



650V Super-junction Power MOSFET

Description

650V Super-junction Power MOSFET

Super-junction power MOSFET is a revolutionary technology for high voltage power MOSFETs, designed according to the SJ principle. The Multi-EPI SJ MOSFET provide an extremely low switching, communication and conduction losses device with highest robustness make especially resonant switching applications more reliable, more efficient, lighter and cooler, designed by Wuxi Unigroup Microelectronics Company.

Features

- Very low FOM $R_{DS(on)} \times Q_g$
- 100% avalanche tested
- Easy to use/drive
- RoHS compliant

Applications

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

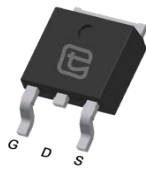
TO-220F



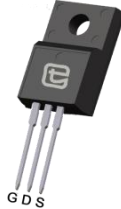
TO-263



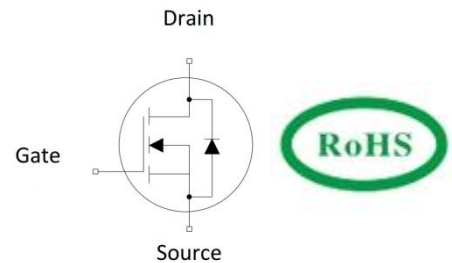
TO-252



TO-220FP-NL



TO-251



Device Marking and Package Information

Device	Package	Marking
TPA65R600M	TO-220F	65R600M
TPB65R600M	TO-263	65R600M
TPD65R600M	TO-252	65R600M
TPR65R600M	TO-220FP-NL	65R600M
TPU65R600M	TO-251	65R600M

Key Performance Parameters

Parameter	Value	Unit
$V_{DS} @ T_{j,max}$	700	V
$R_{DS(on),max}$	0.6	Ω
$Q_{g,typ}$	13	nC
I_D	7	A
$I_{D,pulse}$	21	A
$E_{OSS} @ 400V$	1.59	μJ
Body Diode di_f/dt	500	A/ μs



Absolute Maximum Ratings $T_C = 25^\circ\text{C}$, unless otherwise noted				
Parameter		Symbol	Value	Unit
Continuous Drain Current	$T_C = 25^\circ\text{C}$	I_D	7	A
	$T_C = 100^\circ\text{C}$		4.2	
Pulsed Drain Current	(note1)	$I_{D,pulse}$	21	A
Gate-Source Voltage		V_{GSS}	± 30	V
Single Pulse Avalanche Energy	(note2)	E_{AS}	142	mJ
Repetitive Avalanche Energy	(note2)	E_{AR}	0.21	mJ
Avalanche Current		I_{AR}	1.3	A
MOSFET dv/dt Ruggedness, $V_{DS} = 0 \dots 480\text{V}$		dv/dt	50	V/ns
Power Dissipation For TO-220F, TO-220FP-NL		P_D	28	W
Power Dissipation For TO-263, TO-252, TO-251			63	
Continuous Diode Forward Current		I_S	6	A
Diode Pulsed Current	(note1)	$I_{S,pulse}$	21	
Reverse Diode dv/dt	(note3)	dv/dt	15	V/ns
Maximum Diode Commutation Speed	(note3)	di_f/dt	500	A/ μs
Operating Junction and Storage Temperature Range		T_J, T_{stg}	-55~+150	$^\circ\text{C}$

Thermal Resistance For TO-220F, TO-220FP-NL			
Parameter	Symbol	Value	Unit
Thermal Resistance, Junction-to-Case	R_{thJC}	4.5	$^\circ\text{C}/\text{W}$
Thermal Resistance, Junction-to-Ambient	R_{thJA}	62	

Thermal Resistance For TO-263, TO-252, TO-251			
Parameter	Symbol	Value	Unit
Thermal Resistance, Junction-to-Case	R_{thJC}	2.0	$^\circ\text{C}/\text{W}$
Thermal Resistance, Junction-to-Ambient	R_{thJA}	62	



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
		$V_{DS} = 650V, V_{GS} = 0V, T_J = 150^\circ\text{C}$	--	--	100	
Gate-Source Leakage Current	I_{GSS}	$V_{GS} = \pm 30V$	--	--	± 100	nA
Gate-Source Threshold Voltage	$V_{GS(th)}$	$V_{DS} = V_{GS}, I_D = 250\mu A$	2.5	--	4.5	V
Drain-Source On-State-Resistance	$R_{DS(on)}$	$V_{GS} = 10V, I_D = 3.5A$	--	0.53	0.6	Ω
Gate Resistance	R_G	$f = 1.0\text{MHz}$ open drain	--	7	--	Ω
Dynamic Characteristics						
Input Capacitance	C_{iss}	$V_{GS} = 0V,$ $V_{DS} = 100V,$ $f = 1.0\text{MHz}$	--	509	--	μF
Output Capacitance	C_{oss}		--	23	--	
Reverse Transfer Capacitance	C_{rss}		--	1.5	--	
Total Gate Charge	Q_g	$V_{DD} = 520V, I_D = 7A,$ $V_{GS} = 10V$	--	13	--	nC
Gate-Source Charge	Q_{gs}		--	2.8	--	
Gate-Drain Charge	Q_{gd}		--	5.6	--	
Turn-on Delay Time	$t_{d(on)}$	$V_{DD} = 400V, I_D = 7A,$ $R_G = 25\Omega$	--	55	--	ns
Turn-on Rise Time	t_r		--	61	--	
Turn-off Delay Time	$t_{d(off)}$		--	117	--	
Turn-off Fall Time	t_f		--	42	--	
Drain-Source Body Diode Characteristics						
Body Diode Forward Voltage	V_{SD}	$T_J = 25^\circ\text{C}, I_{SD} = 3.5A, V_{GS} = 0V$	--	0.9	1.2	V
Reverse Recovery Time	t_{rr}	$V_R = 400V, I_F = 7A,$ $di_F/dt = 100A/\mu s$	--	321	--	ns
Reverse Recovery Charge	Q_{rr}		--	3.4	--	μC
Peak Reverse Recovery Current	I_{rrm}		--	21.2	--	A

