TO-220F

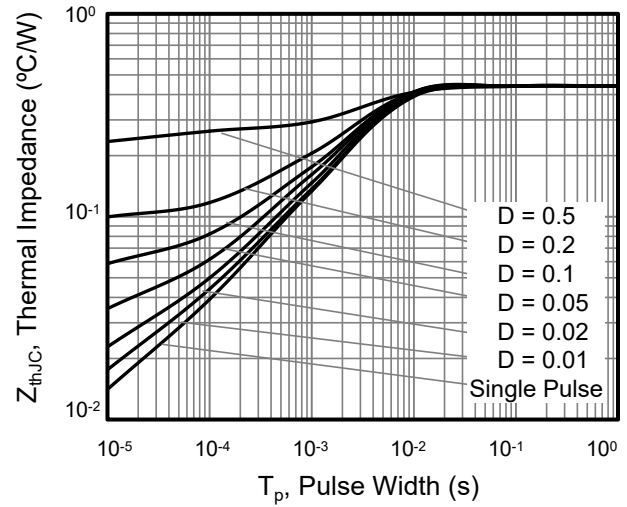


Figure 2. Transient Thermal Impedance For TO-3P/247/263

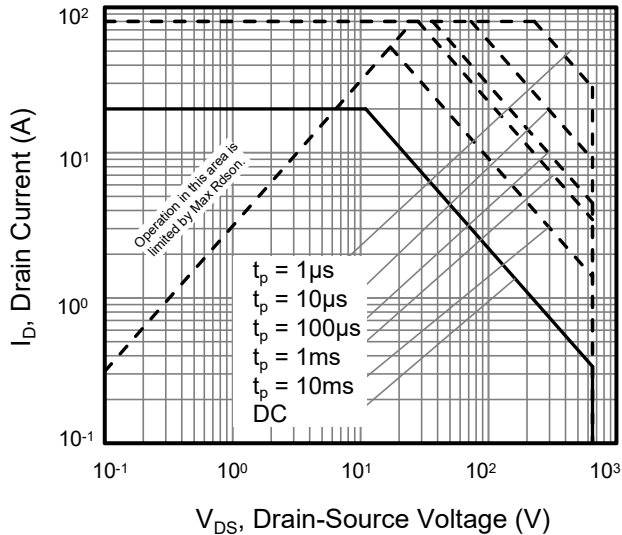


Figure 3. Safe Operation Area For TO-220F

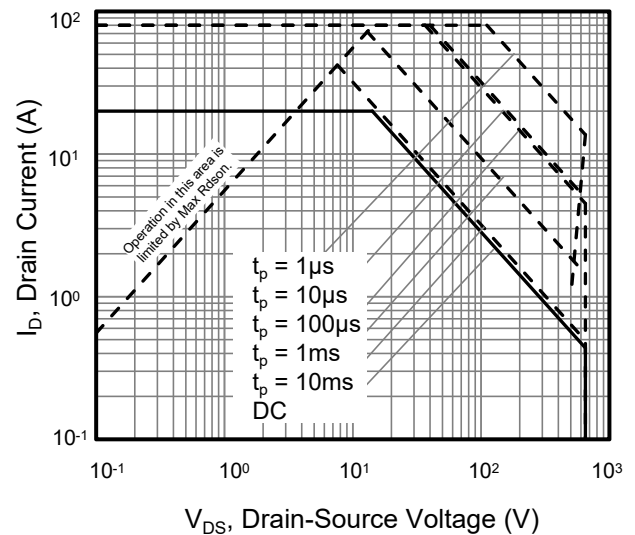


