650V N-Channel Planar MOSFET

MOSFET

Metal Oxide Semiconductor Field Effect Transistor

650V N-Channel Planar MOSFET

650V N-Channel Planar MOSFET Power Transistor

HRH2N65Ax Data Sheet

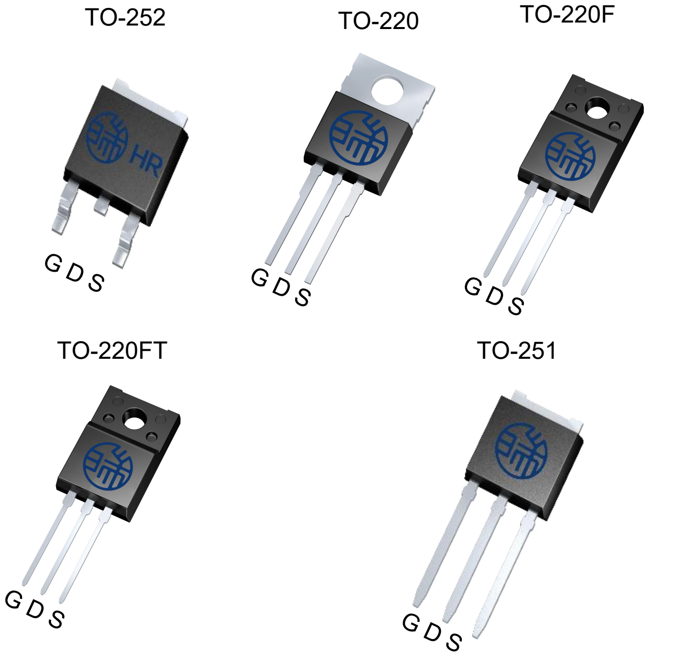
Rev. 2023 V1.0

650V N-Channel Planar MOSFET

Description

650V N-Channel Planar MOSFET

HRH2N65Ax 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.

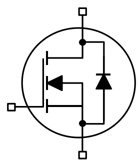


Features

- RDSON≤5Ω @Vgs=10V, Id=1A
- Ultra Low gate Charge(typical 12.4nC)
- Low Crss (typical 1pF)
- Fast switching capability
- 100% avalanche tested
- Improved dv/dt capability

Applications

- Switch Mode Power Supply (SMPS)
- Uninterruptible Power Supply (UPS)
- Power Factor Correction (PFC) (PFC)
- Charger



RoHS

Key Performance Parameters

Parameter	Value	Unit
V_{DS} @ $T_{J,max}$	700	V
$R_{DS(on),max}$	5	Ω
$Q_{g,typ}$	12.4	nC
I_D	2	A
$I_{D,pulse}$	8	A

Device Marking and Package Information

Device	Package	Marking
HRH2N65AD	TO-252	H2N65AD
HRH2N65AF	TO-220F	H2N65AF
HRH2N65AFT	TO-220FT	H2N65AFT
HRH2N65AP	TO-220	H2N65AP
HRH2N65AU	TO-251	H2N65AU

Absolute Maximum Ratings T_C = 25ºC, unless otherwise noted

Parameter		Symbol	Value	Unit
Drain-Source Voltage(V_{GS}=0V)		V_{DS}	650	V
Continuous Drain Current[1)]	T_C = 25ºC	I_D	2	A
	T_C = 100ºC		1.2	
Pulsed Drain Current[2)]		$I_{D,pulse}$	8	A
Gate-Source Voltage		V_{GS}	±30	V
Single Pulse Avalanche Energy[3)]		E_{AS}	152	mJ
MOSFET dv/dt Ruggedness, V_{DS} = 0...480V		dv/dt	5	V/ns
Power Dissipation For TO-220F/220FT		P_D	14.7	W
Power Dissipation For TO-252/220/251			35	
Continuous Diode Forward Current		I_S	2	A
Diode Pulsed Current[2)]		$I_{S,pulse}$	8	
Operating Junction and Storage Temperature Range		T_J, T_{stg}	-55~+150	ºC

Thermal Resistance For TO-220F/220FT

Parameter	Symbol	Value	Unit
Thermal Resistance, Junction-to-Case	R_{thJC}	8.5	ºC/W
Thermal Resistance, Junction-to-Ambient	R_{thJA}	80	

Thermal Resistance For TO-252/220/251

Parameter	Symbol	Value	Unit
Thermal Resistance, Junction-to-Case	R_{thJC}	3.57	ºC/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=10mH, ID=5.5A, Start TJ=25℃

Electrical Characteristics T_J = 25ºC, 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 = 25ºC	--	--	1	μA
		V_{DS} = 650V, V_{GS} = 0V, T_J = 150ºC	--	--	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 = 1A	--	3.8	5.0	Ω
Gate Resistance	R_G	f = 1.0MHz open drain	--	1.84	--	Ω
Dynamic Characteristics						
Input Capacitance	C_{iss}	V_{GS} = 0V, V_{DS} = 100V f = 1.0MHz	--	371	--	pF
Output Capacitance	C_{oss}		--	29	--	
Reverse Transfer Capacitance	C_{rss}		--	1.0	--	
Total Gate Charge	Q_g	V_{DD} = 520V, I_D = 2A V_{GS} = 10V	--	12.4	--	nC
Gate-Source Charge	Q_{gs}		--	3.4	--	
Gate-Drain Charge	Q_{gd}		--	4.2	--	
Gate Plateau Voltage	$V_{Plateau}$		--	4.6	--	V
Turn-on Delay Time	$t_{d(on)}$	V_{DD} = 325V, I_D = 2A R_G = 25Ω, V_{GS} = 10V	--	11	--	ns
Turn-on Rise Time	t_r		--	13	--	
Turn-off Delay Time	$t_{d(off)}$		--	29	--	
Turn-off Fall Time	t_f		--	12	--	
Drain-Source Body Diode Characteristics						
Body Diode Forward Voltage	V_{SD}	T_J = 25ºC, I_{SD} = 2A V_{GS} = 0V	--	--	1.2	V
Reverse Recovery Time	t_{rr}	V_R = 400V I_F = 2A, di_F/dt = 100A/μs	--	187	--	ns
Reverse Recovery Charge	Q_{rr}		--	0.61	--	μC