Notes

1. Repetitive Rating: Pulse width limited by maximum junction temperature
2. $I_{AS} = 2.4A, V_{DD} = 50V, R_G = 25\Omega,$ Starting $T_J = 25^\circ\text{C}$
3. Identical low side and high side switch with identical R_G



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

Figure 1. Output Characteristics

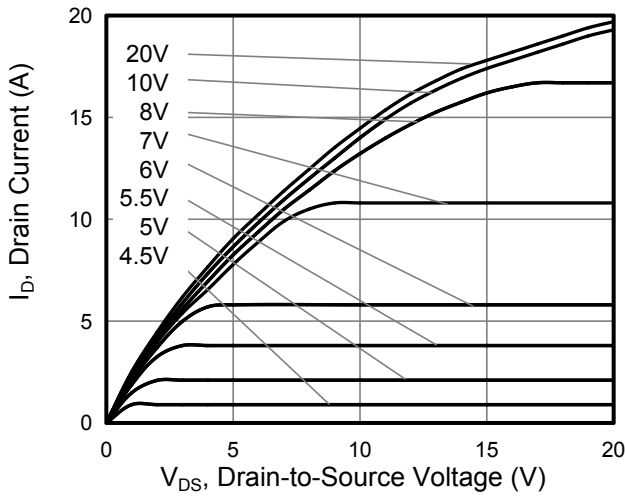


Figure 2. Transfer Characteristics

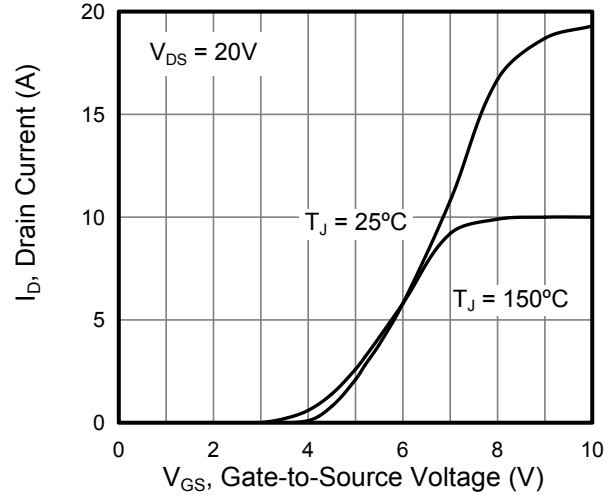


Figure 3. On-Resistance vs. Drain Current

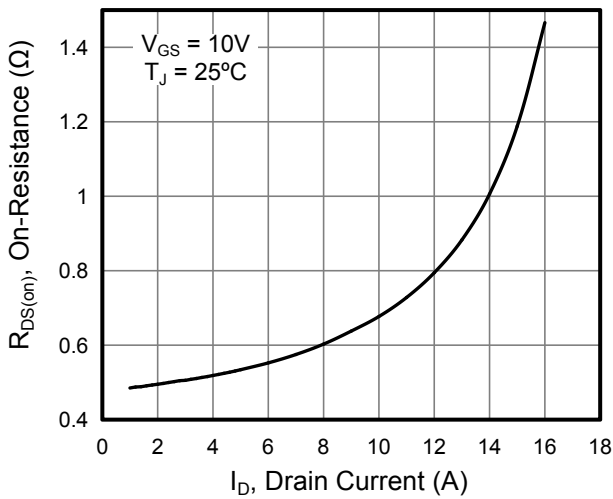


Figure 4. Capacitance

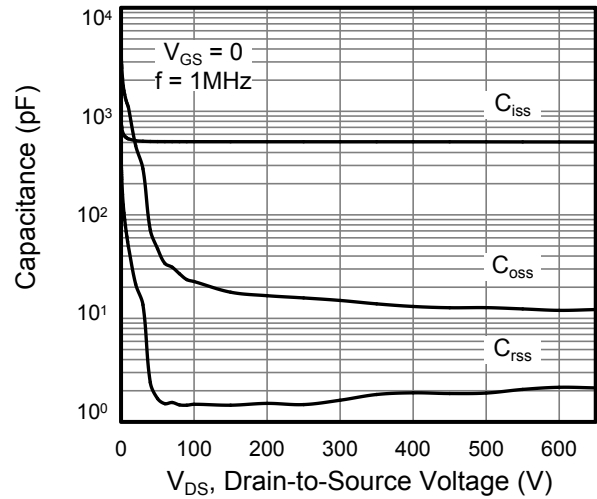


Figure 5. Gate Charge

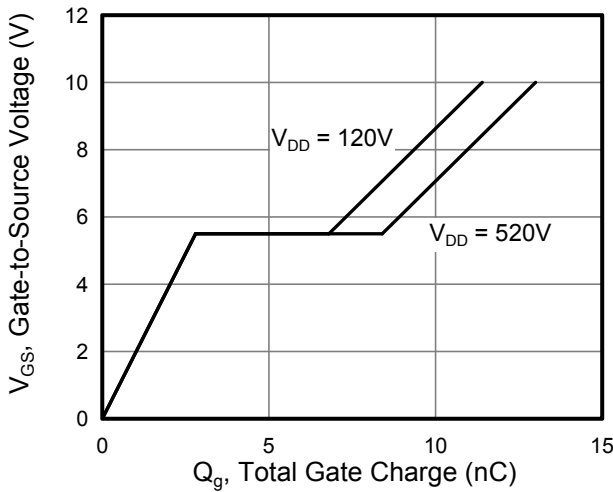
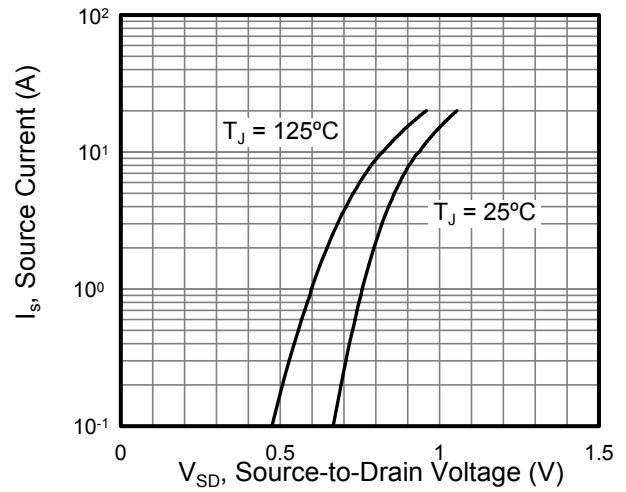


