

650V N-Channel Planar MOSFET

MOSFET

Metal Oxide Semiconductor Field Effect Transistor

650V N-Channel Planar MOSFET

650V N-Channel Planar MOSFET Power Transistor

HRH4N65AEx Data Sheet

Rev. 2023 V1.2



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Description

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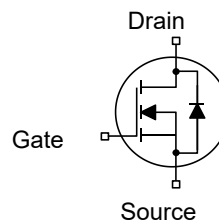
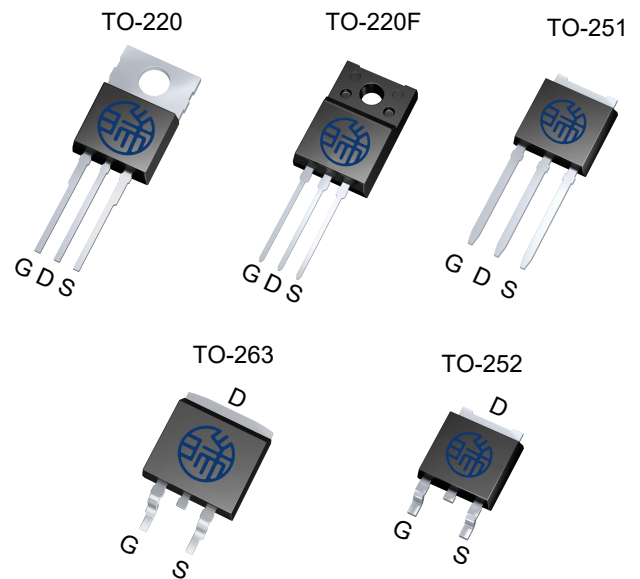
HRH4N65AEx is HRM high voltage MOSFET family based on advanced planar stripe DMOS technology. This advanced MOSFET family has optimized on-state resistance, and also provides superior switching performance and higher avalanche energy strength. This device family is suitable for high efficiency switch mode power supplies.

Features

- $R_{DS(on)}=2.2\Omega$ @ $V_{GS}=10V$, $I_D=2A$
- Low gate Charge(typical 17.8nC)
- Low C_{rss} (typical 2.3pF)
- Fast switching capability
- 100% avalanche tested
- Improved dv/dt capability

Applications

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



Key Performance Parameters

Parameter	Value	Unit
V_{DS}	650	V
$R_{DS(on),typ}$	2.2	Ω
$Q_{g,typ}$	17.8	nC
I_D	4	A
$I_{D,pulse}$	16	A

Device Marking and Package Information

Device	Package	Marking
HRH4N65AEP	TO-220	H4N65AEP
HRH4N65AEF	TO-220F	H4N65AEF
HRH4N65AEFT	TO-220F	H4N65AEFT
HRH4N65AEB	TO-263	H4N65AEB
HRH4N65AED	TO-252	H4N65AED
HRH4N65AEU	TO-251	H4N65AEU

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	4	A
	T _C = 100°C		2.5	
Pulsed Drain Current ²⁾		I _{D,pulse}	16	A
Gate-Source Voltage		V _{GS}	±30	V
Single Pulse Avalanche Energy ³⁾		E _{AS}	216	mJ
Peak Diode Recovery dv/dt ⁴⁾		dv/dt	5	V/ns
Power Dissipation For TO-220F		P _D	14	W
Power Dissipation For TO-220、TO-251、TO-252、TO-263			36	W
Continuous Diode Forward Current		I _S	4	A
Diode Pulsed Current ²⁾		I _{S,pulse}	16	
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}	8.7	$^\circ\text{C/W}$
Thermal Resistance, Junction-to-Ambient	R_{thJA}	80	

Thermal Resistance For TO-220、TO-251、TO-252、TO-263			
Parameter	Symbol	Value	Unit
Thermal Resistance, Junction-to-Case	R_{thJC}	3.5	$^\circ\text{C/W}$
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) $L=27\text{mH}$, $I_D=4\text{A}$, $R_G=25\Omega$, $V_{DD}=100\text{V}$, Start $T_J=25^\circ\text{C}$.
- 4) $I_{SD} \leq 4\text{A}$, $di/dt \leq 100\text{A}/\mu\text{s}$, $V_{DD} \leq BV_{DSS}$, 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	2.5	--	4.5	V
Drain-Source On-State-Resistance	R _{DS(on)}	V _{GS} = 10V, I _D = 2A	--	2.2	2.6	Ω
Gate Resistance	R _G	f = 1.0MHz open drain	--	1.95	--	Ω
Dynamic Characteristics						
Input Capacitance	C _{iss}	V _{GS} = 0V, V _{DS} =25V f = 1.0MHz	--	497	--	pF
Output Capacitance	C _{oss}		--	35	--	
Reverse Transfer Capacitance	C _{rss}		--	2.3	--	
Total Gate Charge	Q _g	V _{DD} = 520V, I _D = 4A V _{GS} = 10V	--	17.8	--	nC
Gate-Source Charge	Q _{gs}		--	7.4	--	
Gate-Drain Charge	Q _{gd}		--	4.25	--	
Gate Plateau Voltage	V _{plateau}		--	5.1	--	V
Turn-on Delay Time	t _{d(on)}	V _{DD} = 325V, I _D = 4A R _G = 25Ω	--	15		ns
Turn-on Rise Time	t _r		--	25		
Turn-off Delay Time	t _{d(off)}		--	30		
Turn-off Fall Time	t _f		--	19		
Drain-Source Body Diode Characteristics						
Body Diode Forward Voltage	V _{SD}	T _J = 25°C, I _{SD} = 4A V _{GS} = 0V	--	--	1.2	V
Reverse Recovery Time	t _{rr}	V _R = 400V I _F = 4A, di _F /dt = 100A/μs	--	211	--	ns
Reverse Recovery Charge	Q _{rr}		--	1.4	--	μC