Typical Characteristics T_J = 25ºC, unless otherwise noted

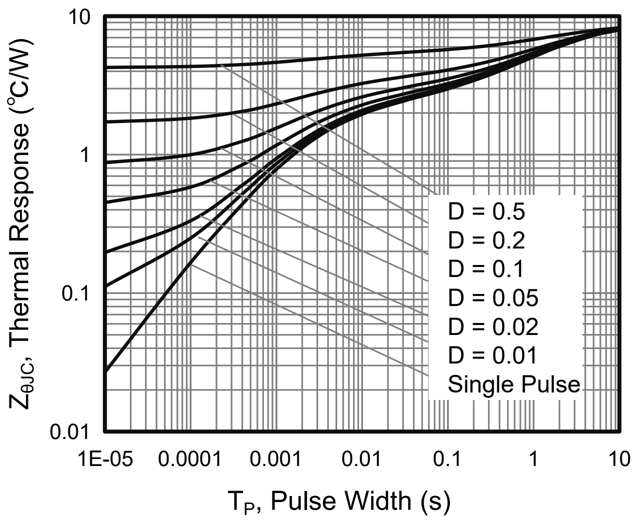


Figure 1. Transient Thermal Impedance For TO-220F

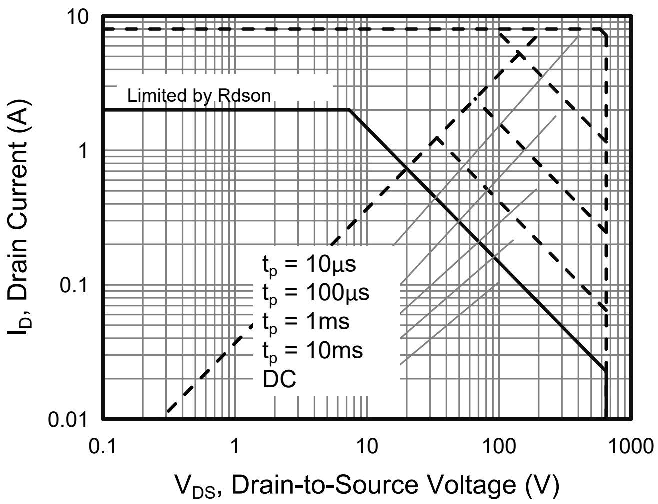


Figure 2. Safe Operation Area For TO-220F/220FT

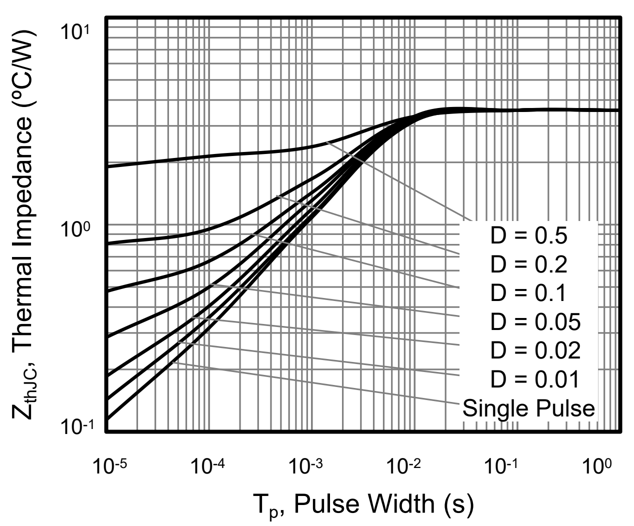


Figure 3. Transient Thermal Impedance For TO-252/220/251