Figure 6. Body Diode Forward Voltage





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

Figure 7. On-Resistance vs. Temperature

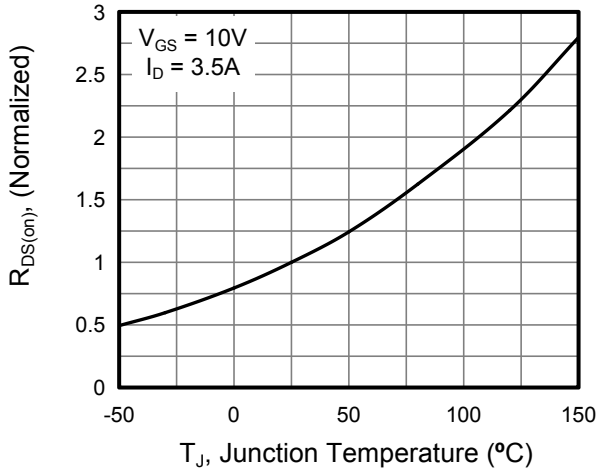


Figure 8. Breakdown voltage vs. Junction Temperature

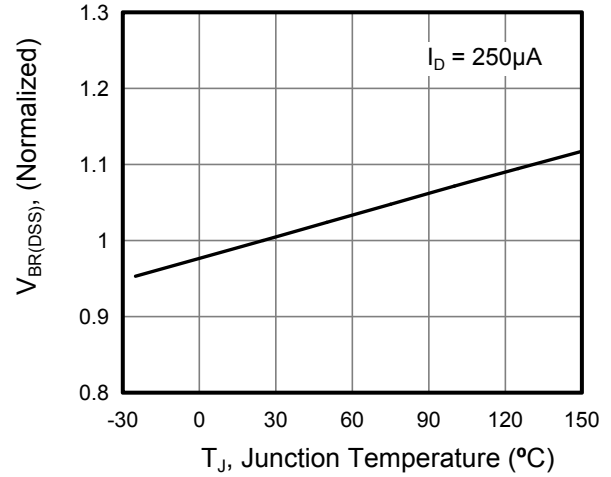


Figure 9. Transient Thermal Impedance For TO-263/TO-252/TO-251

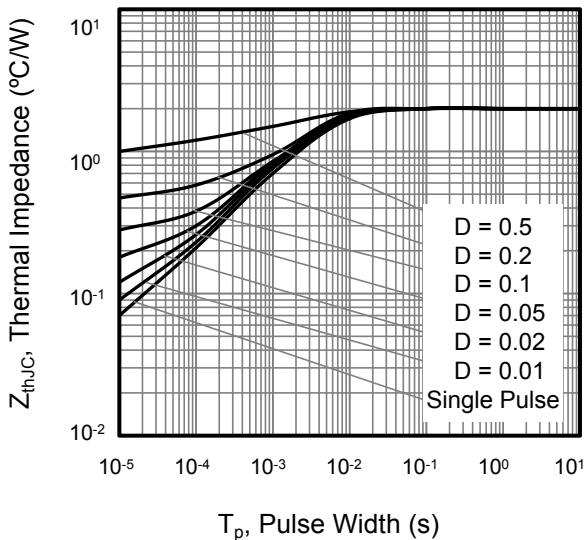


Figure 10. Transient Thermal Impedance For TO-220F/TO-220FP-NL

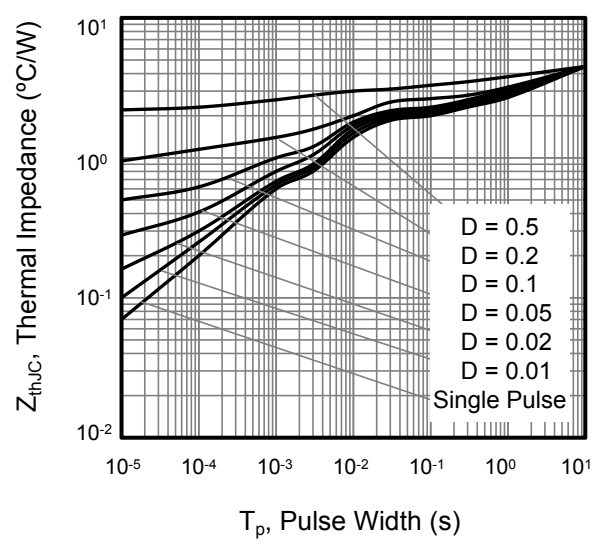


Figure 11. Safe Operation Area For TO-263/TO-252/TO-251

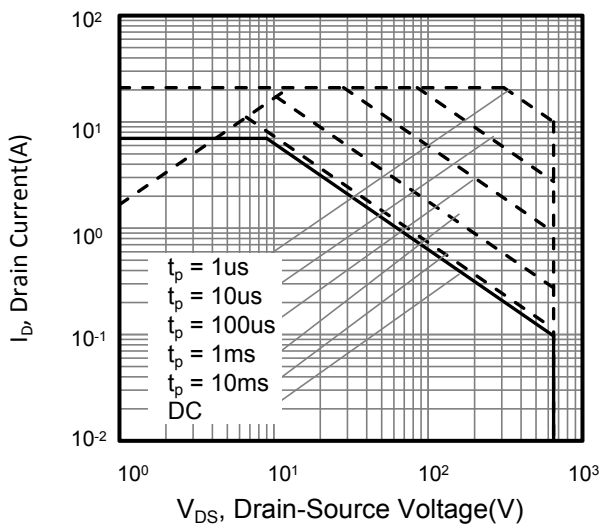
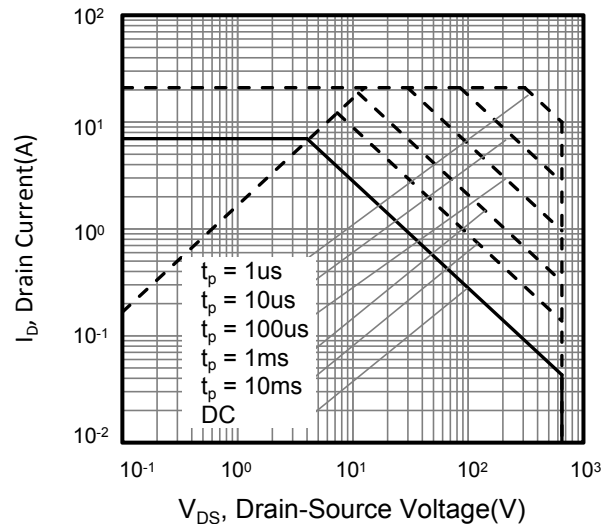