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

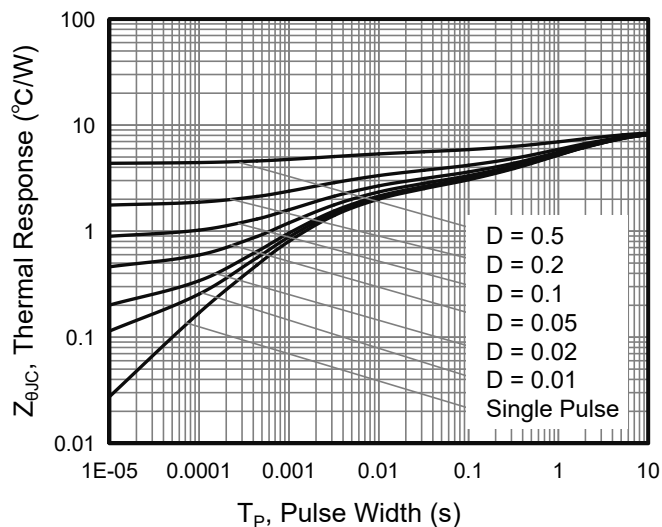


Figure 1. Transient Thermal Impedance For TO-220F

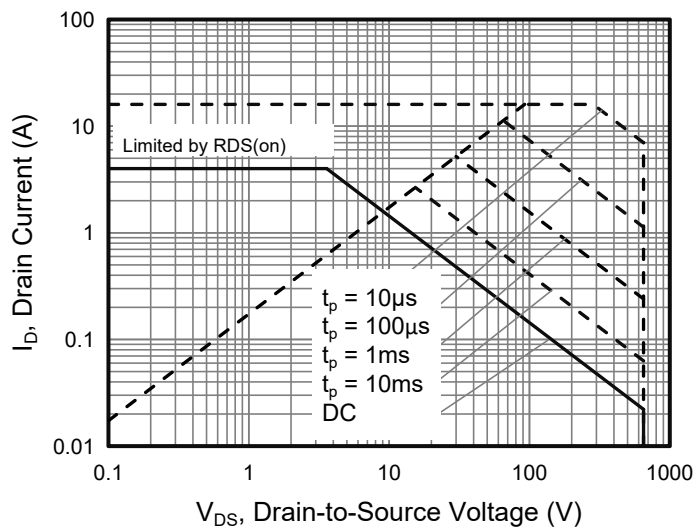


Figure 2. Safe Operation Area For TO-220F

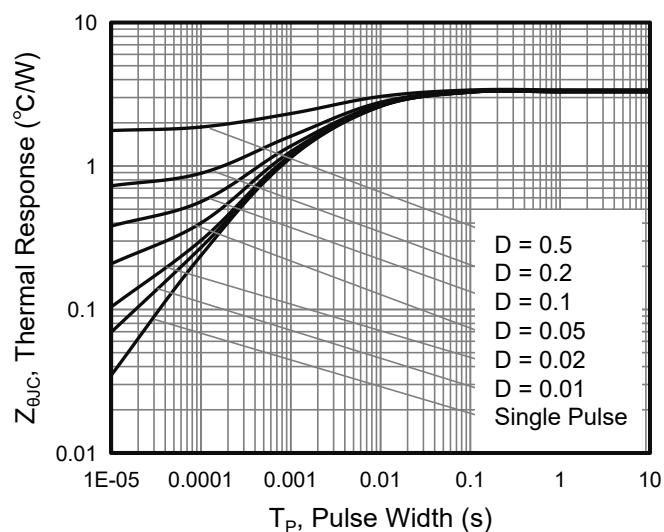


Figure 3. Transient Thermal Impedance For TO-220, TO-251, TO-252, TO-263