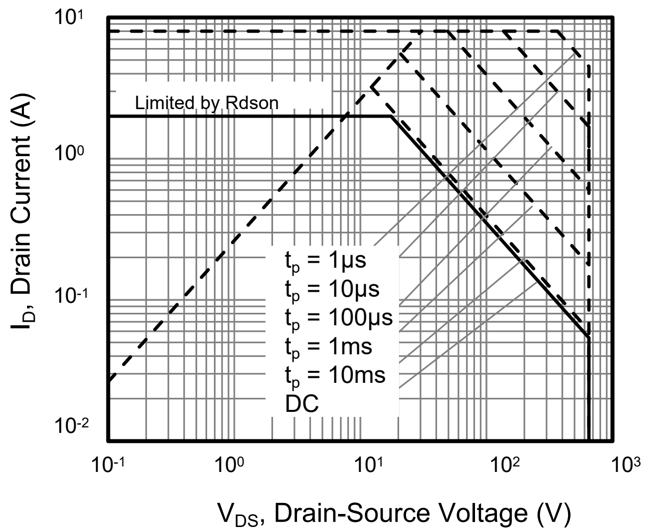


Figure 4. Safe Operation Area For TO-252/220/251

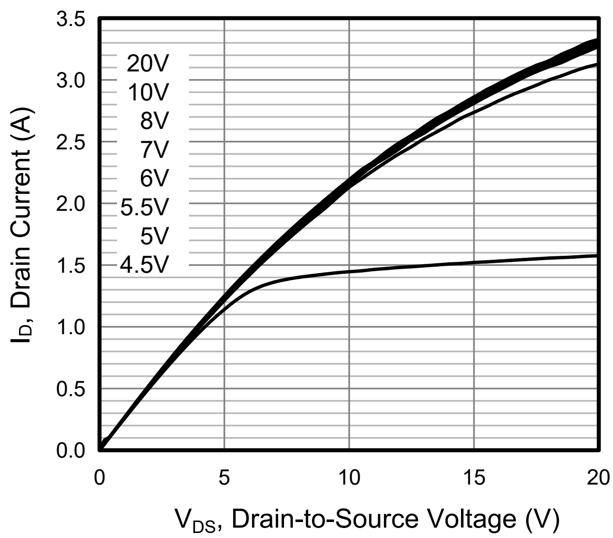


Figure 5. Output Characteristics

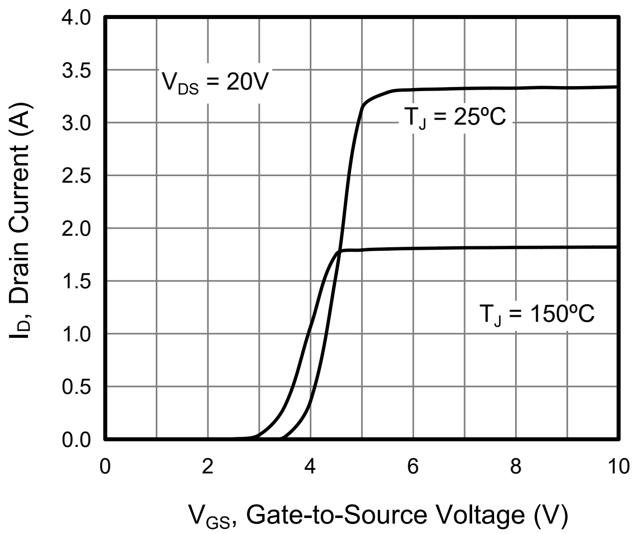


Figure 6. Transfer Characteristics

Typical Characteristics T_J = 25ºC, unless otherwise noted

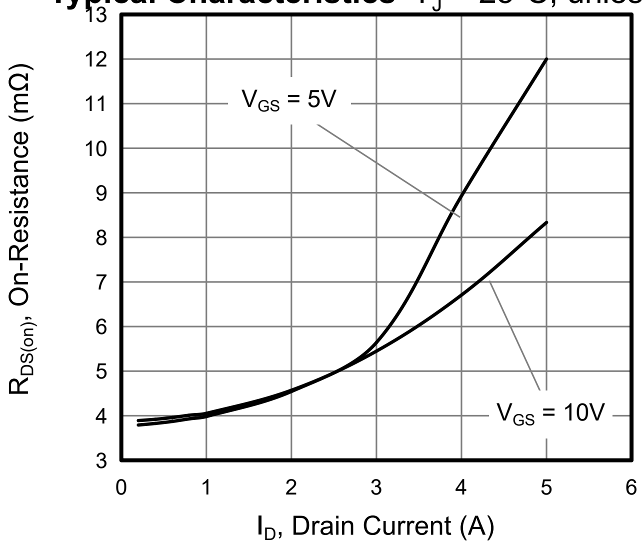