Figure 12. Safe Operation Area For TO-220F/TO-220FP-NL





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

Figure 13. Typ. Coss Stored Energy

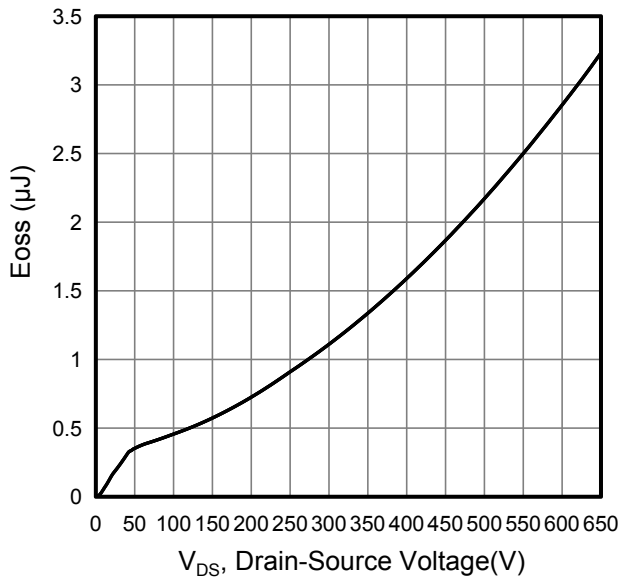




Figure A: Gate Charge Test Circuit and Waveform