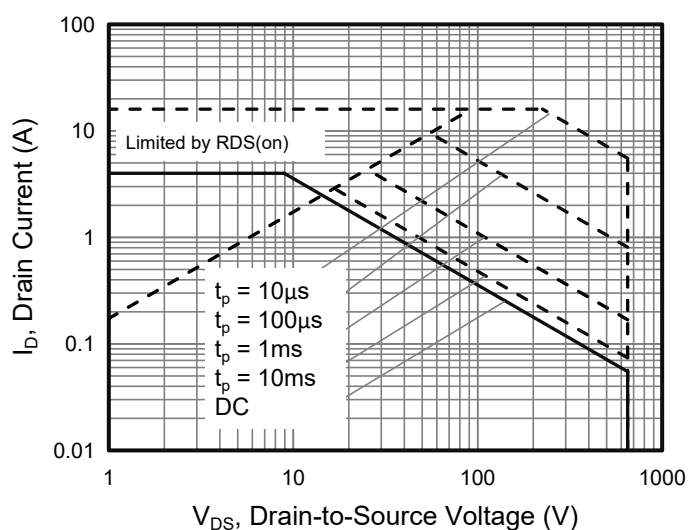


Figure 4. Safe Operation Area For TO-220, TO-251, TO-252, TO-263

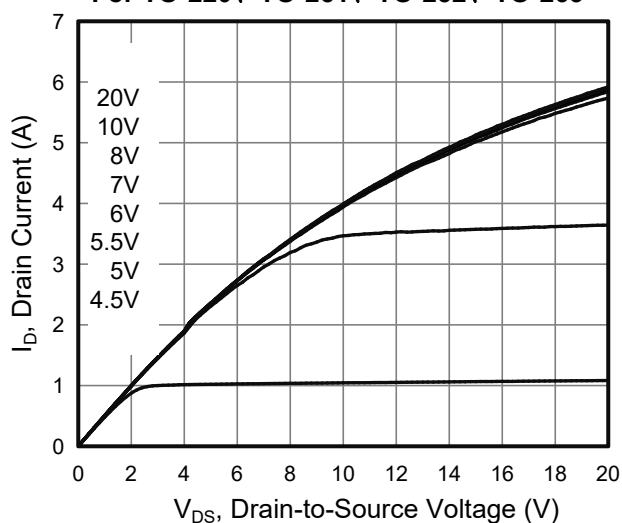


Figure 5. Output Characteristics

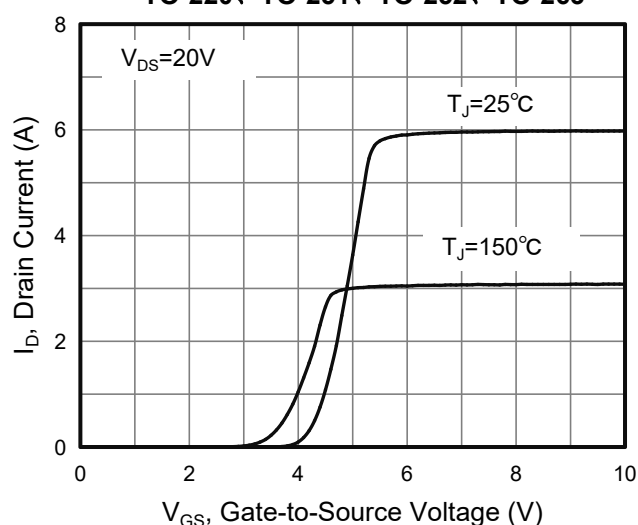


Figure 6. Transfer Characteristics

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

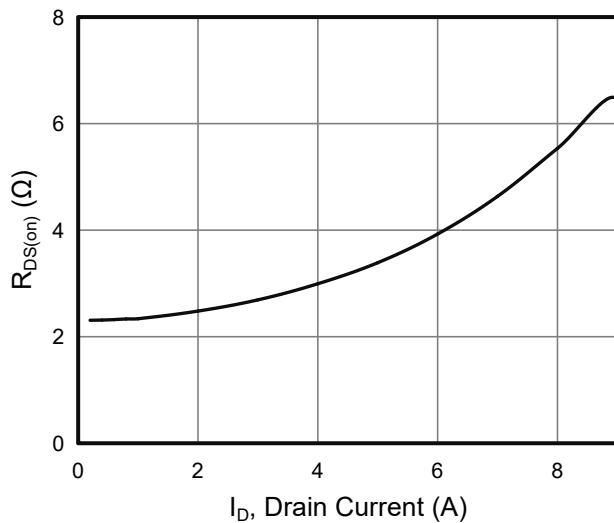