Figure 7. On-Resistance vs Drain Current

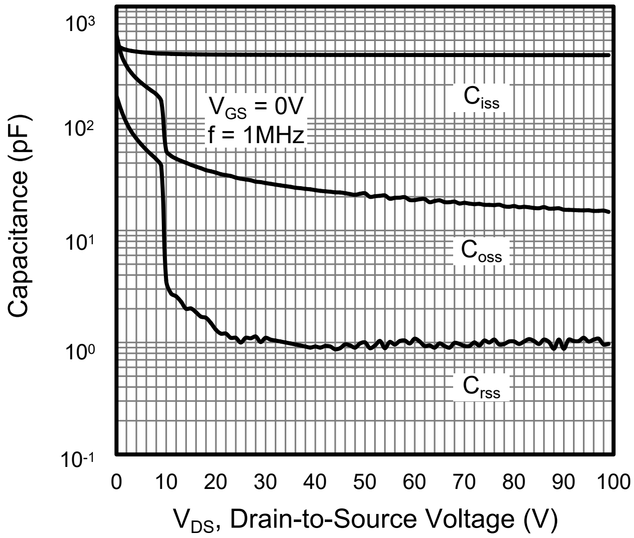


Figure 8. Capacitance

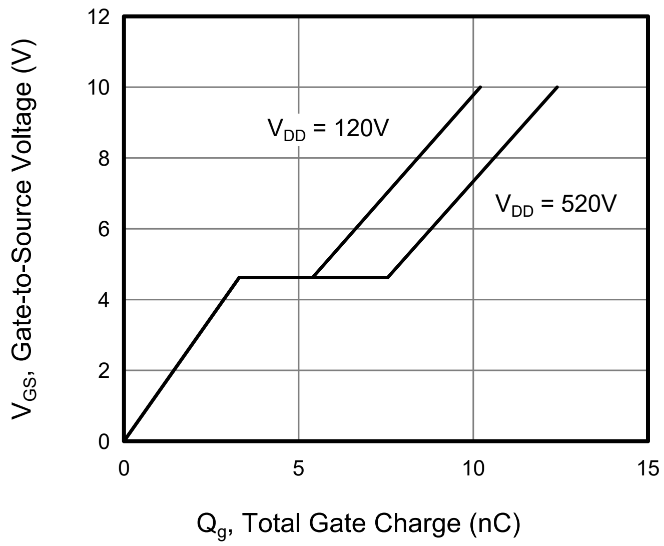


Figure 9. Gate Charge

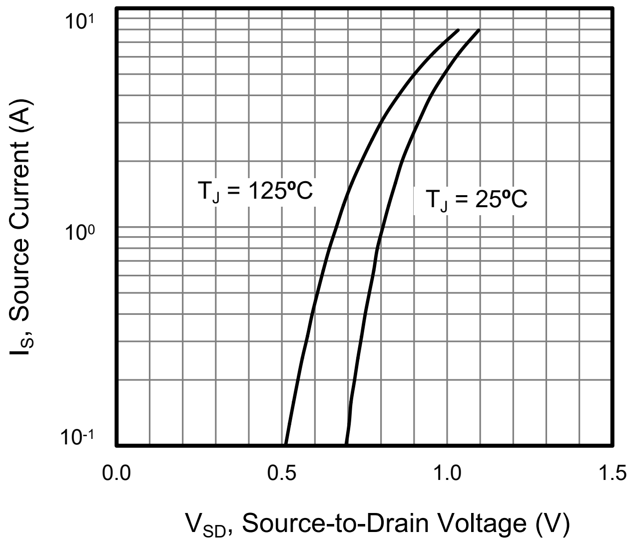


Figure 10. Body Diode Forward Voltage

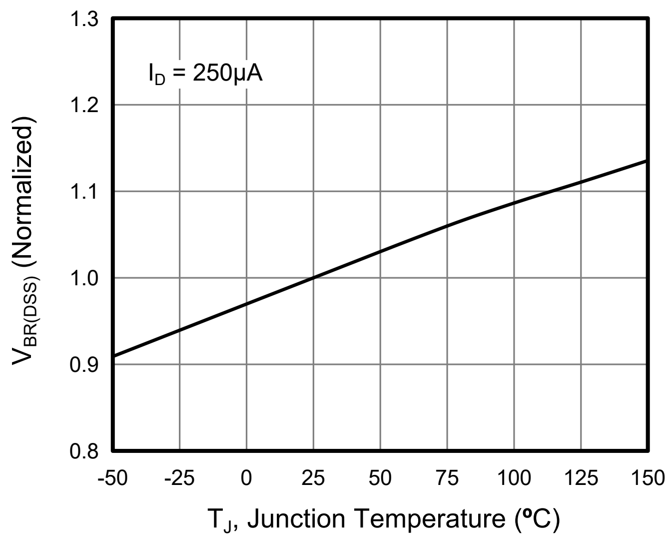


Figure 11. Breakdown Voltage vs Junction Temperature