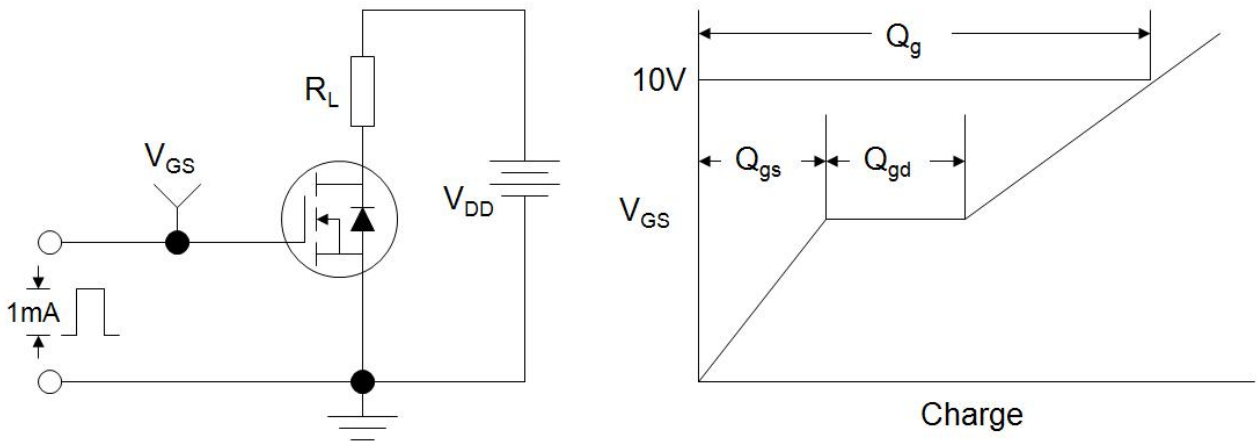


Figure B: Resistive Switching Test Circuit and Waveform

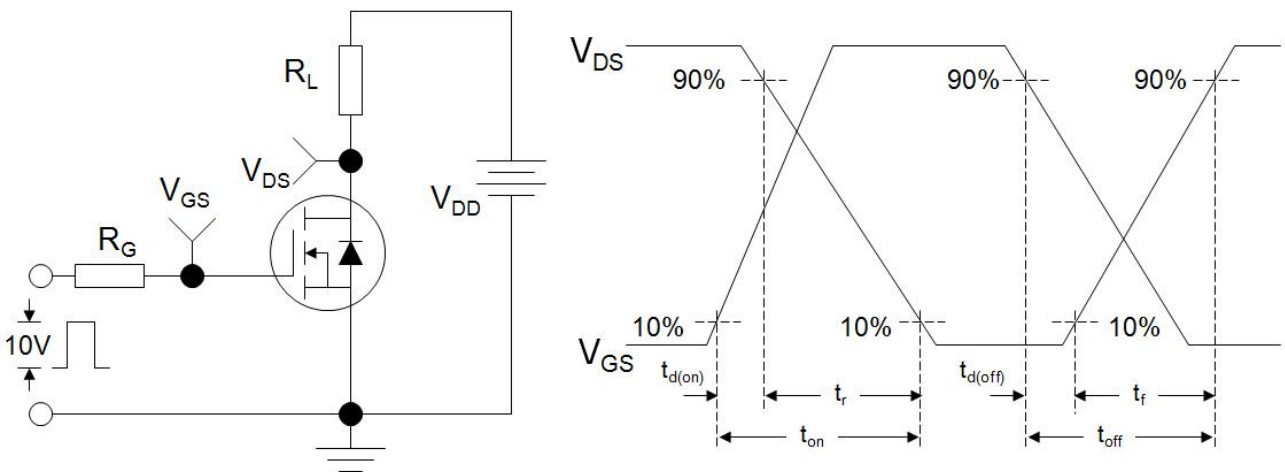
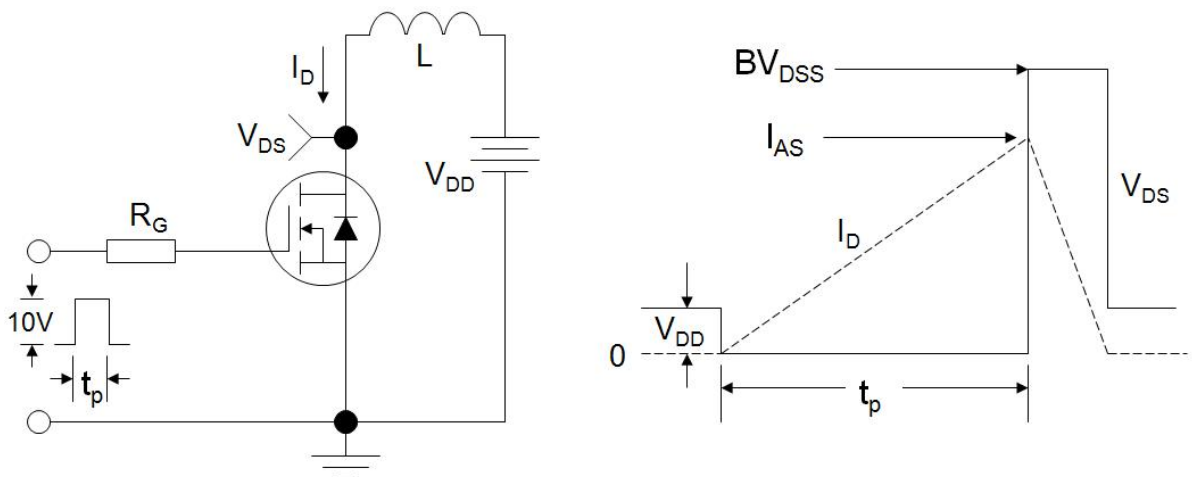
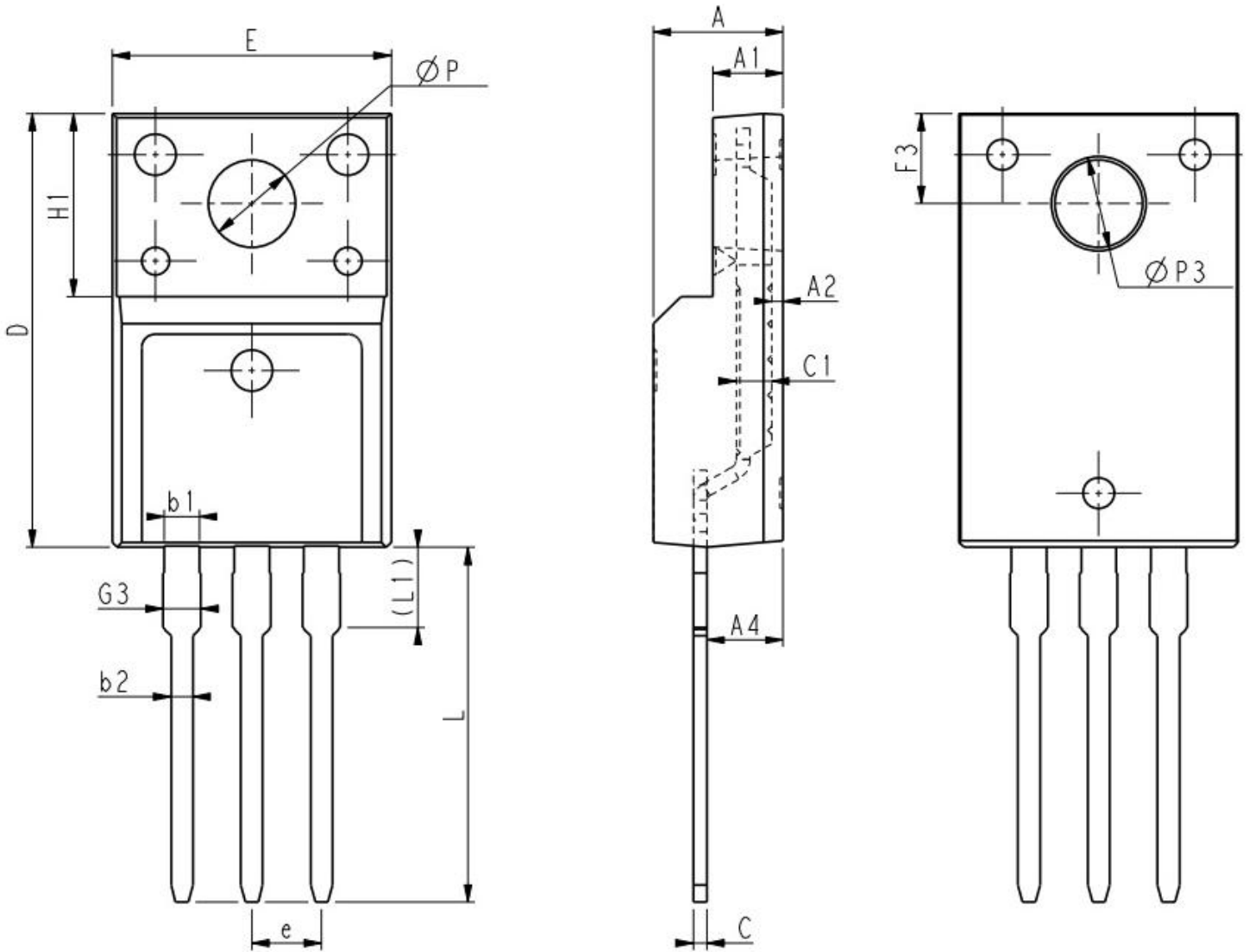