Figure 4. Safe Operation Area For TO-3P/247/263

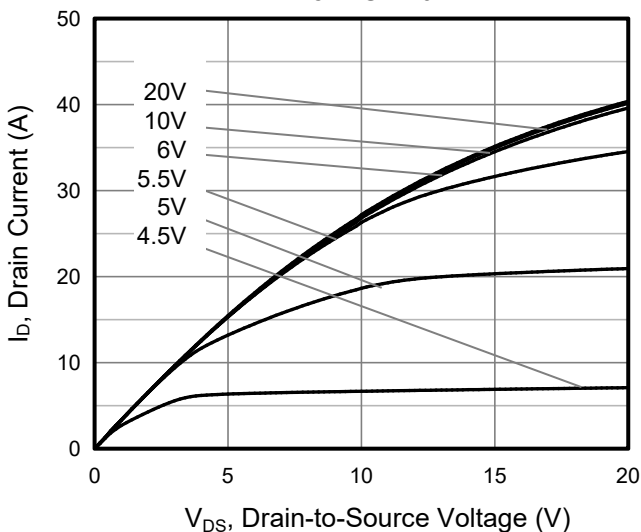


Figure 5. Output Characteristics

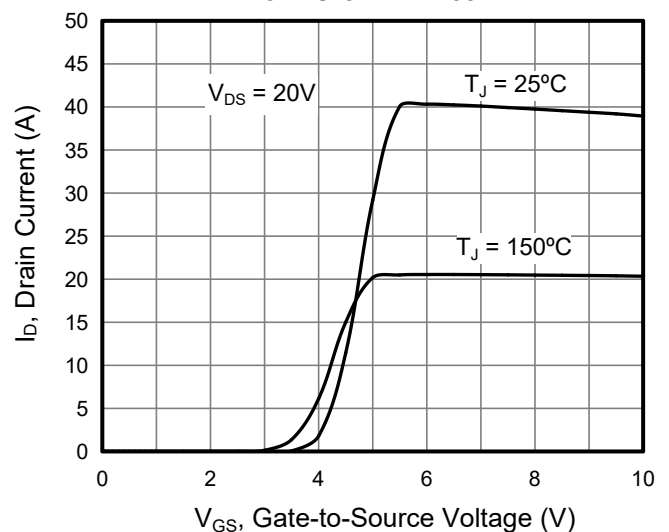


Figure 6. Transfer Characteristics

Typical Characteristics $T_J = 25^\circ\text{C}$, unless otherwise noted