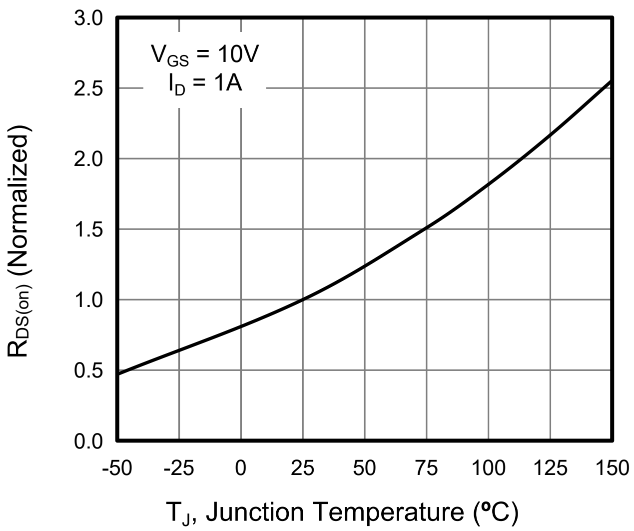


Figure 12. On-Resistance vs Temperature

Figure A：Gate Charge Test Circuit and Waveform

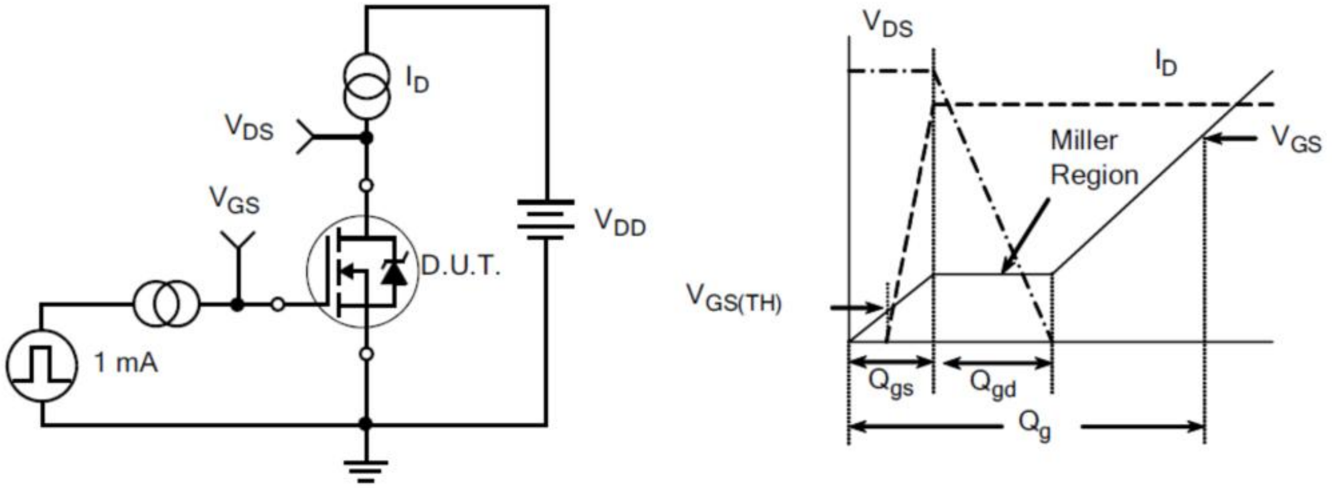


Figure B：Resistive Switching Test Circuit and Waveform

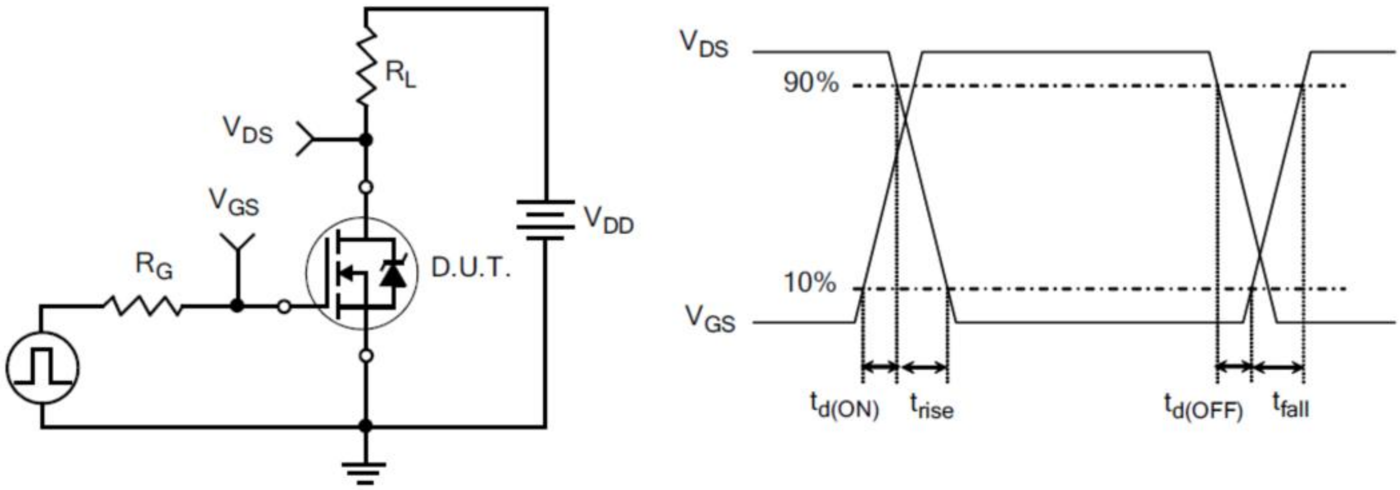
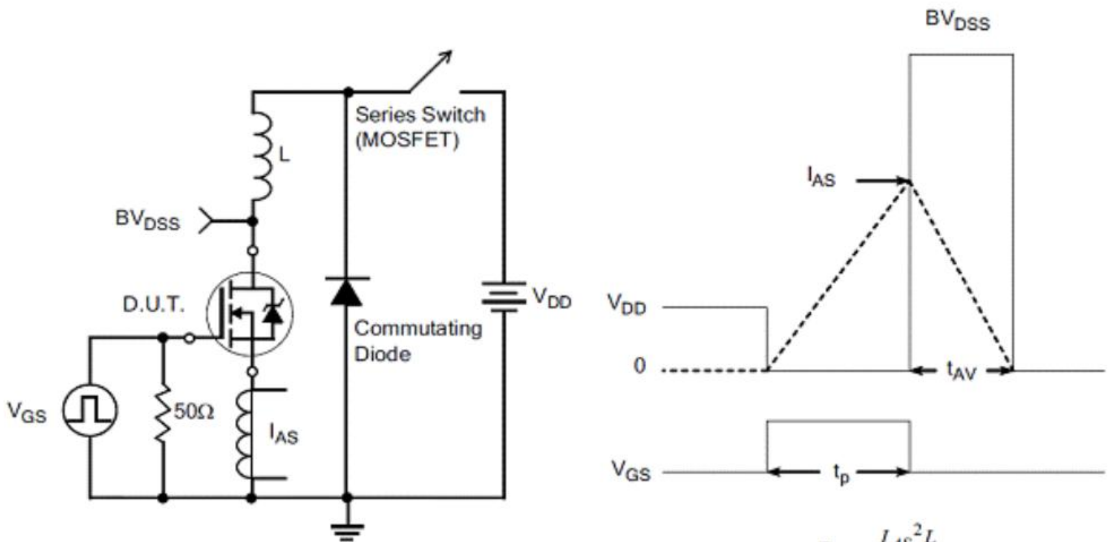
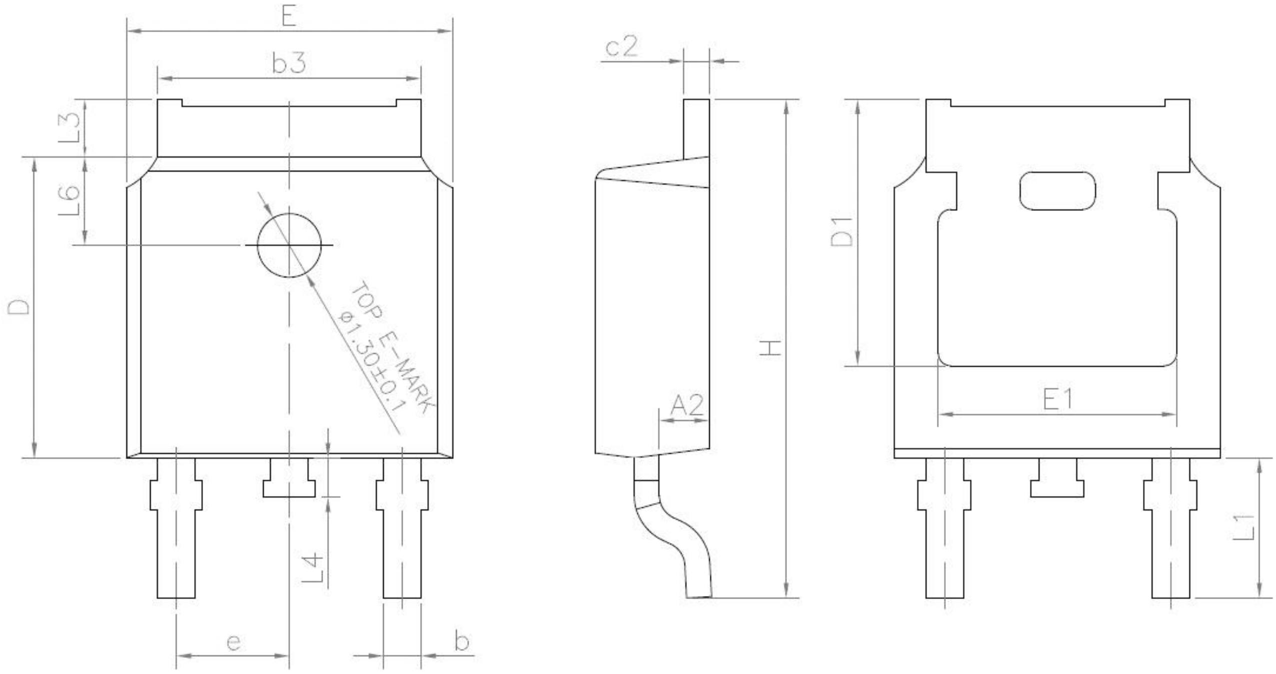