Figure C: Unclamped Inductive Switching Test Circuit and Waveform





TO-220F (封装厂 H)

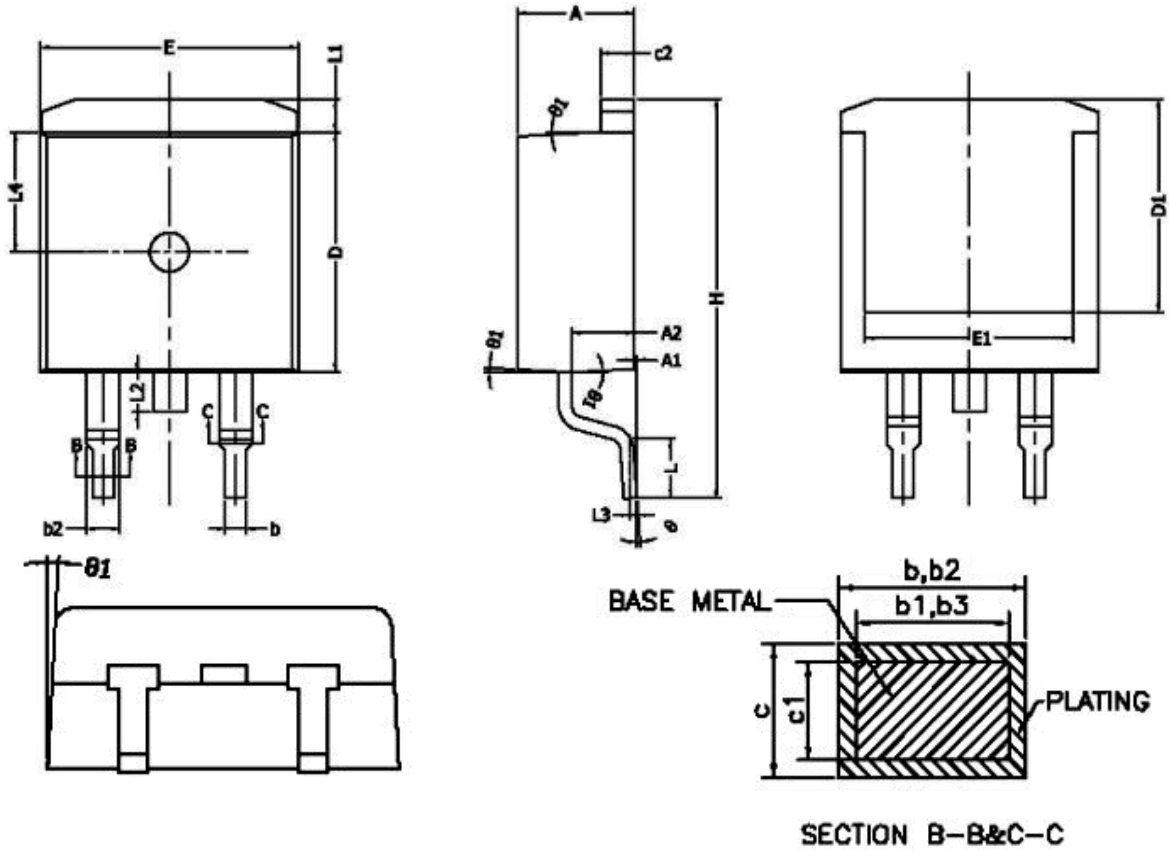


Unit:mm			
Symbol	Min.	Nom	Max.
E	9.96	10.16	10.36
A	4.50	4.70	4.90
A1	2.34	2.54	2.74
A2	0.30	0.45	0.60
A4	2.56	2.76	2.96
c	0.40	0.50	0.65
c1	1.20	1.30	1.35
D	15.57	15.87	16.17
H1	6.70REF		

Unit:mm			
Symbol	Min.	Nom	Max.
e	2.54BSC		
L	12.68	12.98	13.28
L1	2.93	3.03	3.13
ΦP	3.03	3.18	3.38
$\Phi P3$	3.15	3.45	3.65
F3	3.15	3.30	3.45
G3	1.25	1.35	1.55
b1	1.18	1.28	1.43
b2	0.70	0.80	0.95



