

N-Channel Super-junction MOSFET Gen I

MOSFET

Metal Oixde Semiconductor Field Effect Transistor

650V Super-junction Gen I

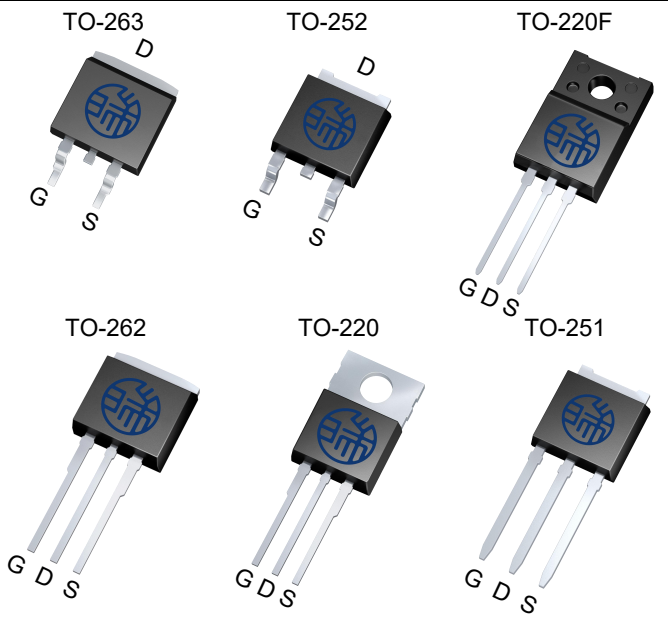
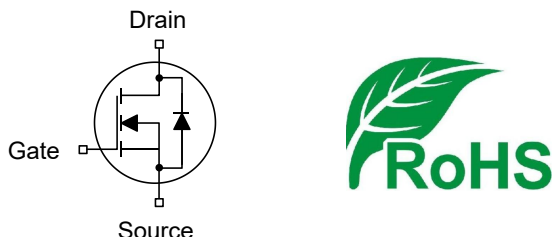
650V Super-junction Gen I Power Transistor

HRM65R400Fx Data Sheet

Rev. 2020 V1.0



650V Super-junction Power MOSFET Gen I

<p>Description</p> <p>650V Super-junction MOSFET Gen I</p> <p>Super-junction MOSFET Gen I is designed by HR-Micro Semiconductor Company, according to the SJ principle. This device provides an excellent Gate charge and $R_{DS(on)}$, which leads to extremely low communication and conduction losses. So it is very suitable for AC/DC power conversion, Laptop adapter, Lighting, and industrial power applications.</p>		
<p>Features</p> <ul style="list-style-type: none"> ● Very low FOM $R_{DS(on)} \times Q_g$ ● 100% avalanche tested ● Ultra-fast body diode ● Easy to use/drive ● RoHS compliant 		
<p>Applications</p> <ul style="list-style-type: none"> ● Switch Mode Power Supply (SMPS) ● Uninterruptible Power Supply (UPS) ● Power Factor Correction (PFC) ● Charger 		
<p>Key Performance Parameters</p>		
<p>Parameter</p>	<p>Value</p>	<p>Unit</p>
<p>$V_{DS} @ T_{j,max}$</p>	<p>700</p>	<p>V</p>
<p>$R_{DS(on),max}$</p>	<p>0.4</p>	<p>Ω</p>
<p>$Q_{g,typ}$</p>	<p>22.0</p>	<p>nC</p>
<p>I_D</p>	<p>11</p>	<p>A</p>
<p>$I_{D,pulse}$</p>	<p>33</p>	<p>A</p>
<p>$E_{OSS} @ 400V$</p>	<p>2.22</p>	<p>μJ</p>
<p>Body Diode di_f/dt</p>	<p>900</p>	<p>A/μs</p>
<p>Device Marking and Package Information</p>		
<p>Device</p>	<p>Package</p>	<p>Marking</p>
<p>HRM65R400FB</p>	<p>TO-263</p>	<p>65R400FB</p>
<p>HRM65R400FD</p>	<p>TO-252</p>	<p>65R400FD</p>
<p>HRM65R400FF</p>	<p>TO-220F</p>	<p>65R400FF</p>
<p>HRM65R400FL</p>	<p>TO-262</p>	<p>65R400FL</p>
<p>HRM65R400FP</p>	<p>TO-220</p>	<p>65R400FP</p>
<p>HRM65R400FU</p>	<p>TO-251</p>	<p>65R400FU</p>

Absolute Maximum Ratings $T_C = 25^\circ\text{C}$, unless otherwise noted			
Parameter	Symbol	Value	Unit
Drain-Source voltage($V_{GS}=0\text{V}$)	V_{DS}	650	V
Continuous Drain Current ¹⁾	I_D	$T_C = 25^\circ\text{C}$	11
		$T_C = 100^\circ\text{C}$	6.6
Pulsed Drain Current ²⁾	$I_{D,pulse}$	33	A
Gate-Source Voltage	V_{GS}	$\pm 30\text{V}$	V
Single Pulse Avalanche Energy	E_{AS}	215	mJ
Repetitive Avalanche Energy	E_{AR}	0.32	mJ
Avalanche Current	I_{AR}	1.8	A
MOSFET dv/dt Ruggedness, $V_{DS} = 0 \dots 480\text{V}$	dv/dt	50	V/ns
Power Dissipation For TO-263、TO-252、TO-262、TO-220、TO-251	P_D	83	W
Power Dissipation For TO-220F		31	
Continuous Diode Forward Current	I_S	11	A
Diode Pulsed Current ²⁾	$I_{S,pulse}$	33	
Reverse Diode dv/dt ³⁾	dv/dt	50	V/ns
Maximum Diode Commutation Speed	di_f/dt	900	A/ μs
Operating Junction and Storage Temperature Range	T_J, T_{stg}	-55~+150	$^\circ\text{C}$

Thermal Resistance For TO-263、TO-252、TO-262、TO-220、TO-251			
Parameter	Symbol	Value	Unit
Thermal Resistance, Junction-to-Case	R_{thJC}	1.5	$^\circ\text{C}/\text{W}$
Thermal Resistance, Junction-to-Ambient	R_{thJA}	62	

Thermal Resistance For TO-220F			
Parameter	Symbol	Value	Unit
Thermal Resistance, Junction-to-Case	R_{thJC}	4	$^\circ\text{C}/\text{W}$
Thermal Resistance, Junction-to-Ambient	R_{thJA}	80	

Notes

- 1) Limited by maximum junction temperature.
- 2) Repetitive Rating: Pulse width limited by maximum junction temperature.
- 3) Identical low side and high side switch with identical R_G .