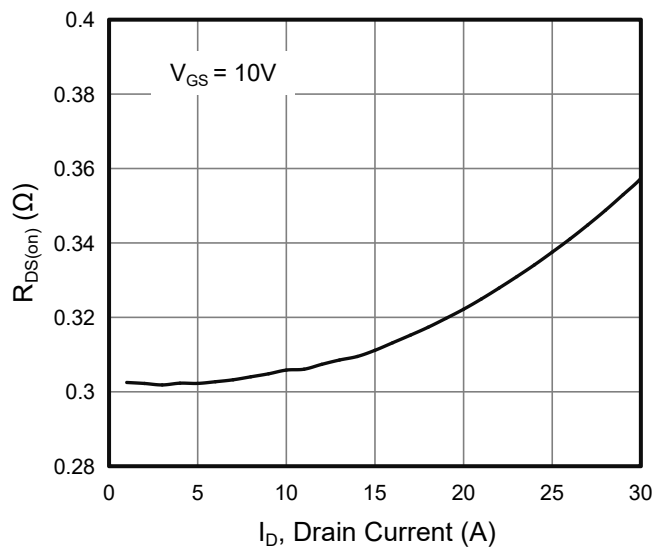


Figure 7. On-Resistance vs Drain Current

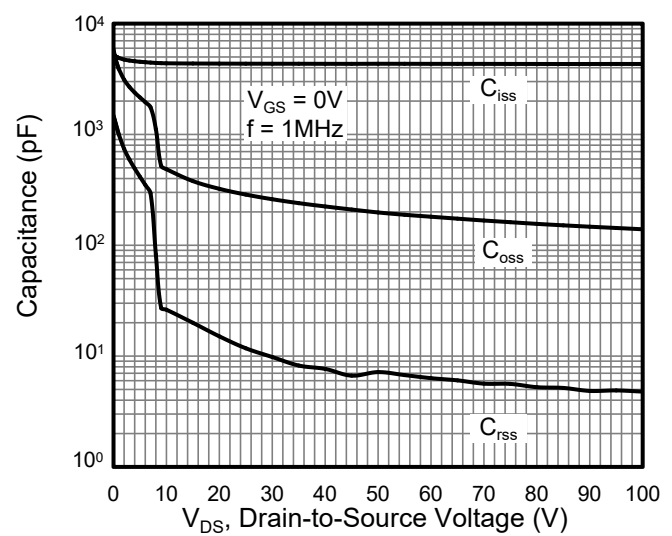


Figure 8. Capacitance

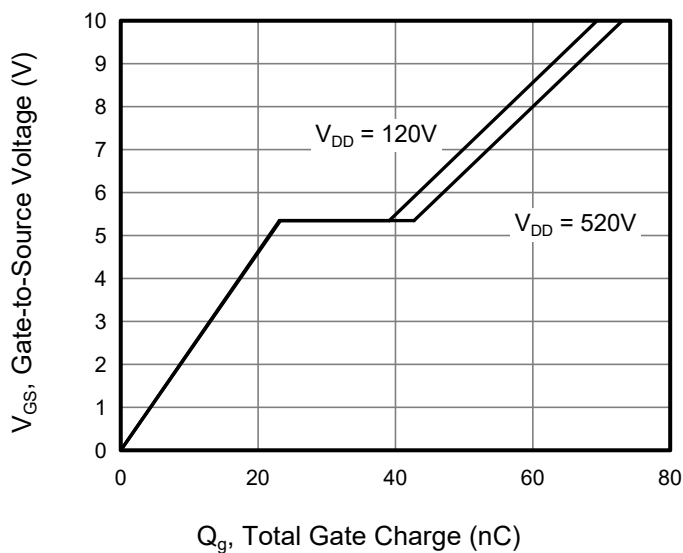


Figure 9. Gate Charge

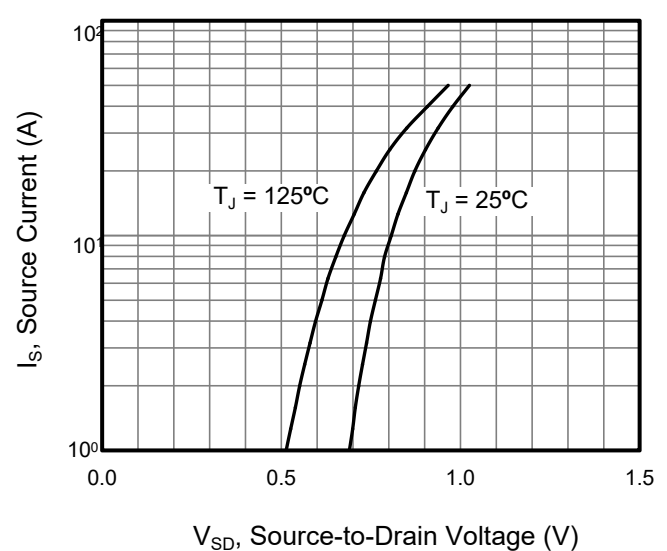