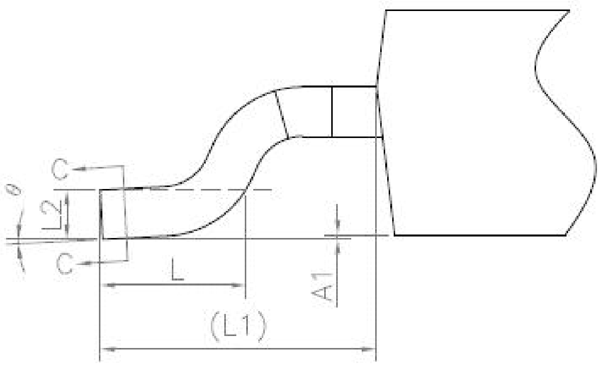
Figure C：Unclamped Inductive Switching Test Circuit and Waveform

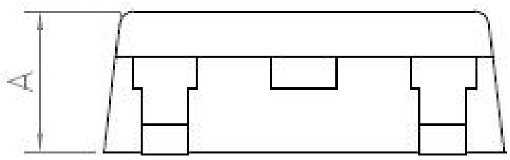


$$E_{AS} = \frac{I_{AS}^2 L}{2}$$

Outlines TO-252 Package

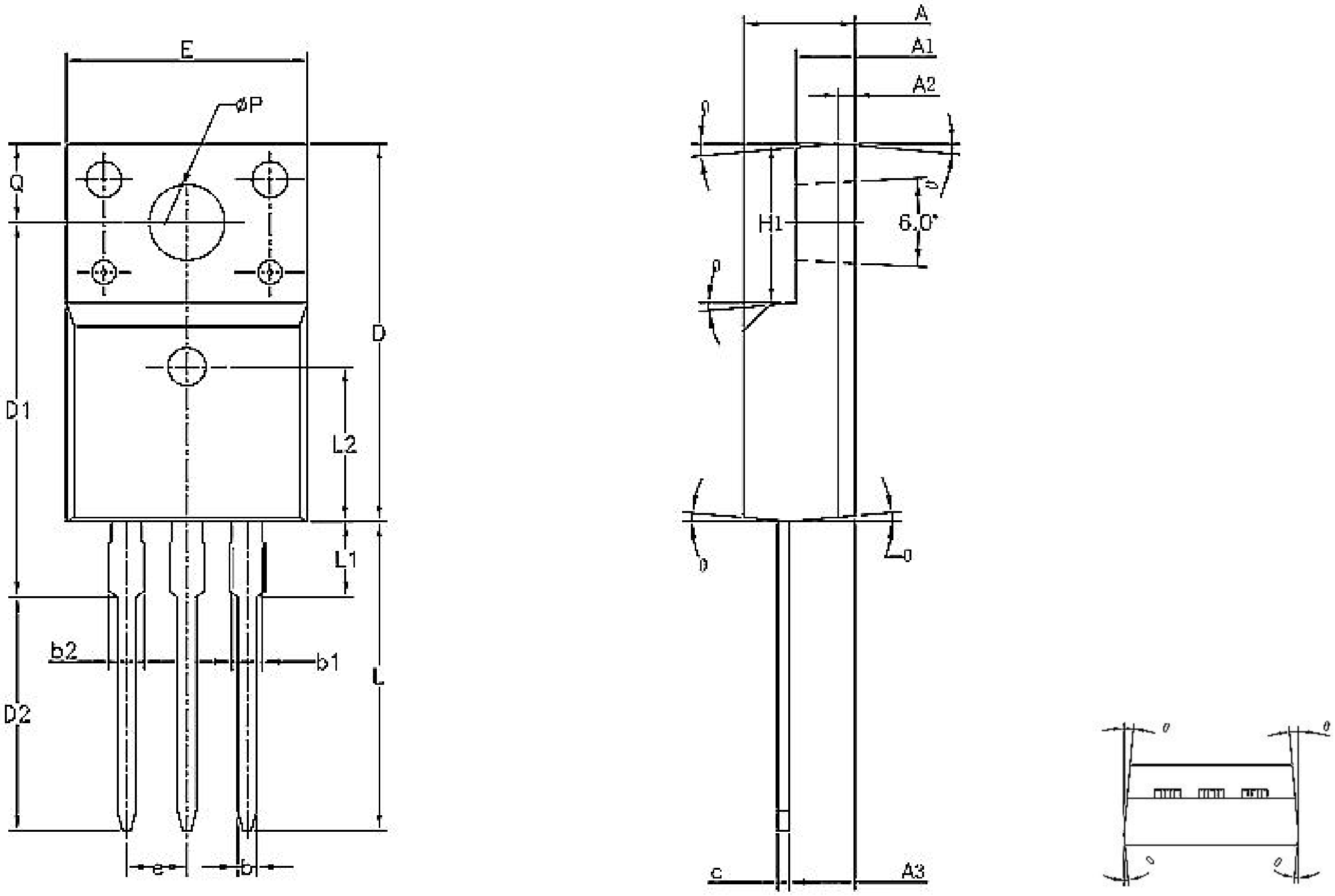






SYMBOL	MIN	NOM	MAX
A	2.2	--	2.4
A1	0	--	0.2
A2	0.9	1.035	1.17
b	0.645	--	0.9
b3	5.13	5.326	5.46
c	0.43	--	0.61
c2	0.41	--	0.61
D	5.98	--	6.65
D1	5.2	--	--
E	5.8	--	6.73
E1	4.63	--	--
e	2.186	2.286	2.386
H	9.4	10.04	10.5
L	1.38	1.5	1.75
L1	2.6	2.872	3.1
L2	0.43	--	0.55
L3	0.88	--	1.28
L4	0.5	--	1
L6	1.5	1.7	1.95
ϴ	0°	--	10°