Figure 7. On-Resistance vs Drain Current

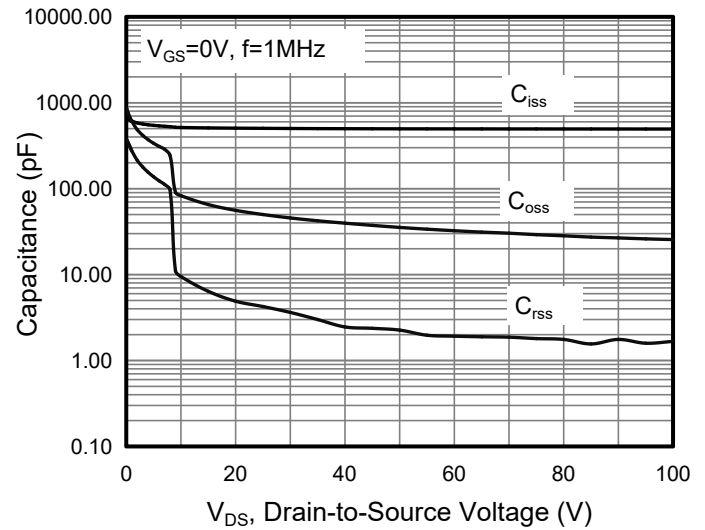


Figure 8. Capacitance

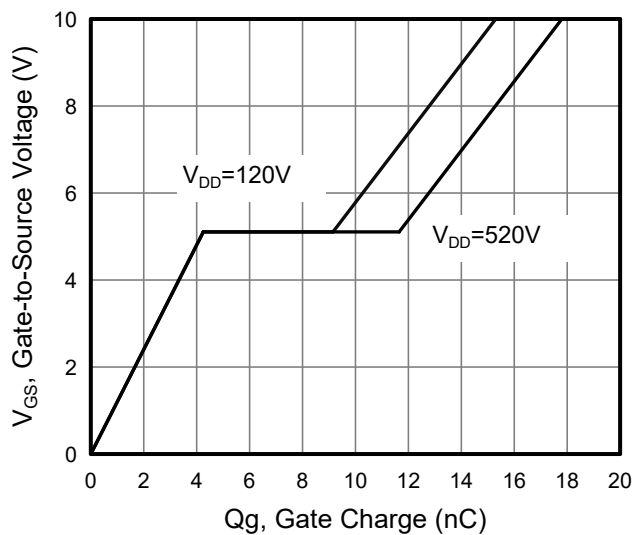


Figure 9. Gate Charge

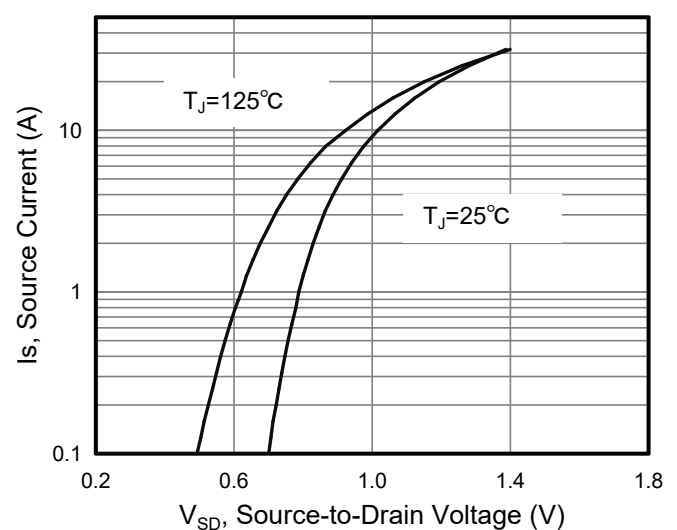


Figure 10. Body Diode Forward Voltage

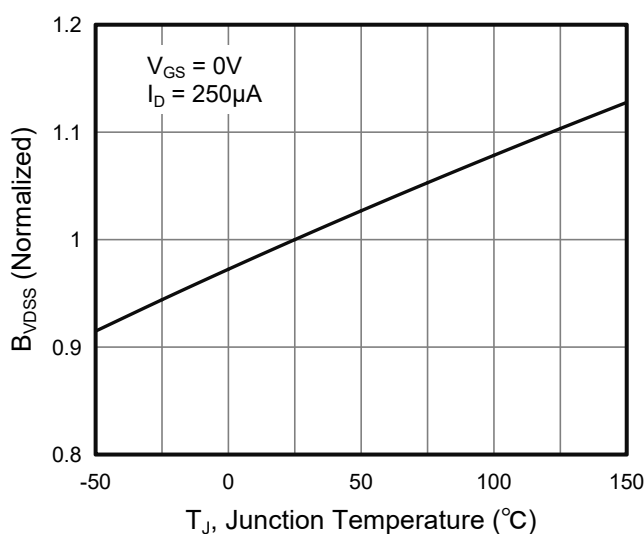


Figure 11. Breakdown Voltage vs Junction Temperature