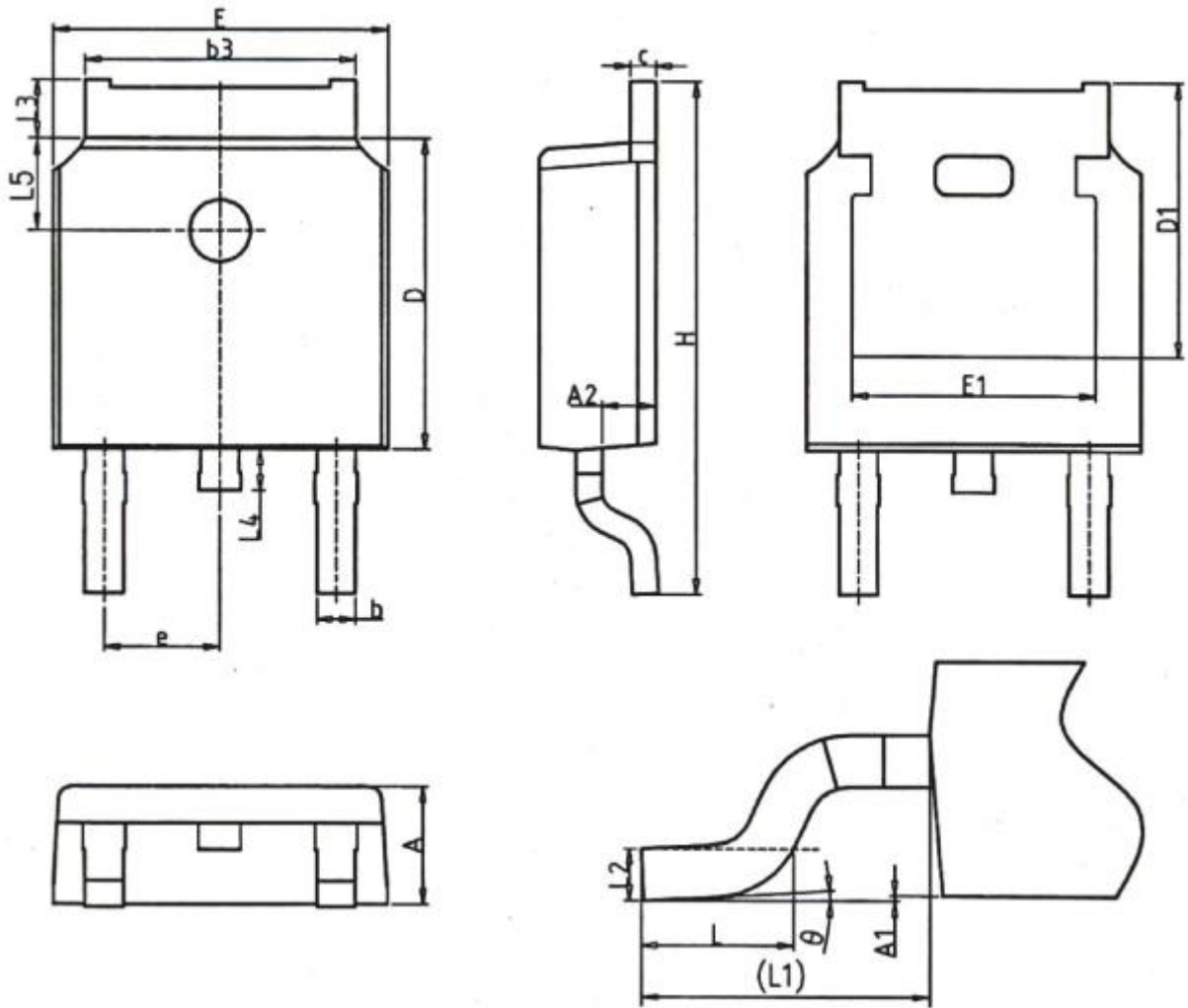
TO-263 (封装厂 I)



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
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	0.25BSC		
L4	4.60 REF		
theta	0°	--	8°
theta1	1°	3°	5°



TO-252 (封装厂 H)

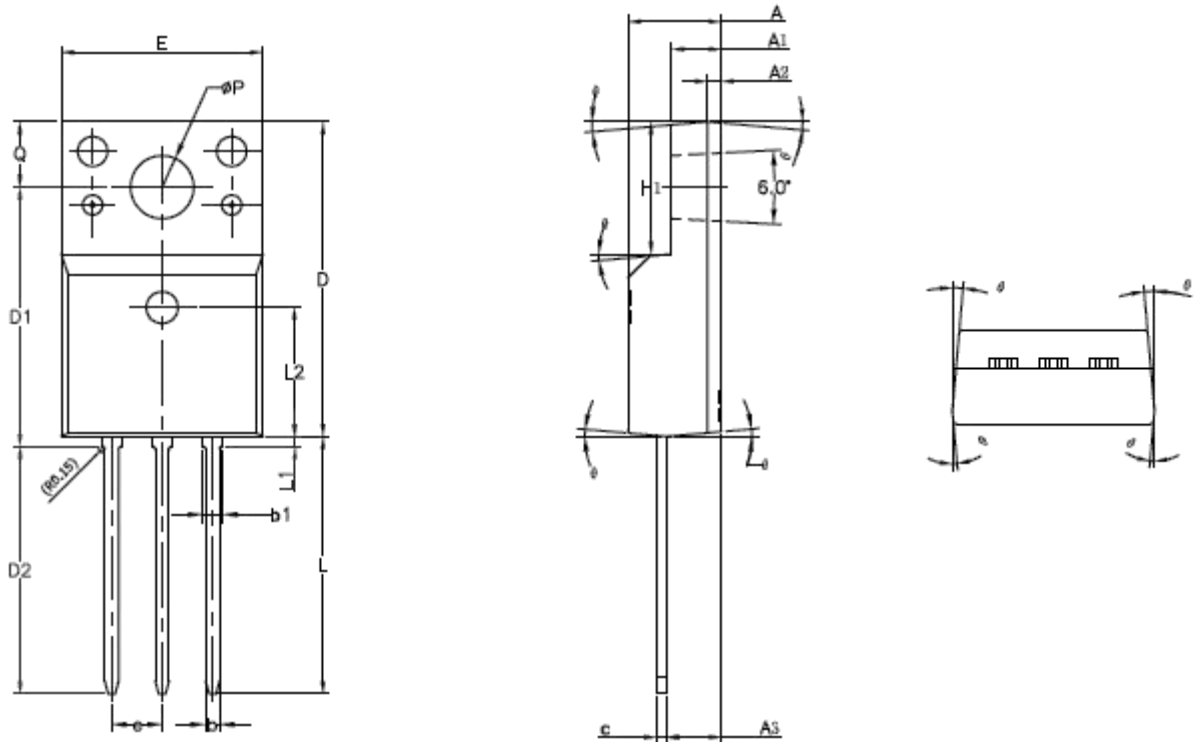


Unit:mm			
Symbol	Min.	Nom	Max.
A	2.20	2.30	2.40
A1	0.00	-	0.20
A2	0.97	1.07	1.17
b	0.68	0.78	0.90
b3	5.20	5.33	5.50
c	0.43	0.53	0.63
D	5.98	6.10	6.22
D1	5.30 REF		
E	6.40	6.60	6.80
E1	4.63	-	-