Electrical Characteristics $T_J = 25^\circ\text{C}$, unless otherwise noted						
Parameter	Symbol	Test Conditions	Value			Unit
			Min.	Typ.	Max.	
Static Characteristics						
Drain-Source Breakdown Voltage	$V_{(BR)DSS}$	$V_{GS} = 0V, I_D = 250\mu A$	650	--	--	V
Zero Gate Voltage Drain Current	I_{DSS}	$V_{DS} = 650V$ $V_{GS} = 0V, T_J = 25^\circ\text{C}$	--	--	1	μA
		$V_{DS} = 650V$, $V_{GS} = 0V, T_J = 150^\circ\text{C}$	--	--	1000	
Gate-Source Leakage Current	I_{GSS}	$V_{GS} = \pm 30V$	--	--	± 100	nA
Gate-Source Threshold Voltage	$V_{GS(th)}$	$V_{DS} = V_{GS}, I_D = 250\mu A$	3.0	4.0	5.0	V
Drain-Source On-State-Resistance	$R_{DS(on)}$	$V_{GS} = 10V, I_D = 5.5A$	--	0.35	0.40	Ω
Gate Resistance	R_G	$f = 1.0\text{MHz}$ open drain	--	4.8	--	Ω
Dynamic Characteristics						
Input Capacitance	C_{iss}	$V_{GS} = 0V$, $V_{DS} = 100V$ $f = 1.0\text{MHz}$	--	803	--	μF
Output Capacitance	C_{oss}		--	28.7	--	
Reverse Transfer Capacitance	C_{rss}		--	2.1	--	
Total Gate Charge	Q_g	$V_{DD} = 520V, I_D = 11A$ $V_{GS} = 10V$	--	22.0	--	nC
Gate-Source Charge	Q_{gs}		--	7.3	--	
Gate-Drain Charge	Q_{gd}		--	8.6	--	
Gate Plateau Voltage	$V_{Plateau}$		--	6.6	--	V
Turn-on Delay Time	$t_{d(on)}$	$V_{DD} = 400V, I_D = 11A$ $R_G = 15\Omega, V_{GS} = 10V$	--	15	--	ns
Turn-on Rise Time	t_r		--	25	--	
Turn-off Delay Time	$t_{d(off)}$		--	80	--	
Turn-off Fall Time	t_f		--	35	--	
Drain-Source Body Diode Characteristics						
Body Diode Forward Voltage	V_{SD}	$T_J = 25^\circ\text{C}, I_{SD} = 5.5A$, $V_{GS} = 0V$	--	1.0	1.5	V
Reverse Recovery Time	t_{rr}	$V_R = 400V$ $I_F = 5.5A, di_F/dt = 100A/\mu s$	--	115	--	ns
Reverse Recovery Charge	Q_{rr}		--	0.49	--	μC
Peak Reverse Recovery Current	I_{rrm}		--	8.5	--	A