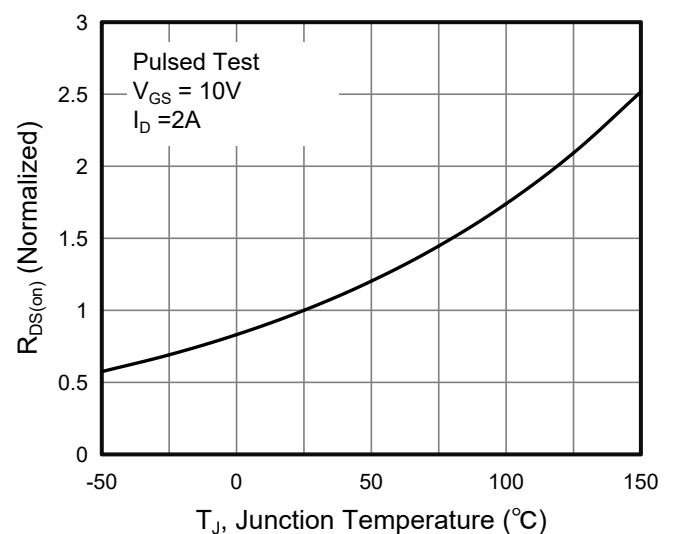


Figure 12. On-Resistance vs Temperature

Figure A: Gate Charge Test Circuit and Waveform

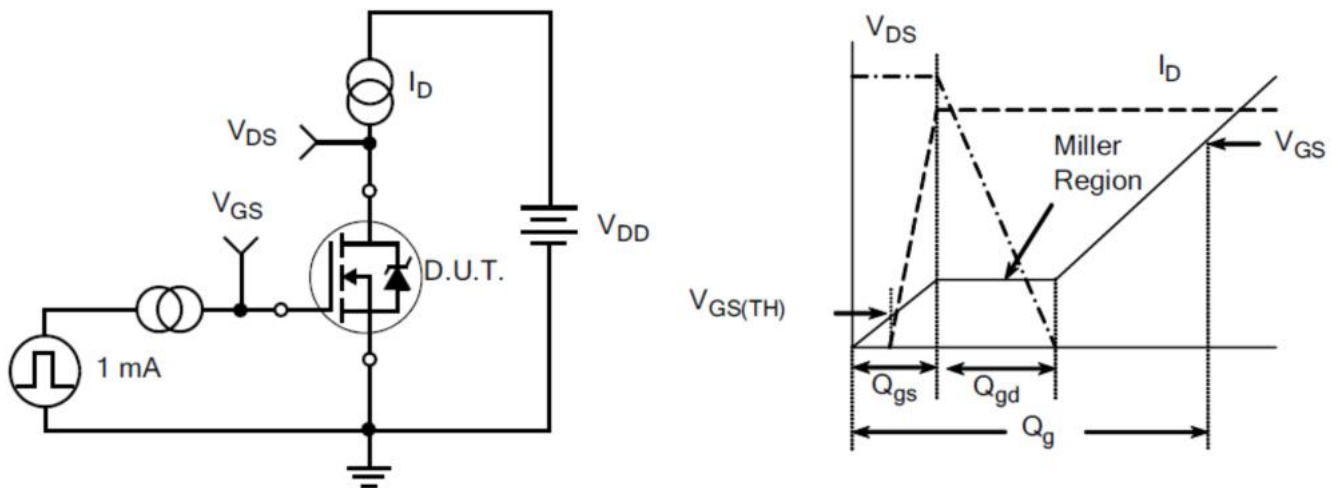


Figure B: Resistive Switching Test Circuit and Waveform

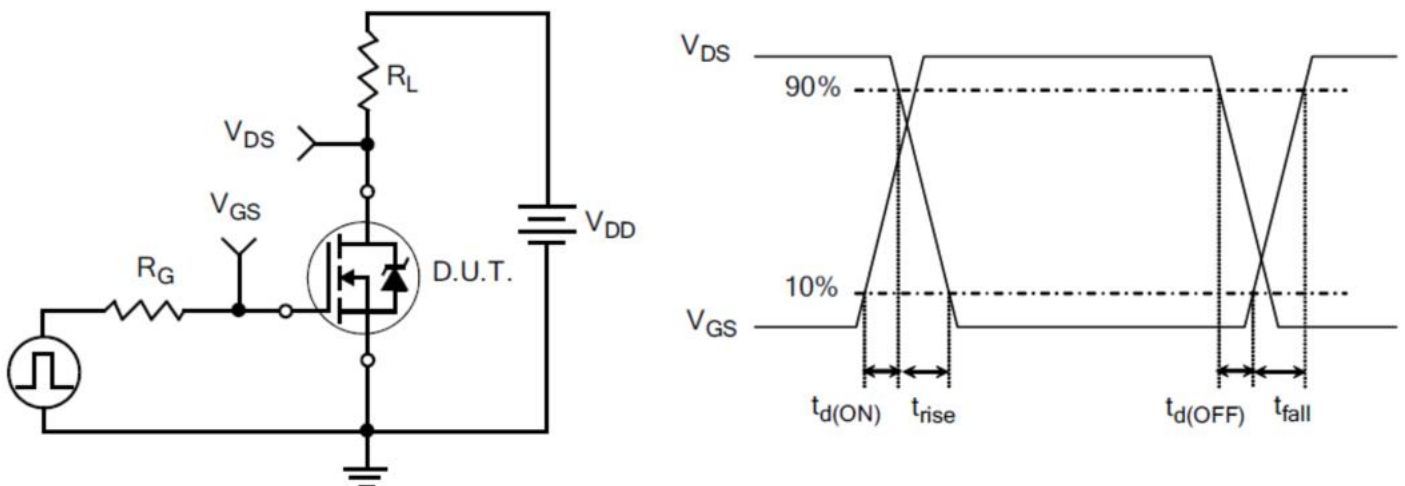
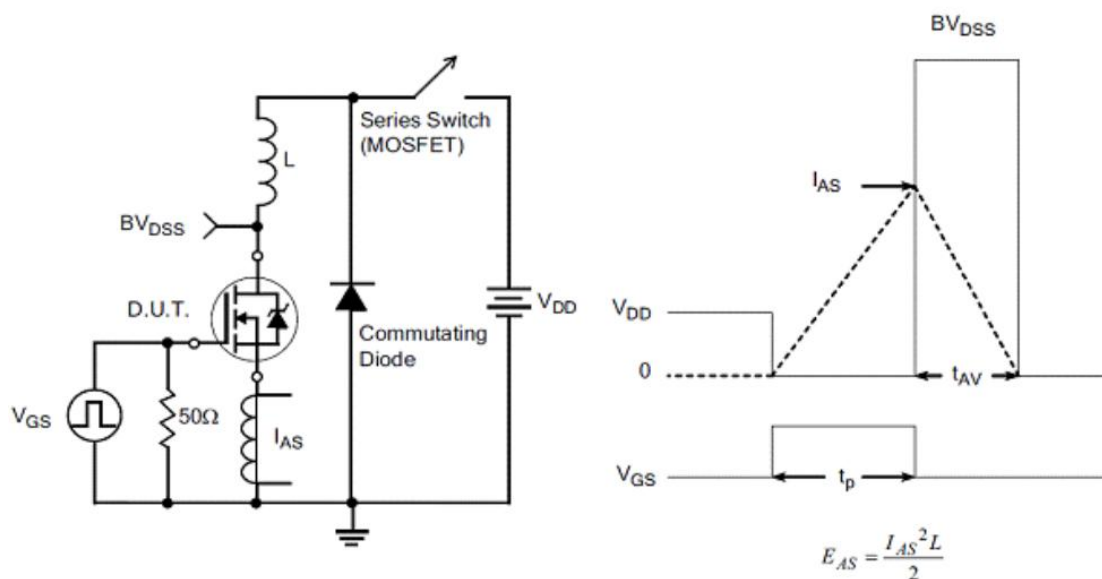
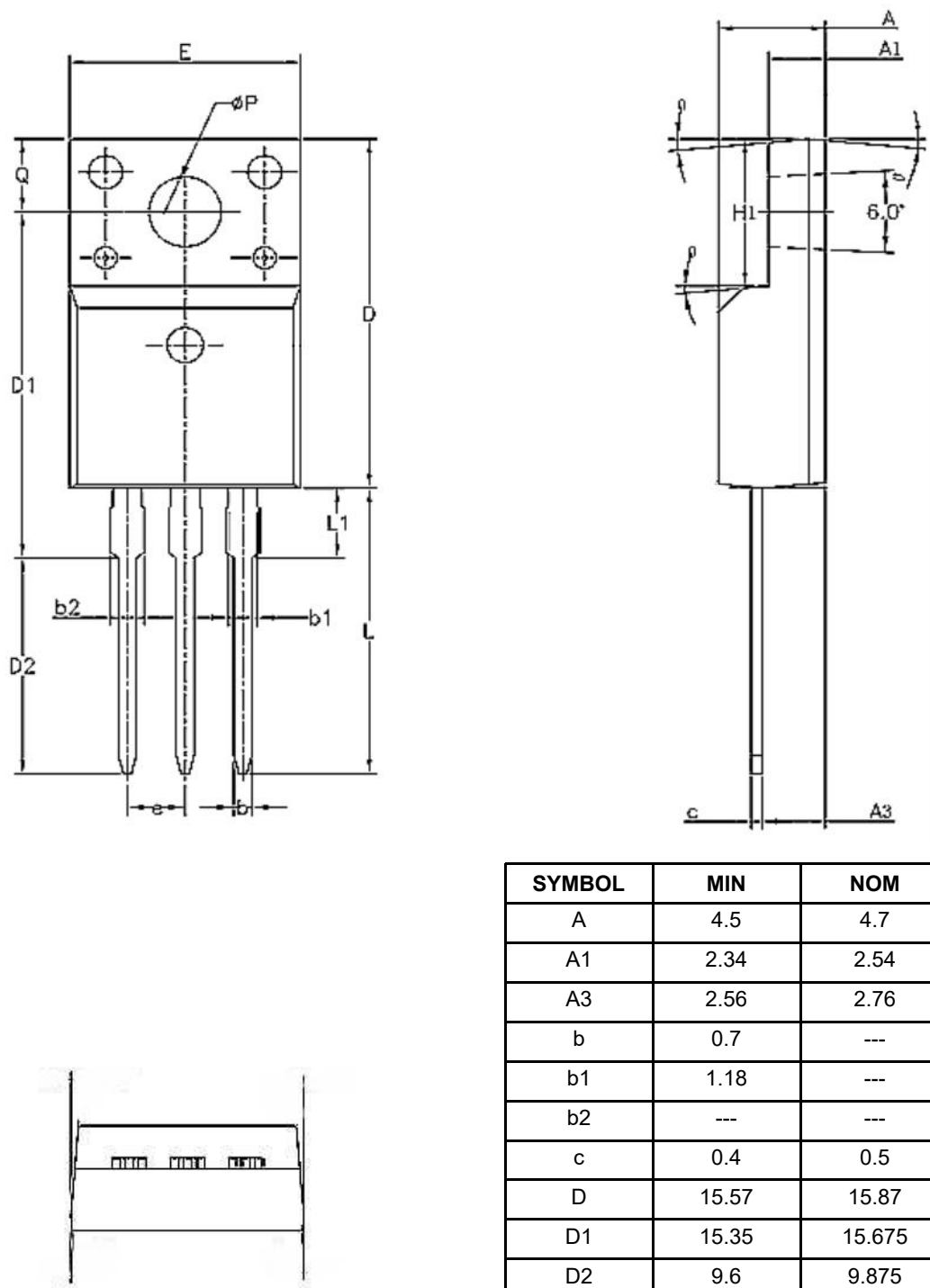