Unit:mm			
Symbol	Min.	Nom	Max.
e	2.286 BSC		
H	9.40	10.10	10.50
L	1.38	1.50	1.75
L1	2.90 REF		
L2	0.51 BSC		
L3	0.88	-	1.28
L4	-	-	1.00
L5	1.65	1.80	1.95
θ	0°	-	8°



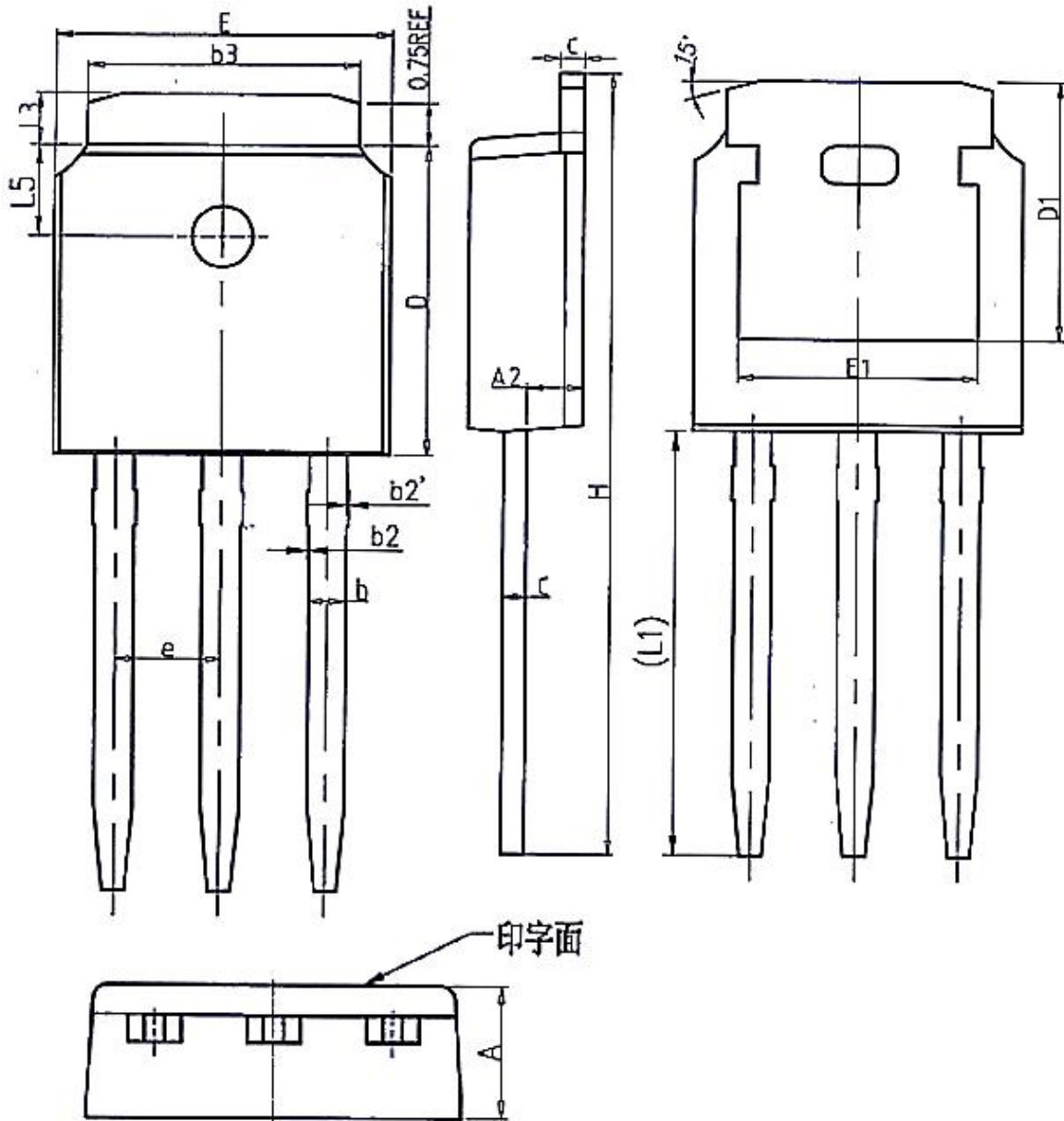
TO-220FP-NL (封装厂 I)



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	0.60	—	0.80
b1	0.90	—	1.10
c	0.45	0.50	0.60
D	15.67	15.87	16.07
D1	12.87	13.07	13.27
D2	12.28	12.48	12.68
E	9.96	10.16	10.36
e	2.54BSC		
H1	6.48	6.68	6.88
L	12.68	12.98	13.28
L1	—	—	0.85
L2	6.50REF		
phi P	3.08	3.18	3.28
Q	3.20	—	3.40
theta 1	1°	3°	5°



TO-251 (封装厂 H)



Unit:mm			
Symbol	Min.	Nom	Max.
A	2.20	2.30	2.40
A2	0.97	1.07	1.17
b	0.68	0.78	0.90
b2	0.00	0.04	0.10
b2'	0.00	0.04	0.10
b3	5.20	5.33	5.50
c	0.43	0.53	0.63
D	5.98	6.10	6.22

Unit:mm			
Symbol	Min.	Nom	Max.
D1	5.30 REF		
E	6.40	6.60	6.80
E1	4.63	-	-
e	2.286 BSC		
H	16.22	16.52	16.82
L1	9.15	9.40	9.65
L3	0.88	1.02	1.28
L5	1.65	1.80	1.95



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