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

Figure 1. Transient Thermal Impedance For TO-263/TO-252/TO-262/TO-220/TO-251

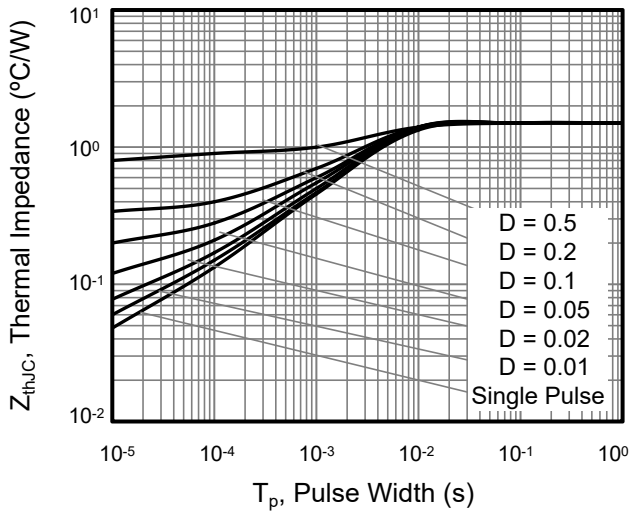


Figure 2. Transient Thermal Impedance For TO-220F

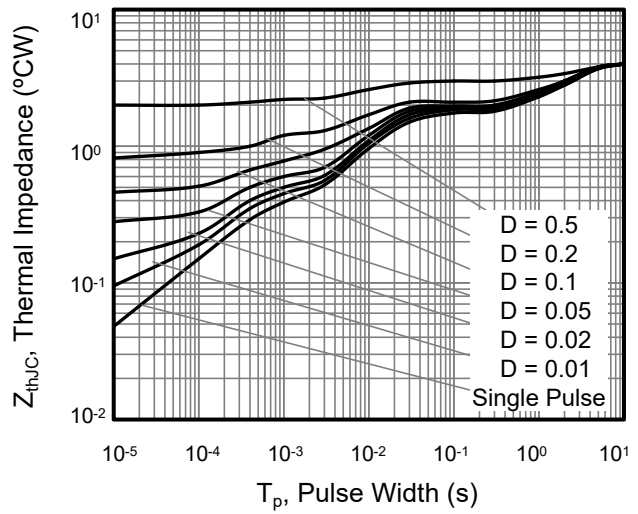


Figure 3. Safe Operation Area For TO-263/TO-252/TO-262/TO-220/TO-251

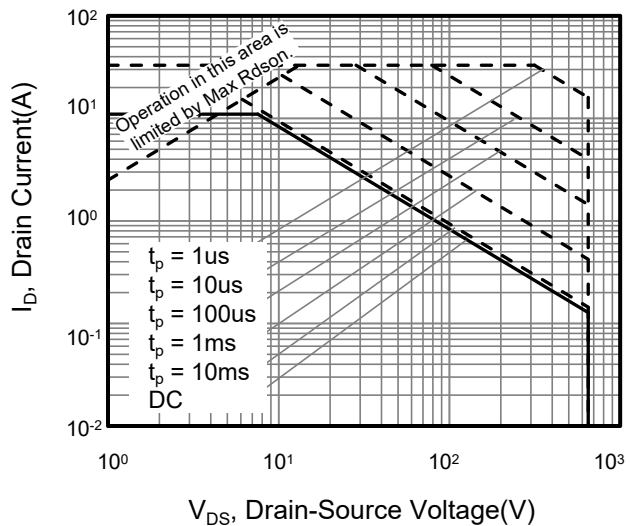


Figure 4. Safe Operation Area For TO-220F

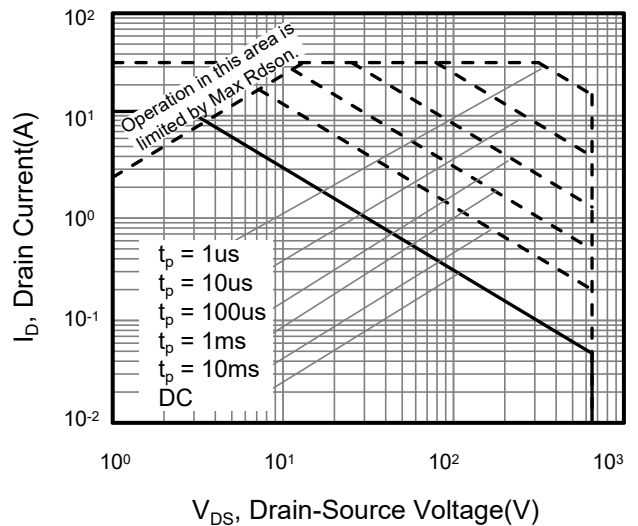


Figure 5. Output Characteristics

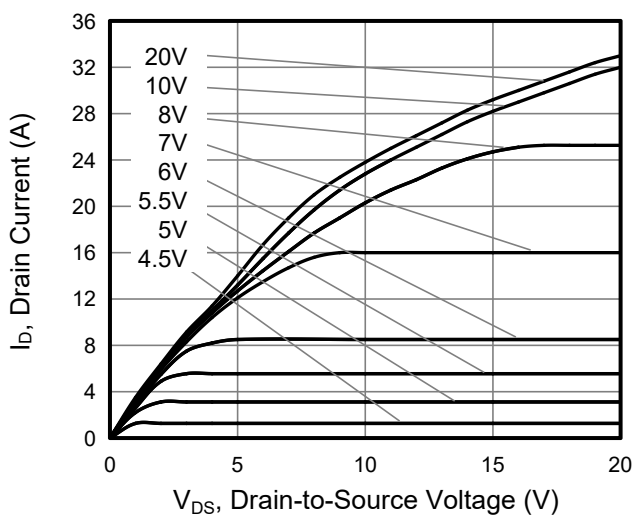
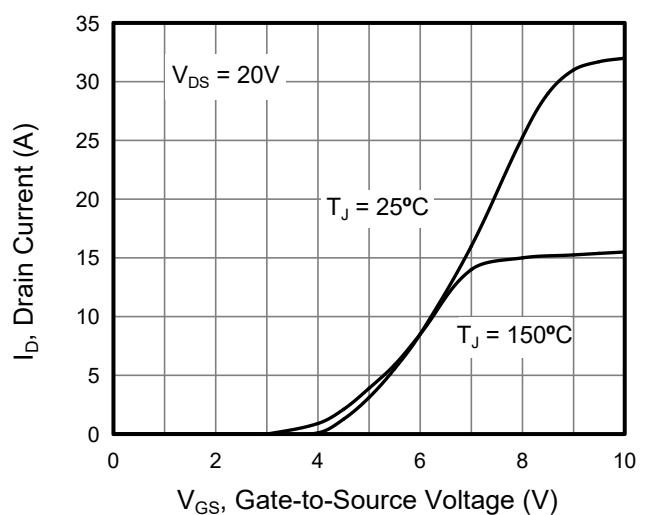