Figure C: Unclamped Inductive Switching Test Circuit and Waveform

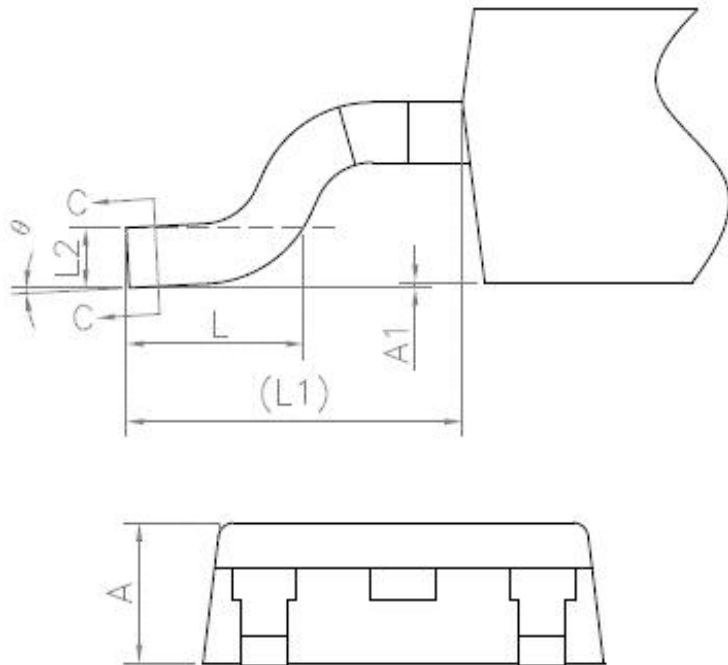
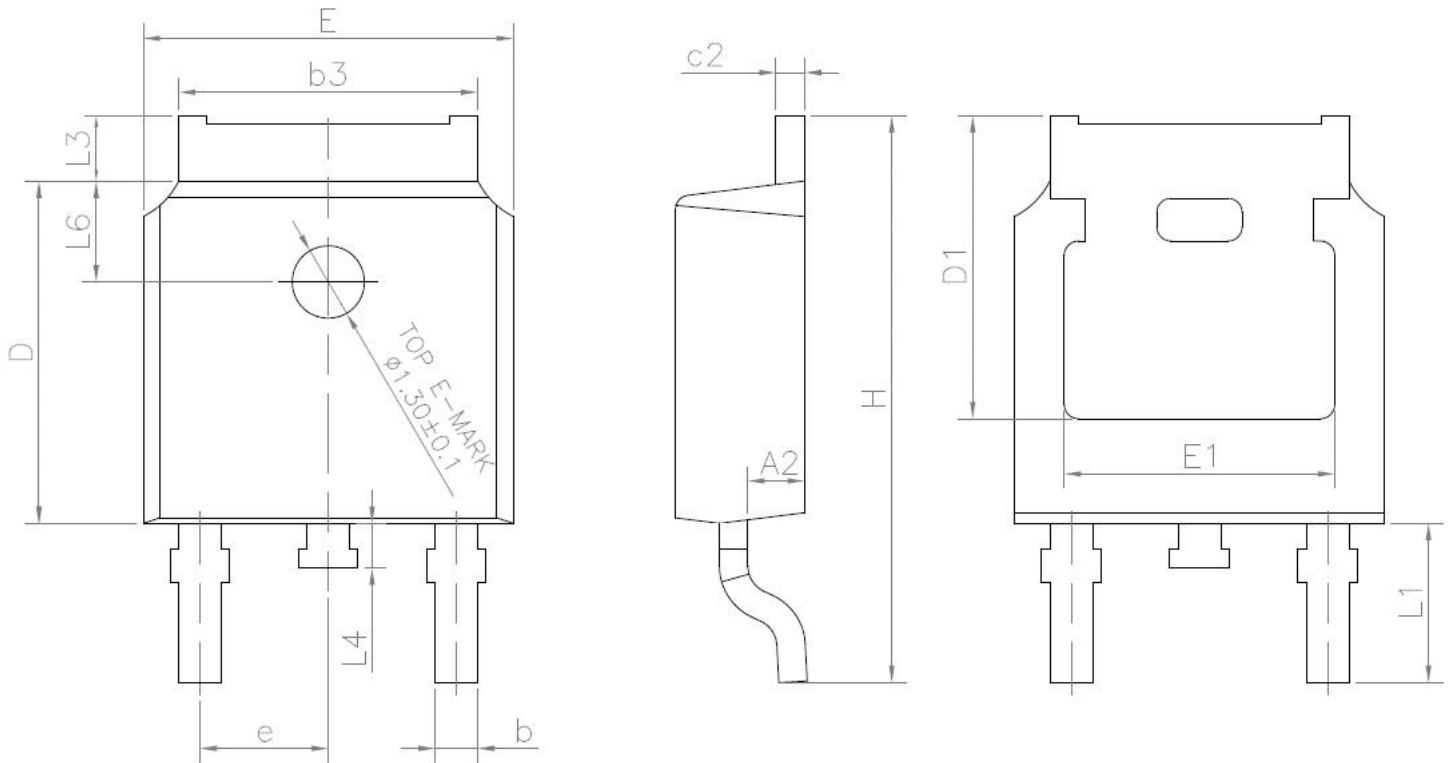


Outlines TO-220F Package



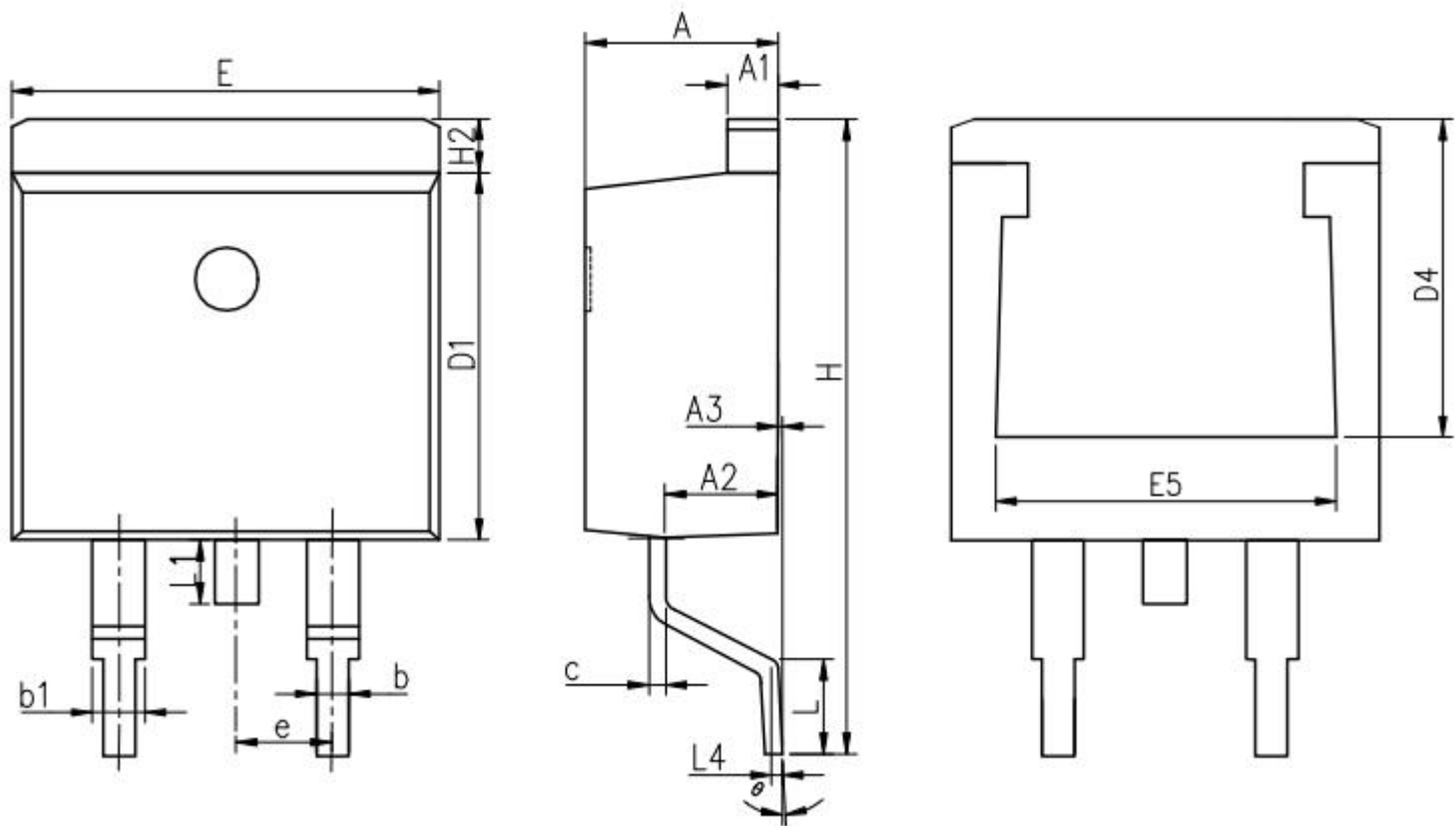
SYMBOL	MIN	NOM	MAX
A	4.5	4.7	4.9
A1	2.34	2.54	2.74
A3	2.56	2.76	2.96
b	0.7	---	0.95
b1	1.18	---	1.43
b2	---	---	1.55
c	0.4	0.5	0.65
D	15.57	15.87	16.17
D1	15.35	15.675	15.95
D2	9.6	9.875	10.15
E	9.96	10.16	10.36
e	2.54 BSC		
H1	6.48	6.68	6.88
L	12.68	12.98	13.28
L1	---	---	3.5