Figure 10. Body Diode Forward Voltage

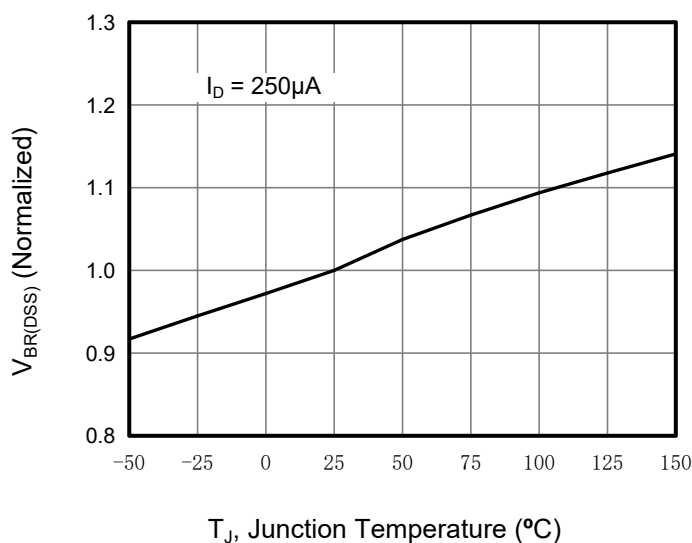


Figure 11. Breakdown Voltage vs Junction Temperature

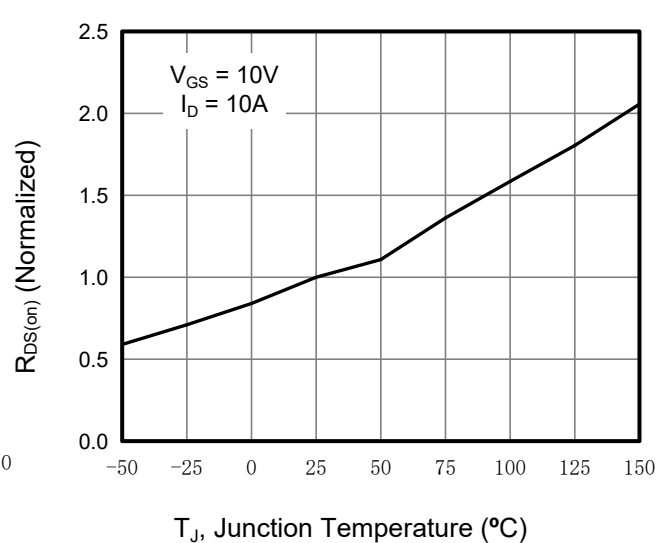


Figure 12. On-Resistance vs Temperature