Figure 6. Transfer Characteristics



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

Figure 7. On-Resistance vs. Drain Current

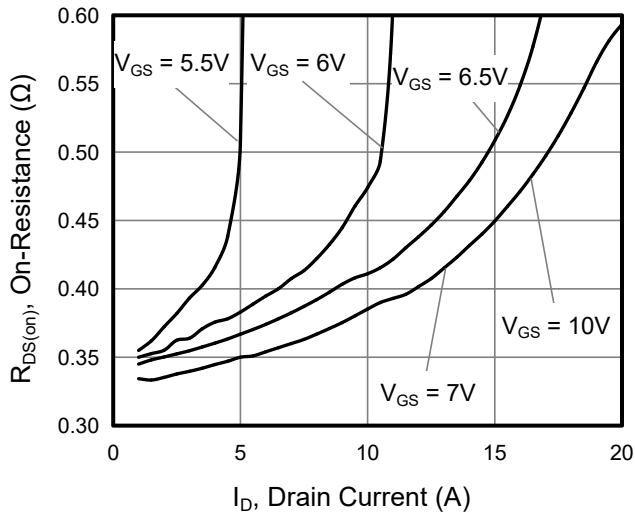


Figure 9. Gate Charge

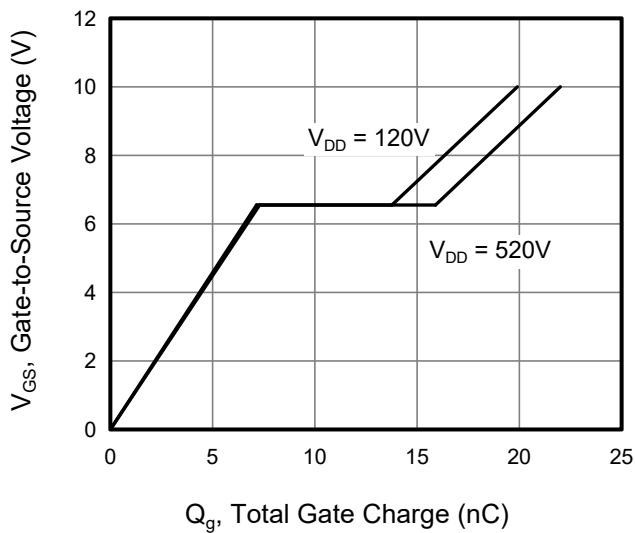


Figure 11. Typ. Coss Stored Energy

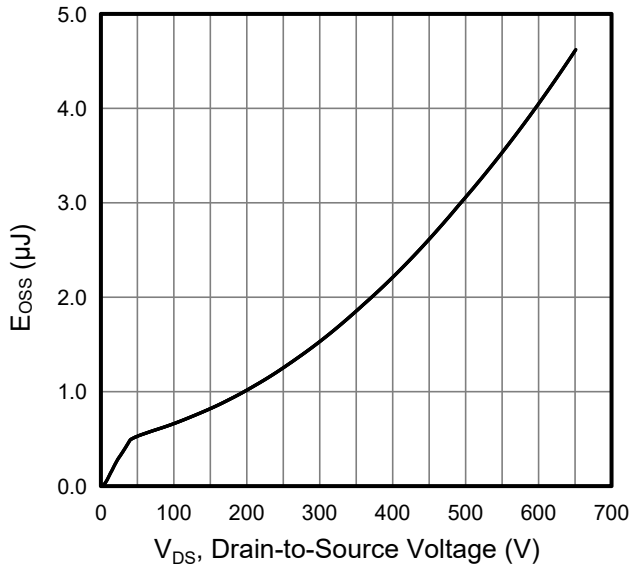


Figure 8. Capacitance

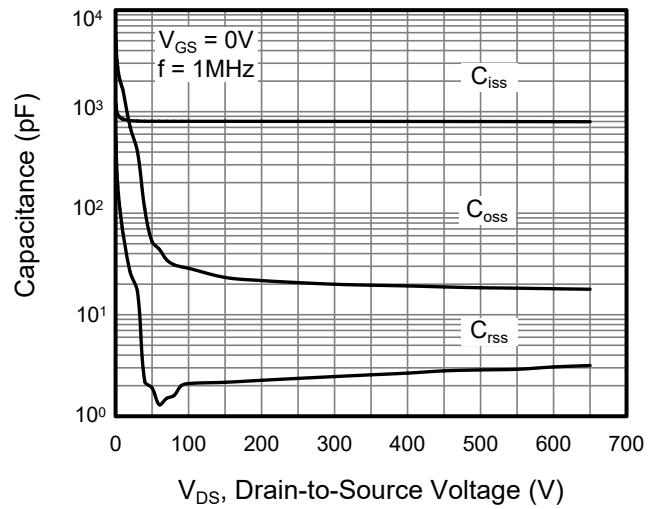


Figure 10. Body Diode Forward Voltage

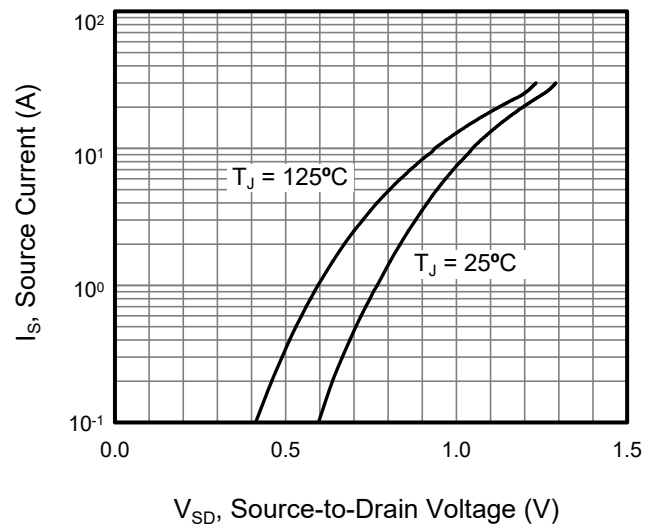
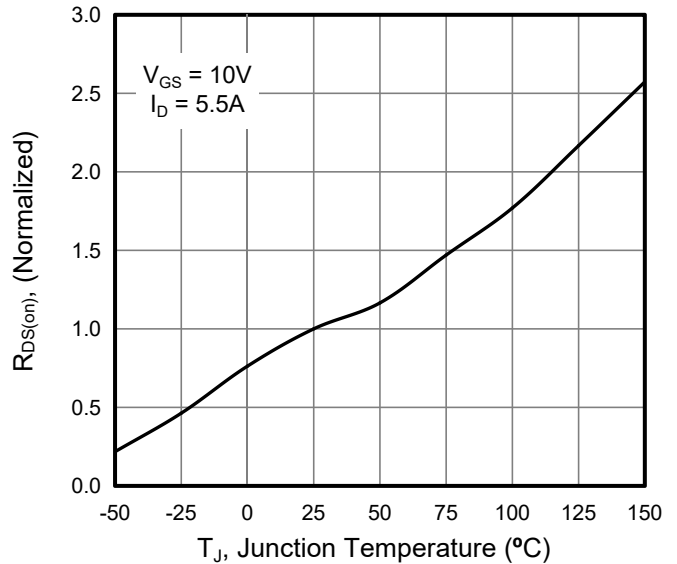