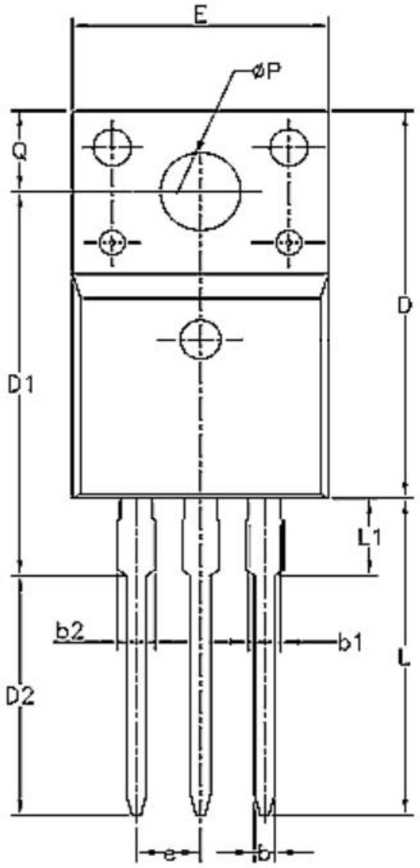
Outlines TO-220F Package

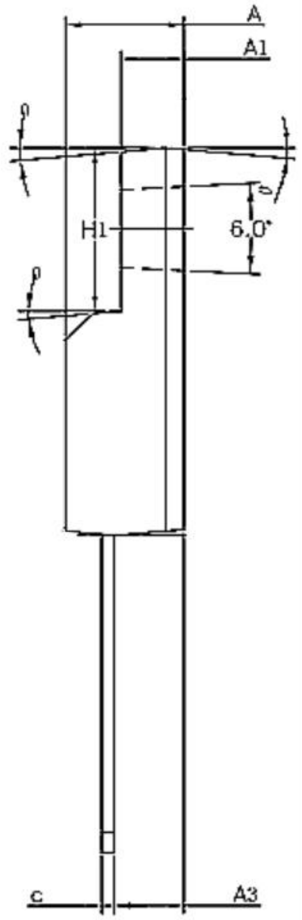


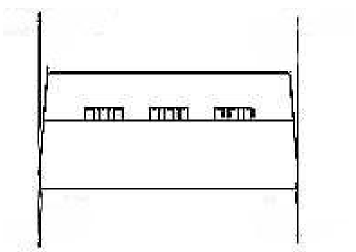
Unit:mm			
Symbol	**Min.**	**Nom**	**Max.**
A	4.50	4.70	4.83
A1	2.34	2.54	2.74
A2	0.70 REF		
A3	2.56	2.76	2.93
b	0.70	---	0.90
b1	1.18	---	1.38
b2	---	---	1.47
c	0.45	0.50	0.60
D	15.67	15.87	16.07
D1	15.55	15.75	15.95

Unit:mm			
Symbol	**Min.**	**Nom**	**Max.**
D2	9.60	9.80	10.0
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	---	---	3.50
L2	6.50 REF		
ΦP	3.08	3.18	3.28
Q	3.20	---	3.40
θ1	1°	3°	5°

Outlines TO-220FT Package

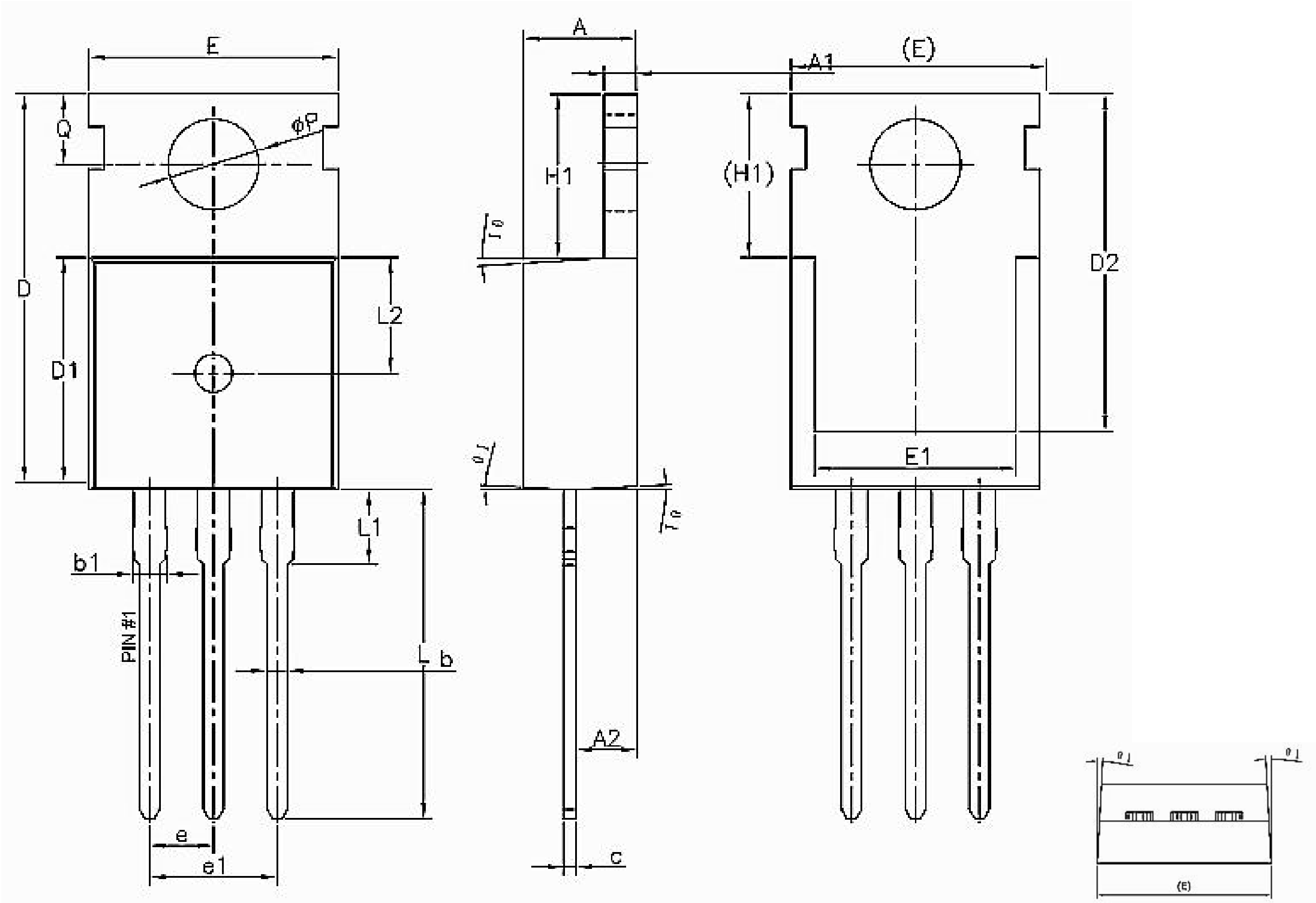






SYMBOL	MIN	NOM	MAX
A	4.5	4.7	4.9
A1	2.34	2.54	2.74
A3	2.56	2.76	2.96
b	0.7	---	0.95
b1	1.18	---	1.43
b2	---	---	1.55
c	0.4	0.5	0.65
D	15.57	15.87	16.17
D1	15.35	15.675	15.95
D2	9.6	9.875	10.15
E	9.96	10.16	10.36
e	2.54 BSC		
H1	6.48	6.68	6.88
L	12.68	12.98	13.28
L1	---	---	3.5