Figure A: Gate Charge Test Circuit and Waveform

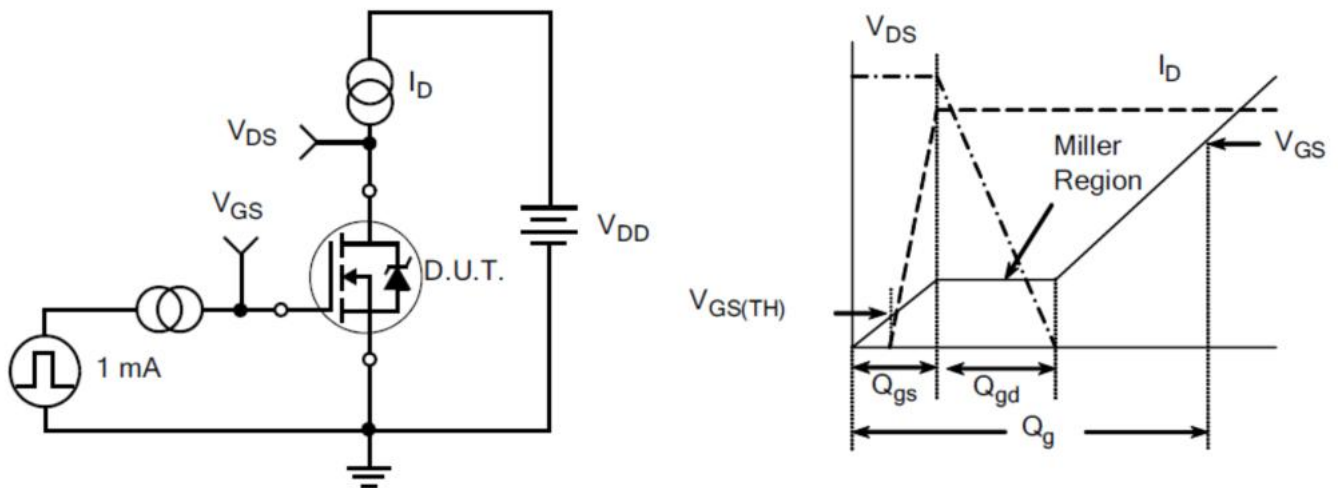


Figure B: Resistive Switching Test Circuit and Waveform

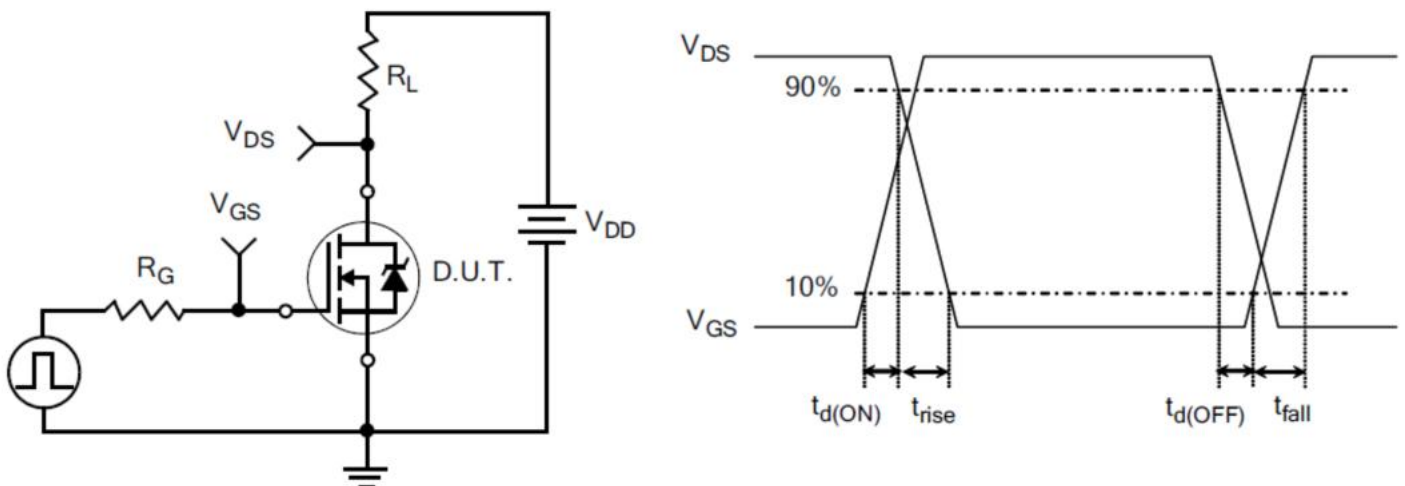
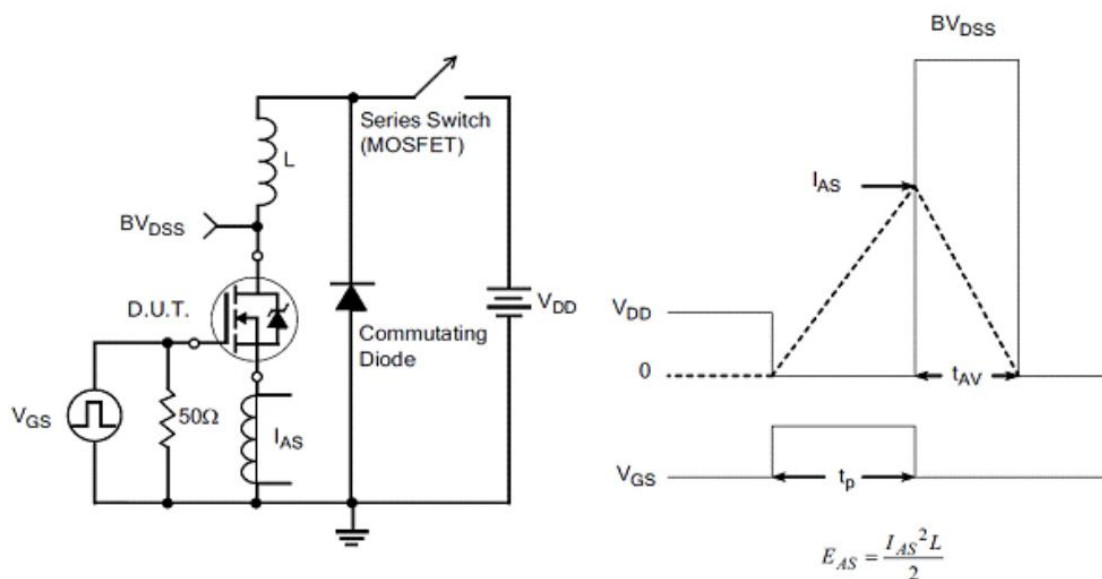
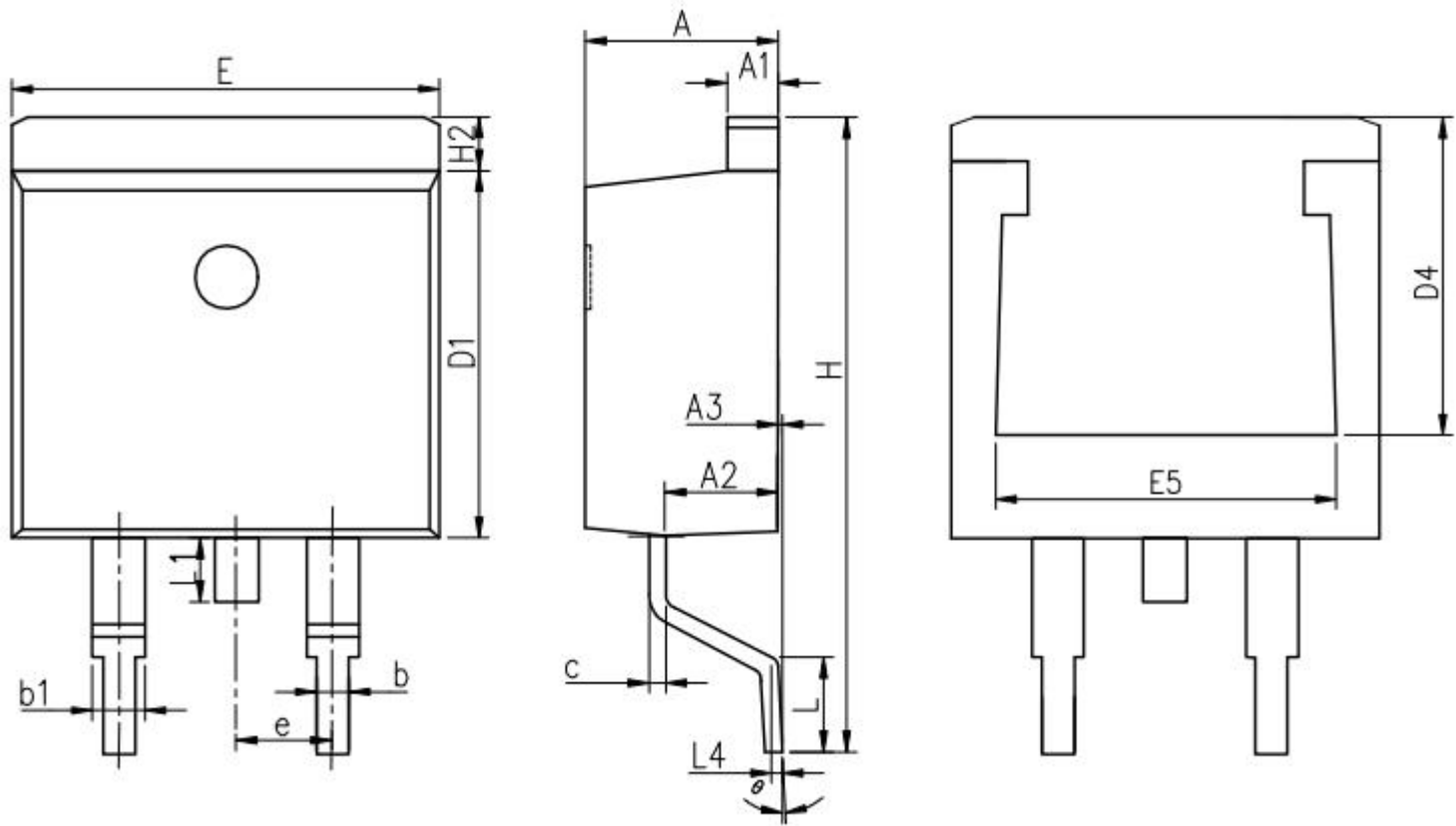