Figure 12. On-Resistance vs. Temperature



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

Figure 13. Breakdown Voltage vs. Junction Temperature

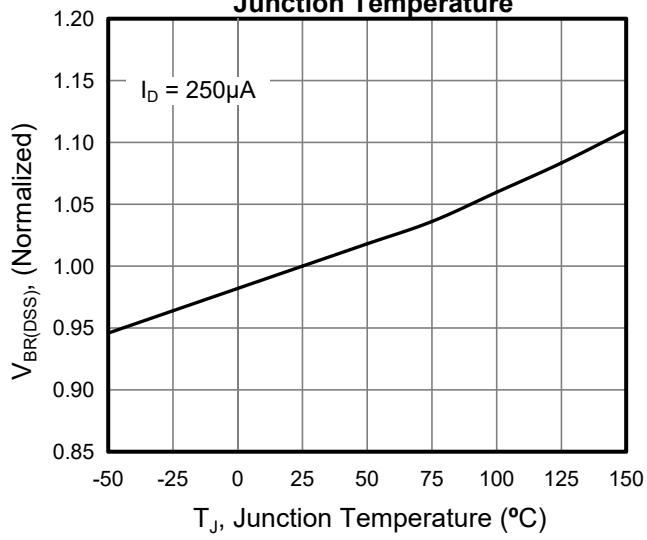


Figure A: Gate Charge Test Circuit and Waveform

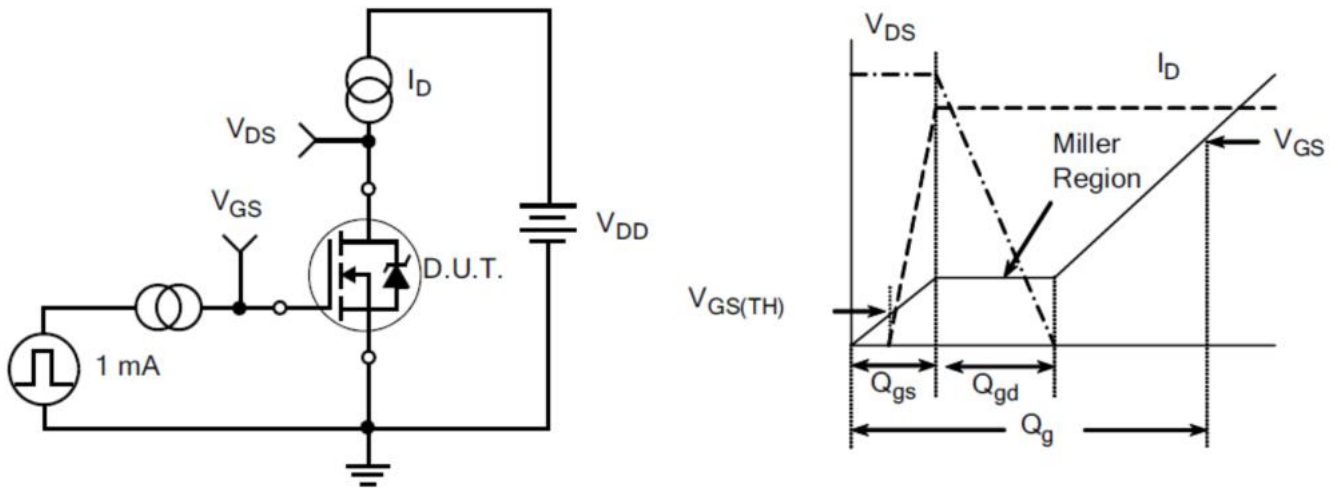


Figure B: Resistive Switching Test Circuit and Waveform

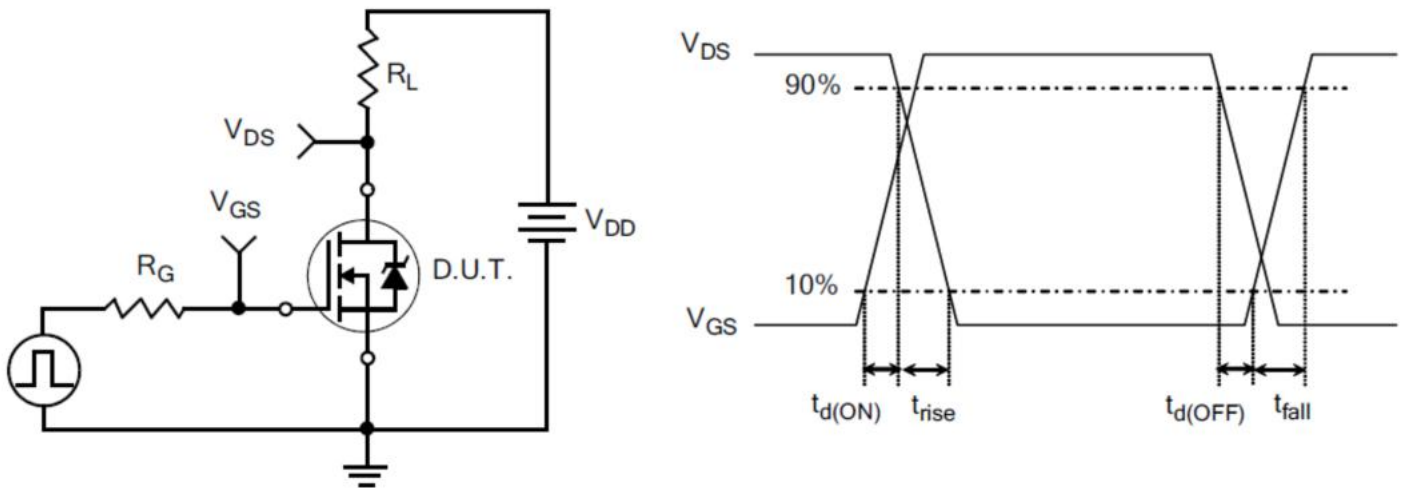
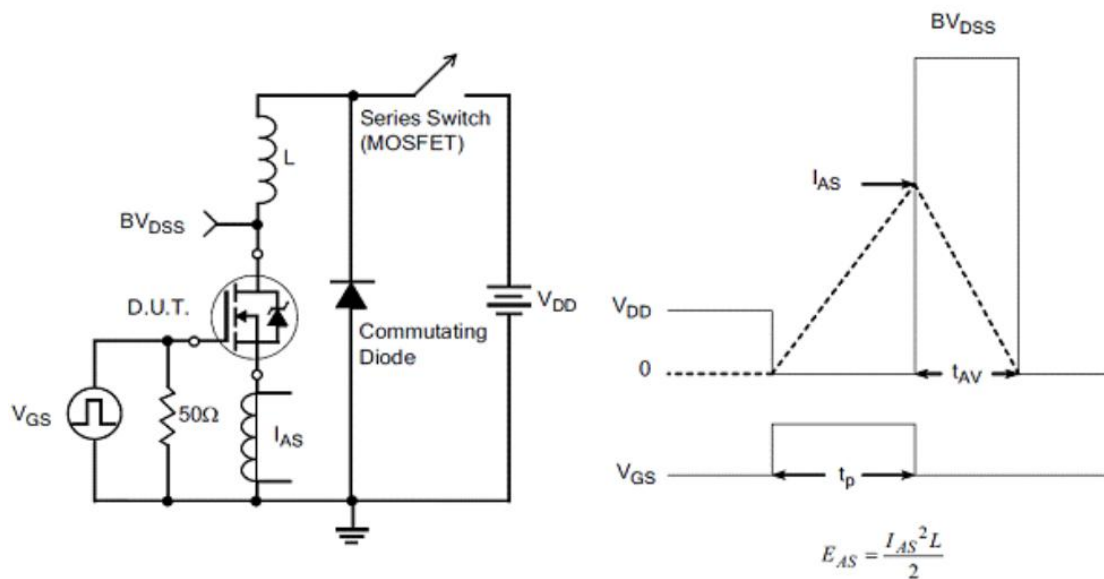
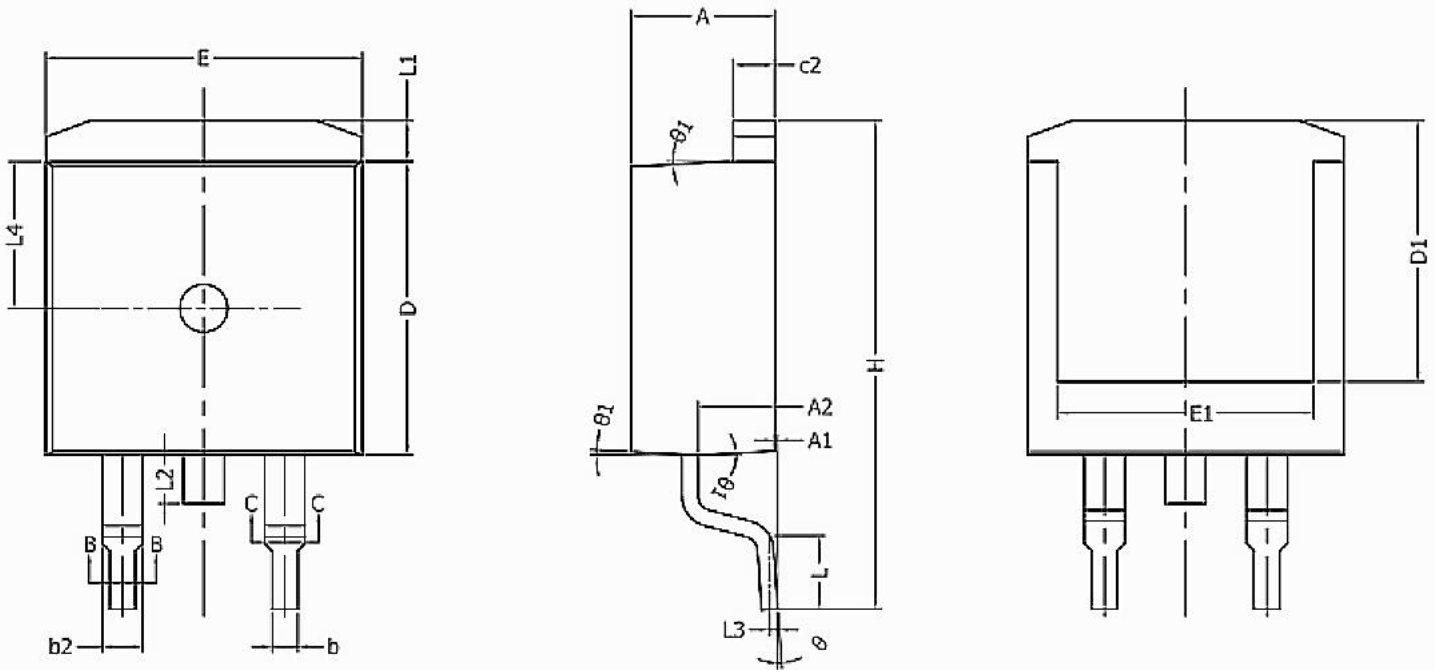