Outlines TO-252 Package



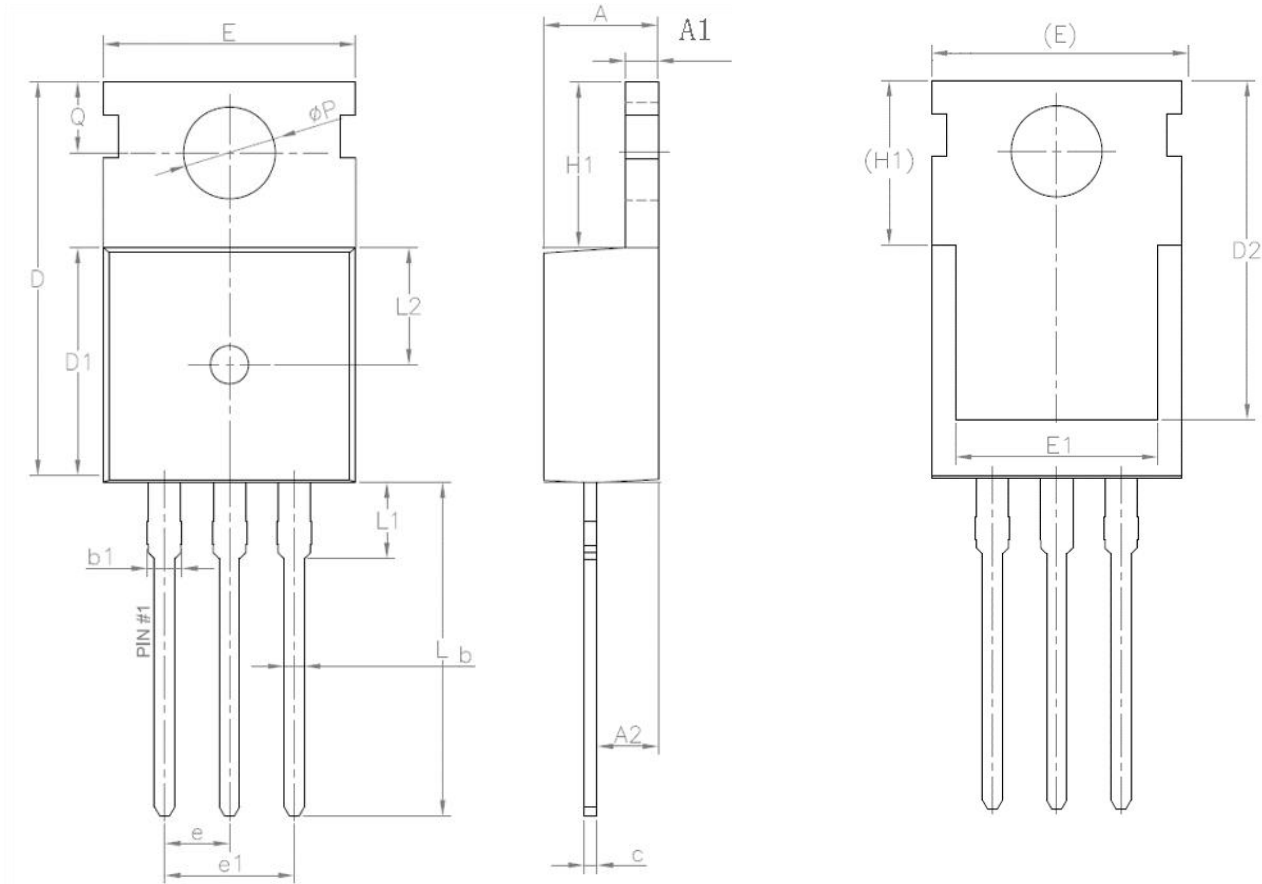
SYMBOL	MIN	NOM	MAX
A	2.2	2.3	2.4
A1	0	--	0.2
A2	0.9	1.035	1.17
b	0.645	--	0.9
b3	5.13	5.326	5.46
c	0.43	--	0.61
c2	0.41	--	0.61
D	5.98	6.1	6.22
D1	5.244	--	--
E	6.4	6.6	6.73
E1	4.63	--	--
e	2.186	2.286	2.386
H	9.4	10.04	10.5
L	1.38	1.5	1.75
L1	2.6	2.872	3
L2	0.5	0.509	0.52
L3	0.88	--	1.28
L4	0.5	--	1
L6	1.5	1.7	1.95
Θ	0°	--	10°