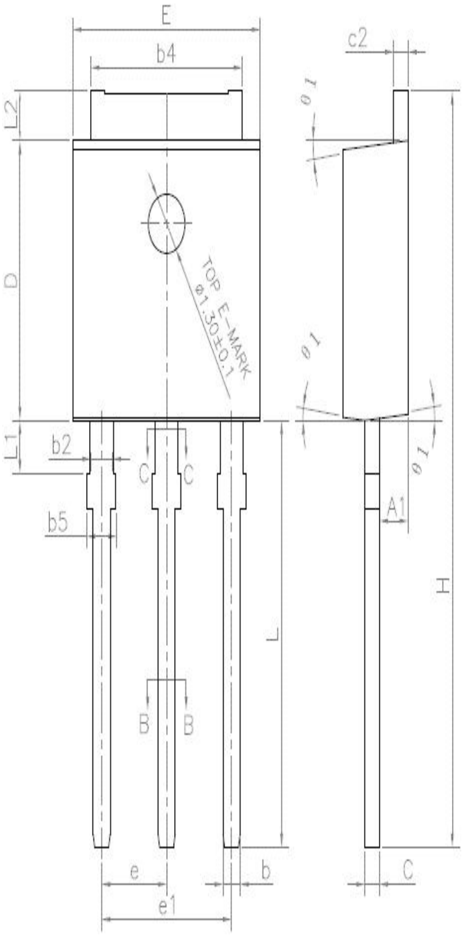
Outlines TO-220 Package

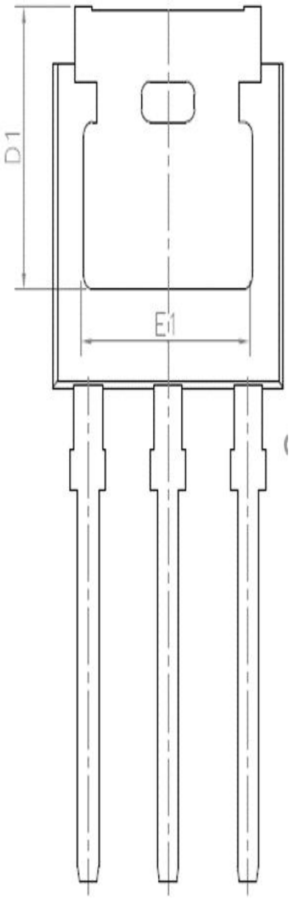


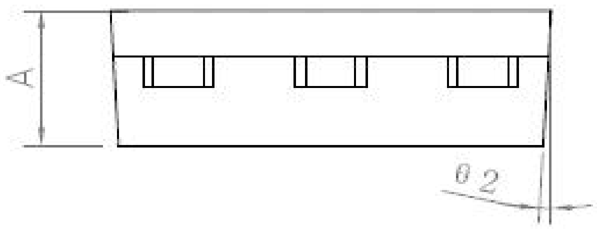
Unit:mm			
Symbol	Min.	Nom	Max.
A	4.40	4.50	4.60
A1	1.27	1.30	1.33
A2	2.30	2.40	2.50
b	0.70	---	0.90
b2	1.27	---	1.40
c	0.45	0.50	0.60
D	15.30	15.70	16.10
D1	9.10	9.20	9.30
D2	13.10	---	13.70
E	9.70	9.90	10.20

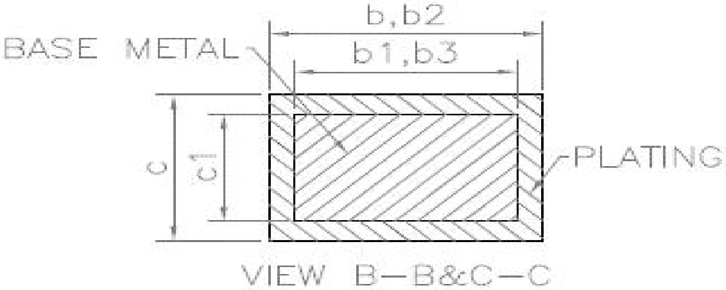
Unit:mm			
Symbol	Min.	Nom	Max.
E1	7.80	8.00	8.20
e	2.54 BSC		
e1	5.08 BSC		
H1	6.30	6.50	6.70
L	12.78	13.08	13.38
L1	---	---	3.50
L2	4.60 REF		
ΦP	3.55	3.60	3.65
Q	2.73	---	2.87
θ1	1°	3°	5°

Outlines TO-251 Package









SYMBOL	MiN	NOM	MAX
A	2.2	2.3	2.35
A1	0.9	1.01	1.1
b	0.56	--	0.69
b1	0.55	0.6	0.65
b2	0.77	--	0.9
b3	0.76	0.81	0.86
b4	5.23	5.33	5.43
b5	--	--	1.05
c	0.46	--	0.59
c1	0.45	0.51	0.55
c2	0.46	--	0.59
D	6	6.1	6.2
D1	5.2	--	--
E	6.5	6.6	6.7
E1	4.6	4.83	5
e	2.24	2.29	2.34
e1	4.47	4.57	4.67
H	16.18	16.48	16.78
L	9	9.3	9.6
L1	0.95	1.16	1.35
L2	0.9	1.08	1.25
Θ	3°	5°	7°
Θ1	1°	3°	5°

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