Figure C: Unclamped Inductive Switching Test Circuit and Waveform



TO-263



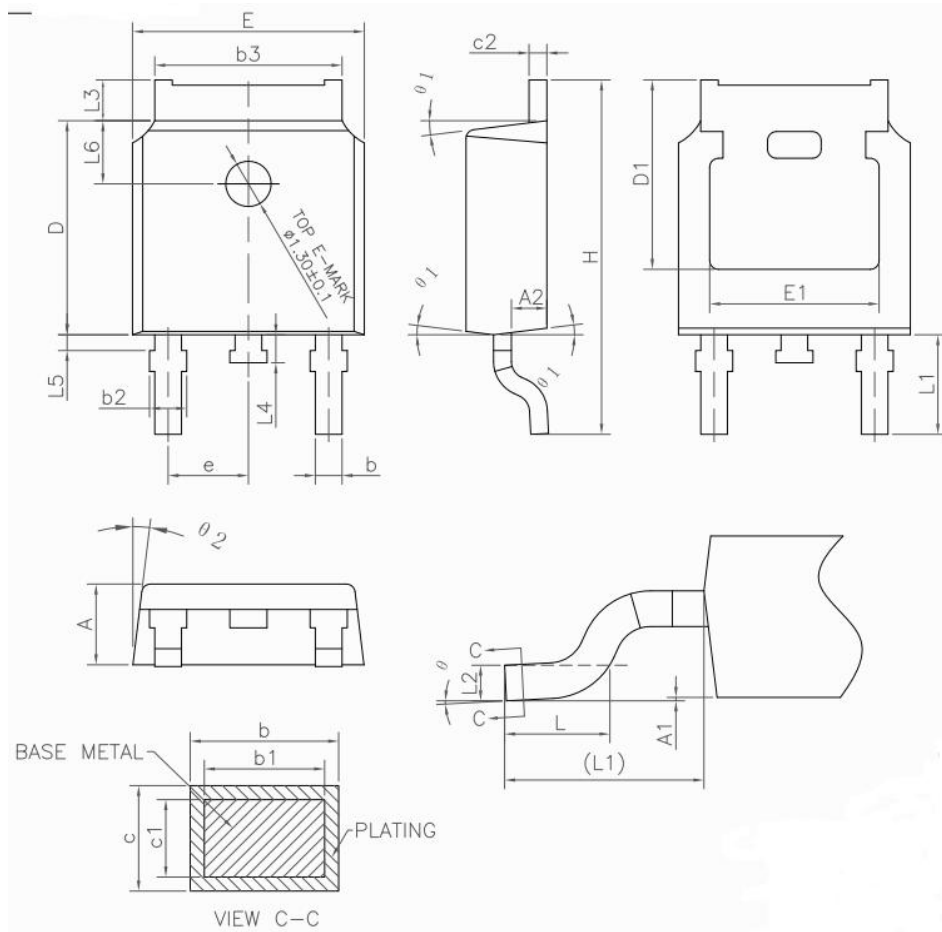
Unit:mm			
Symbol	Min.	Nom	Max.
A	4.40	4.50	4.60
A1	0	0.10	0.25
A2	2.20	2.40	2.60
b	0.76	---	0.89
b1	0.75	0.80	0.85
b2	1.23	---	1.37
b3	1.22	1.27	1.32
c	0.47	---	0.60
c1	0.46	0.51	0.56
c2	1.25	1.30	1.35
D	9.10	9.20	9.30

Unit:mm			
Symbol	Min.	Nom	Max.
D1	8.00	---	---
E	9.80	9.90	10.00
E1	7.80	---	---
e	2.54 BSC		
H	14.90	15.30	15.70
L	2.00	2.30	2.60
L1	1.17	1.27	1.40
L2	---	---	1.75
L3	0.25 BSC		
L4	4.60 REF		
θ	0°	---	8°
θ_1	1°	3°	5°

Ordering information For TO-263

Package	Units/Tape	Tapes/ Inner Box	Units/Inner Box	Inner Box/Carton Box	Units/Carton Box
TO-263	800	1	800	10	8000

TO-252



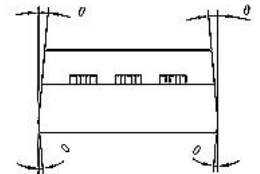
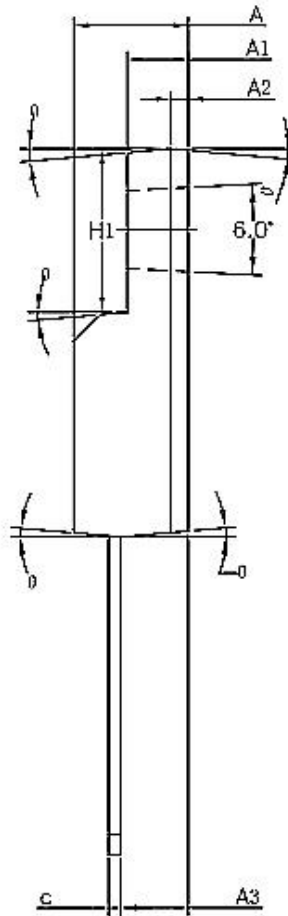
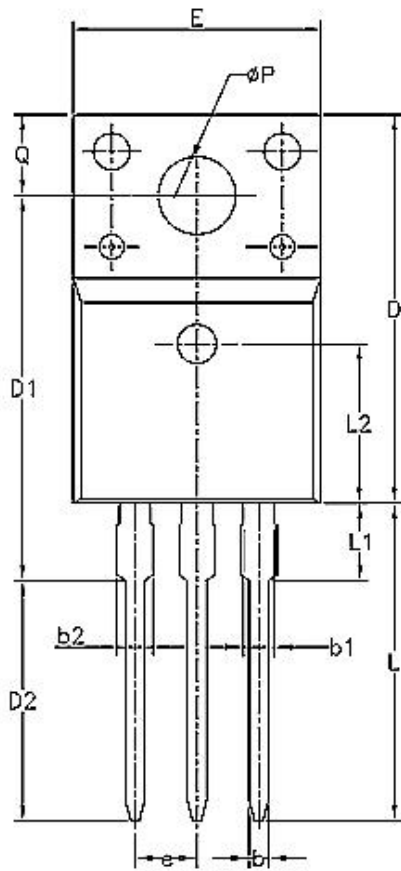
Unit:mm			
Symbol	Min.	Nom	Max.
A	2.20	2.30	2.38
A1	0.00	-	0.20
A2	0.90	1.01	1.10
b	0.72	--	0.85
b1	0.71	0.76	0.81
b2	0.72	--	0.90
b3	5.13	5.33	5.46
c	0.47	--	0.60
c1	0.46	0.51	0.56
c2	0.47	--	0.60
D	6.00	6.10	6.20
D1	5.25	--	--
E	6.50	6.60	6.70

Unit:mm			
Symbol	Min.	Nom	Max.
E1	4.70	--	--
e	2.186	2.286	2.386
H	9.80	10.10	10.40
L	1.40	1.50	1.70
L1	2.90 REF		
L2	0.508 BSC		
L3	0.90	--	1.25
L4	0.60	0.80	1.00
L5	0.15	--	0.75
L6	1.80 REF		
θ	0°	-	8°
$\theta 1$	5°	7°	9°
$\theta 2$	5°	7°	9°