Figure C: Unclamped Inductive Switching Test Circuit and Waveform

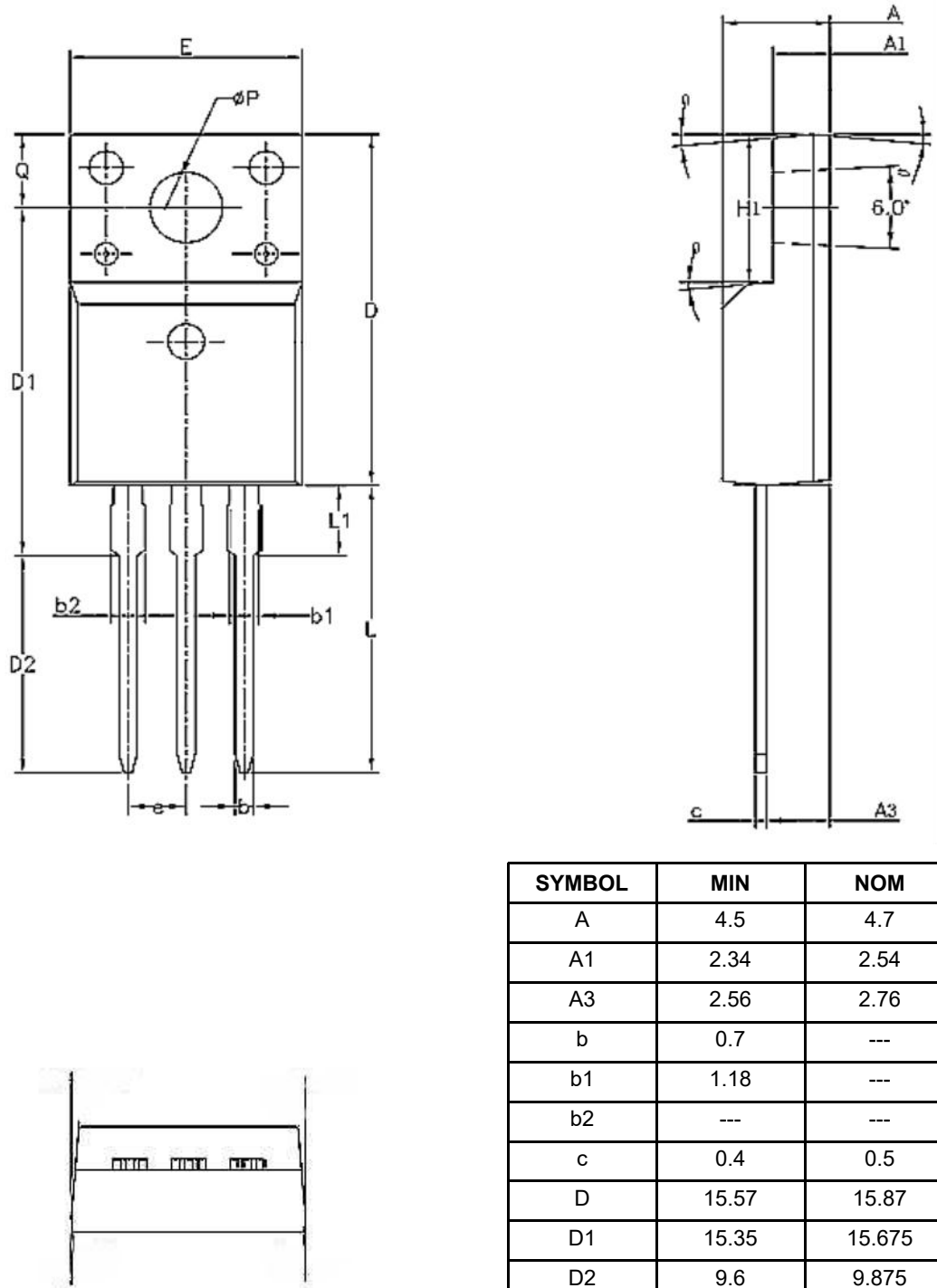


Outlines TO-263 Package



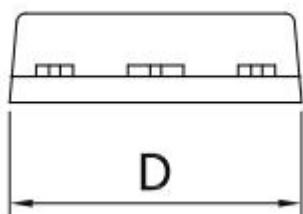
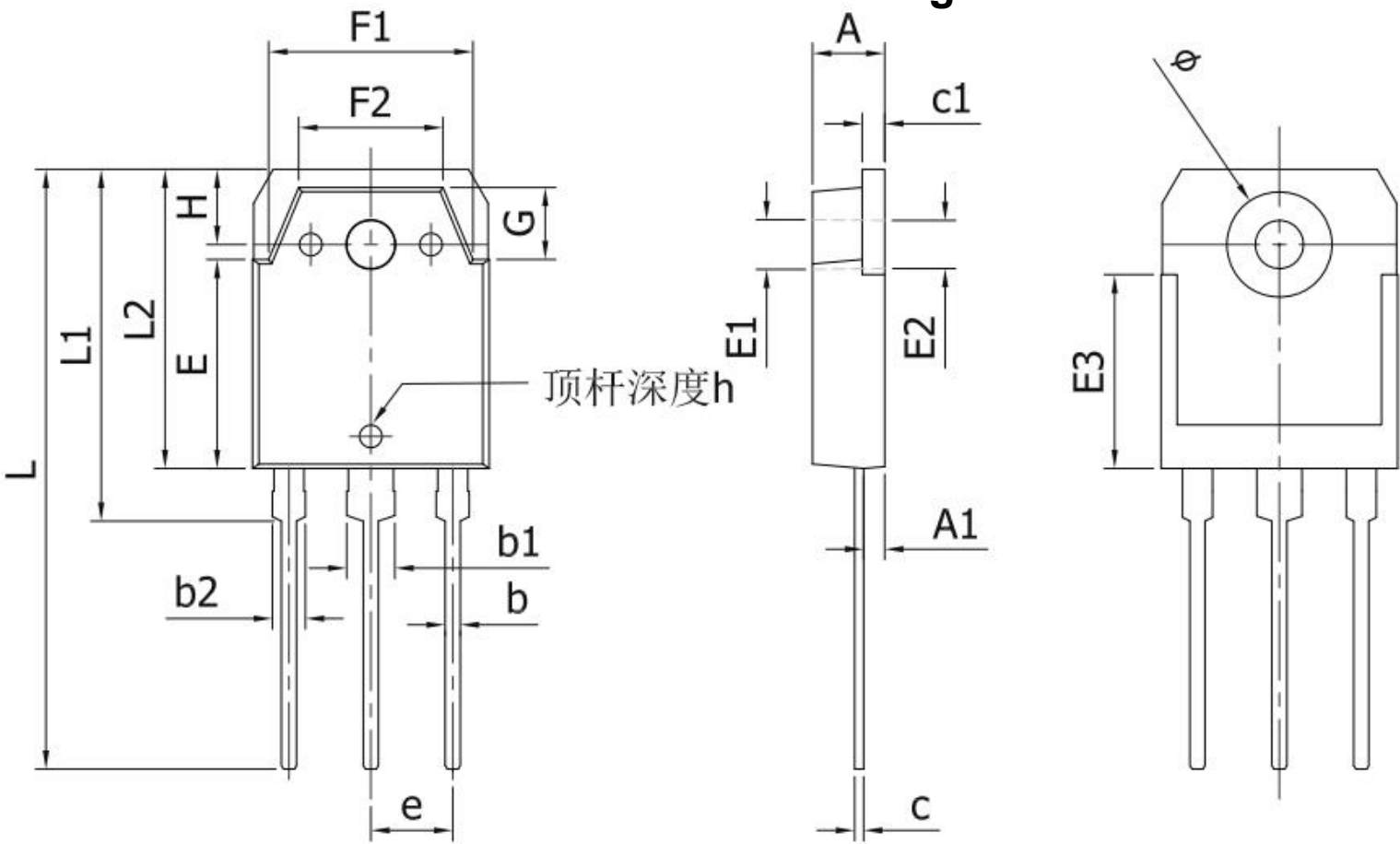
SYMBOL	MIN	NOM	MAX	SYMBOL	MIN	NOM	MAX
A	4.37	4.57	4.77	E5	7.06	---	---
A1	1.22	1.27	1.42	e	2.54 BSC		
A2	2.49	2.69	2.89	H	14.70	15.10	15.50
A3	0	0.13	0.25	H2	1.07	1.27	1.47
b	0.7	0.81	0.96	L	2.00	2.30	2.60
b1	1.17	1.27	1.47	L1	1.40	1.55	1.70
c	0.30	0.38	0.53	L4	0.25 BSC		
D1	8.50	8.70	8.90	θ	0°	5°	9°
D4	6.60	---	---	Θ	0°	--	8°
E	9.86	10.16	10.36	$\Theta 1$	1°	3°	5°

Outlines TO-220F Package



SYMBOL	MIN	NOM	MAX
A	4.5	4.7	4.9
A1	2.34	2.54	2.74
A3	2.56	2.76	2.96
b	0.7	---	0.95
b1	1.18	---	1.43
b2	---	---	1.55
c	0.4	0.5	0.65
D	15.57	15.87	16.17
D1	15.35	15.675	15.95
D2	9.6	9.875	10.15
E	9.96	10.16	10.36
e	2.54 BSC		
H1	6.48	6.68	6.88
L	12.68	12.98	13.28
L1	---	---	3.5