Outlines TO-263 Package



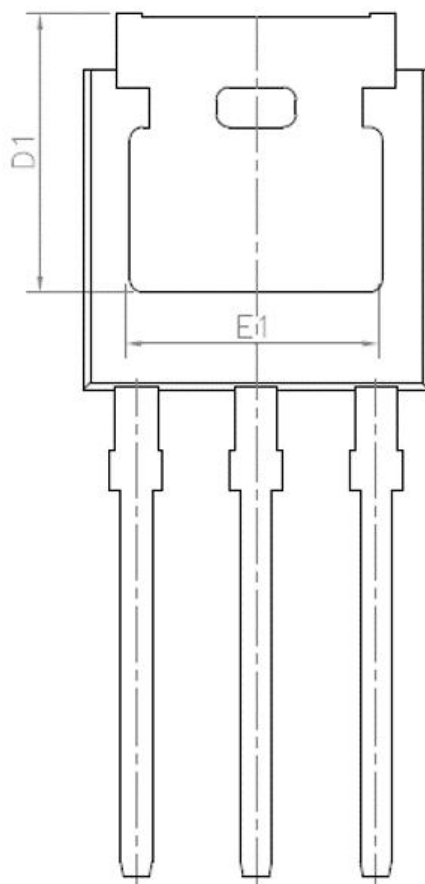
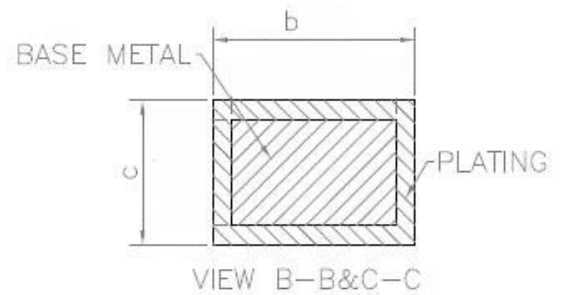
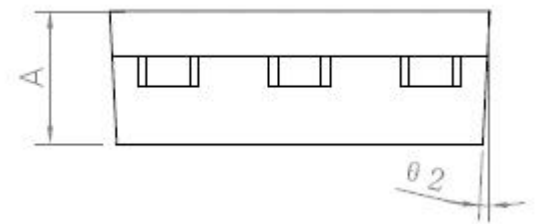
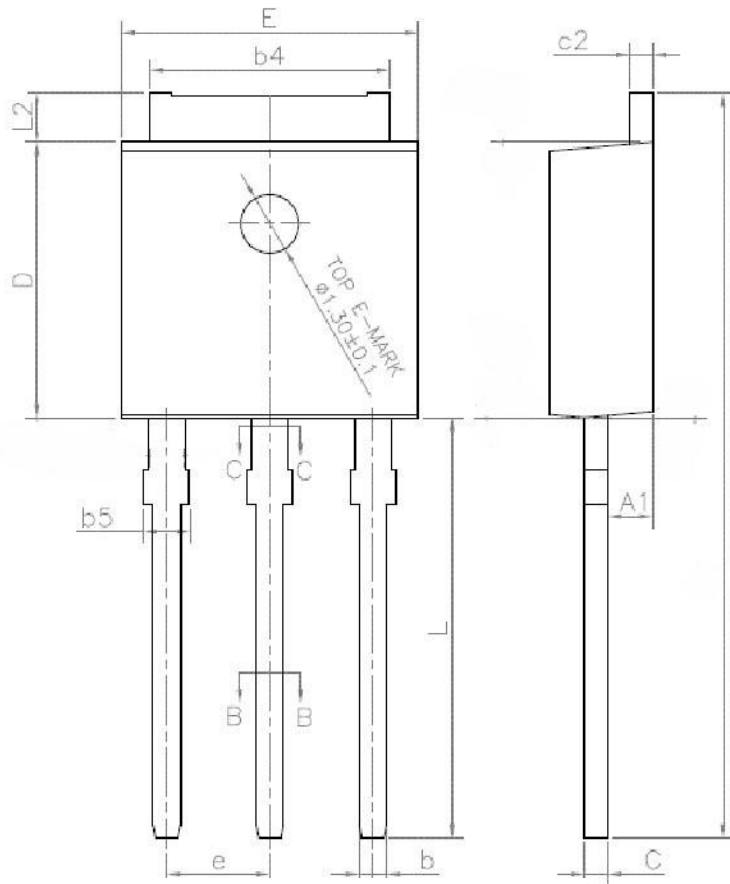
SYMBOL	MIN	NOM	MAX	SYMBOL	MIN	NOM	MAX
A	4.37	4.57	4.77	E5	7.06	---	---
A1	1.22	1.27	1.42	e	2.54 BSC		
A2	2.49	2.69	2.89	H	14.70	15.10	15.50
A3	0	0.13	0.25	H2	1.07	1.27	1.47
b	0.7	0.81	0.96	L	2.00	2.30	2.60
b1	1.17	1.27	1.47	L1	1.40	1.55	1.70
c	0.30	0.38	0.53	L4	0.25 BSC		
D1	8.50	8.70	8.90	θ	0°	5°	9°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

Outlines TO-220 Package



SYMBOL	MIN	NOM	MAX
A	4.37	4.535	4.7
A1	1.25	1.3	1.4
A2	2.2	2.4	2.6
b	0.7	---	0.95
b1	1.17	---	1.47
c	0.45	0.5	0.6
D	15.1	15.65	16.1
D1	8.8	9.15	9.4
D2	11.8	---	---
E	9.7	9.95	10.3
E1	7	---	---
e	2.54 BSC		
e1	5.08 BSC		
H1	6.25	6.5	6.85
L	12.75	13.29	13.8
L1	---	---	3.5
ΦP	3.4	3.67	3.8
Q	2.6	---	3

Outlines TO-251 Package



SYMBOL	MIN	NOM	MAX
A	2.20	2.30	2.38
A1	0.90	1.04	1.17
b	0.56	--	0.90
b4	5.20	5.33	5.46
b5	--	--	1.05
c	0.43	--	0.61
c2	0.43	--	0.61
D	5.98	6.10	6.22
D1	5.2	--	--
E	6.40	6.60	6.73
E1	4.60	--	--
e	2.24	2.29	2.34
e1	4.47	4.57	4.67
H	16.18	16.50	16.82
L	9	9.35	9.65
L2	0.88	1.05	1.28

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