Ordering information For TO-252

Package	Units/Tape	Tapes/ Inner Box	Units/Inner Box	Inner Box/Carton Box	Units/Carton Box
TO-252	2500	2	5000	5	25000

TO-220F



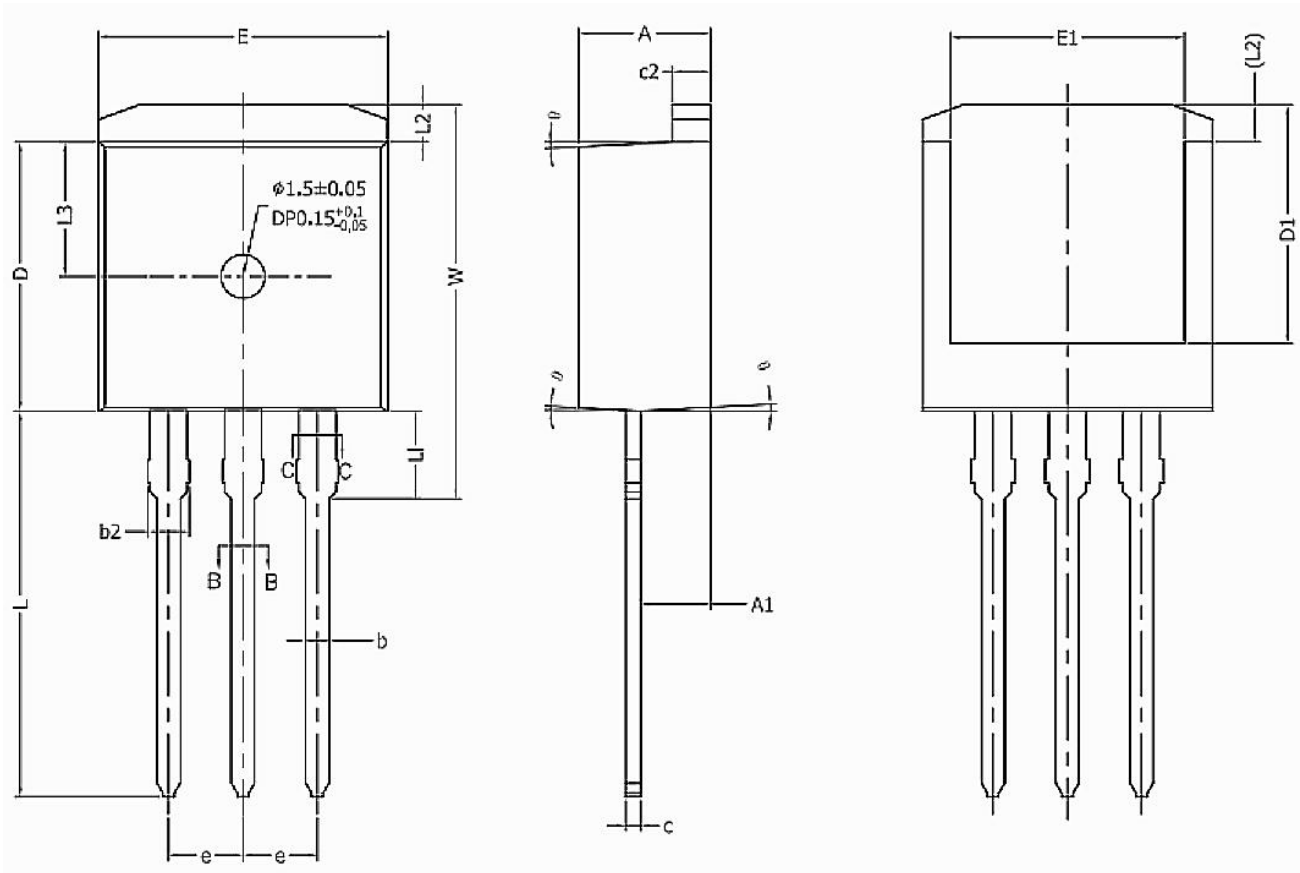
Unit:mm			
Symbol	Min.	Nom	Max.
A	4.50	4.70	4.83
A1	2.34	2.54	2.74
A2	0.70 REF		
A3	2.56	2.76	2.93
b	0.70	---	0.90
b1	1.18	---	1.38
b2	---	---	1.47
c	0.45	0.50	0.60
D	15.67	15.87	16.07
D1	15.55	15.75	15.95

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°

Ordering information For TO-220F

Package	Units/Tube	Tubes/ Inner Box	Units/Inner Box	Inner Box/Carton Box	Units/Carton Box
TO-220F	50	40	2000	4	8000

TO-262



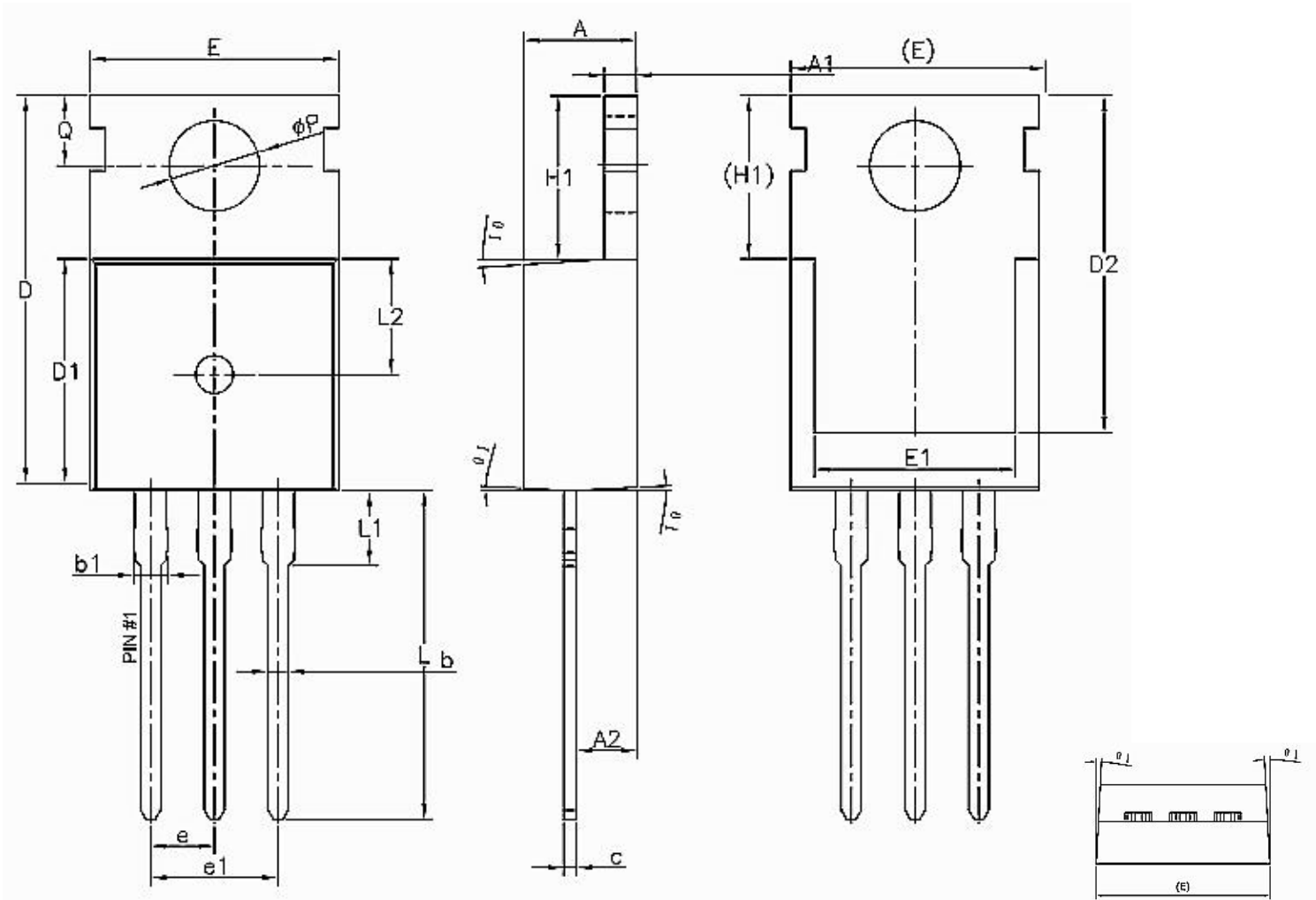
Unit:mm			
Symbol	Min.	Nom	Max.
A	4.40	4.50	4.60
A1	2.20	2.40	2.60
b	0.76	---	0.89
b1	0.75	0.80	0.85
b2	1.23	---	1.37
b3	1.22	1.27	1.32
c	0.47	---	0.60
c1	0.46	0.51	0.56
c2	1.25	1.30	1.35
D	9.10	9.20	9.30