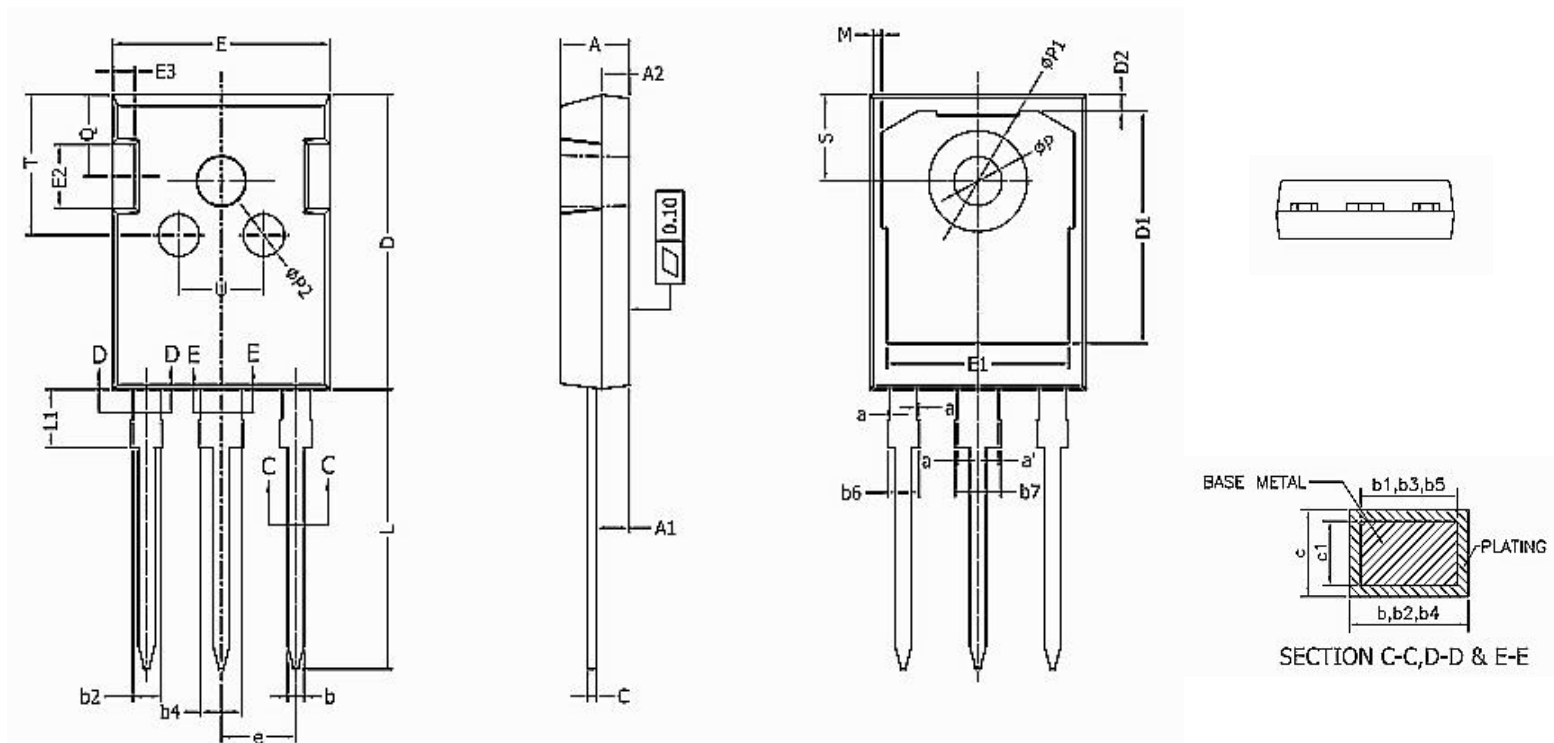
Outlines TO-3P Package



SYMBOL	MIN	NOM	MAX
A	4.6	4.8	5.0
A1	1.2	1.4	1.6
b	0.8	1	1.2
b1	2.8	3	3.2
b2	1.8	2	2.2
c	0.5	0.6	0.7
c1	1.45	1.55	1.65
D	15.45	15.65	15.85
E	13.7	13.9	14.1
E1	3.3REF		
E2	3.2REF		

SYMBOL	MIN	NOM	MAX
E3	12.9REF		
F1	13.4	13.6	13.8
F2	9.4	9.6	9.8
L	39.7	39.9	40.1
L1	23.2	23.4	23.6
L2	19.7	19.9	20.1
ϕ	6.9	7	7.1
G	4.6	4.8	5.0
e	5.45TYP		
H	5.0REF		
h	0.0	0.15	0.3

Outlines TO-247 Package



SYMBOL	MIN	NOM	MAX
A	4.9	5	5.1
A1	2.31	2.41	2.51
A2	1.9	2	2.1
a	0	---	0.15
a'	0	---	0.15
b	1.16	---	1.26
b1	1.15	1.2	1.22
b2	1.96	---	2.06
b3	1.95	2	2.02
b4	2.96	---	3.06
b5	2.96	3	3.02
b6	---	---	2.25
b7	---	---	3.25
c	0.59	---	0.66
c1	0.58	0.6	0.62
D	20.9	21	21.1
D1	16.25	16.55	16.85

SYMBOL	MIN	NOM	MAX
D2	1.05	1.17	1.35
E	15.7	15.8	15.9
E1	13.1	13.3	13.5
E2	4.4	4.5	4.6
E3	2.4	2.5	2.6
e	5.436 BSC		
L	19.8	19.92	20.1
L1	---	---	4.3
M	0.35	---	0.95
P	3.4	3.5	3.6
P1	7	---	7.4
P2	2.4	2.5	2.6
Q	5.6	---	6
S	6.05	6.15	6.25
T	9.8	---	10.2
U	6	---	6.4

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