Unit:mm			
Symbol	Min.	Nom	Max.
D1	8.00	---	---
E	9.80	9.90	10.00
E1	7.80	---	---
e	2.54 BSC		
L	12.90	13.20	13.50
L1	2.80	3.00	3.20
L2	1.17	1.27	1.40
L3	4.60 REF		
W	13.25	---	14.00
θ	1°	3°	5°

Ordering information For TO-262

Package	Units/Tube	Tubes/ Inner Box	Units/Inner Box	Inner Box/Carton Box	Units/Carton Box
TO-262	50	40	2000	4	8000

TO-220



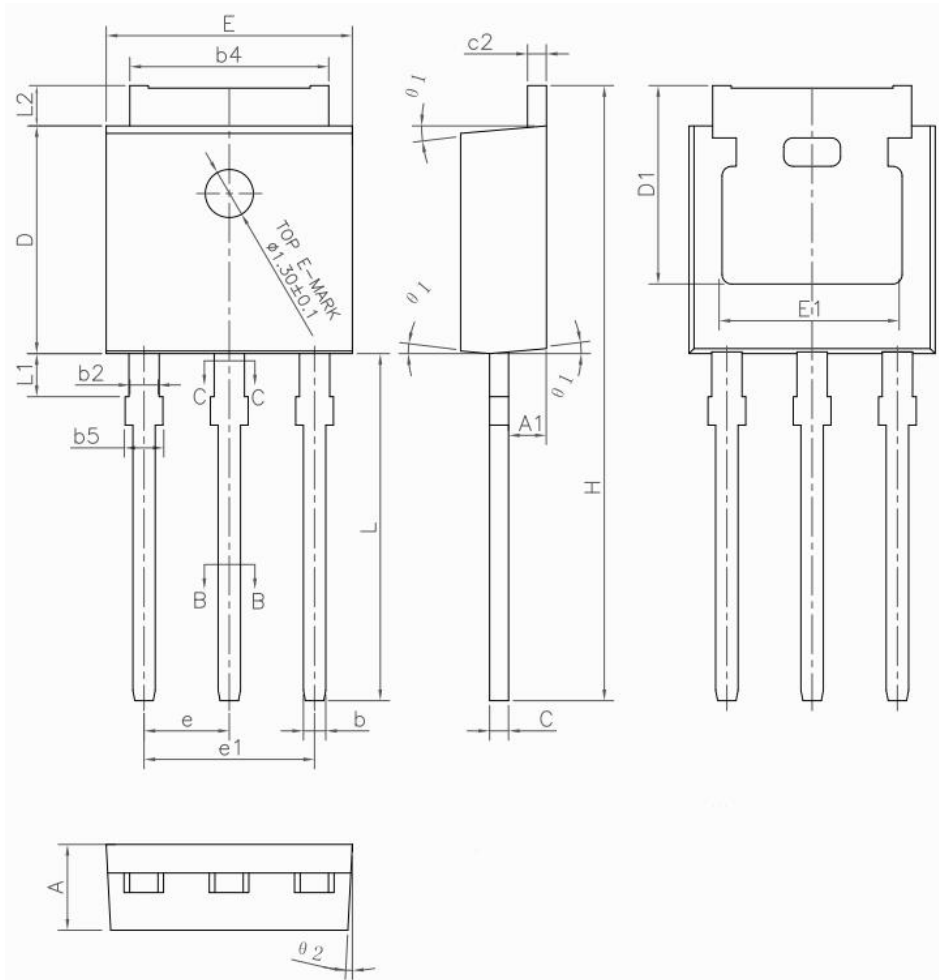
Unit:mm			
Symbol	Min.	Nom	Max.
A	4.40	4.50	4.60
A1	1.27	1.30	1.33
A2	2.30	2.40	2.50
b	0.70	---	0.90
b2	1.27	---	1.40
c	0.45	0.50	0.60
D	15.30	15.70	16.10
D1	9.10	9.20	9.30
D2	13.10	---	13.70
E	9.70	9.90	10.20

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°

Ordering information For TO-220

Package	Units/Tube	Tubes/ Inner Box	Units/Inner Box	Inner Box/Carton Box	Units/Carton Box
TO-220	50	40	2000	4	8000

TO-251



Unit:mm			
Symbol	Min.	Nom	Max.
A	2.20	2.30	2.35
A1	0.90	1.01	1.10
b	0.56	--	0.69
b1	0.55	0.60	0.65
b2	0.77	--	0.90
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	6.00	6.10	6.20

Unit:mm			
Symbol	Min.	Nom.	Max.
D1	5.20	--	--
E	6.50	6.60	6.70
E1	4.60	4.83	5.00
e	2.24	2.29	2.34
e1	4.47	4.57	4.67
H	16.18	16.48	16.78
L	9.00	9.30	9.60
L1	0.95	1.16	1.35
L2	0.90	1.08	1.25
θ1	3°	5°	7°
θ2	1°	3°	5°

Ordering information For TO-251

Package	Units/Tube	Tubes/ Inner Box	Units/Inner Box	Inner Box/Carton Box	Units/Carton Box
TO-251	75	120	9000	4	36000

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