



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.

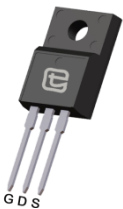
Features

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

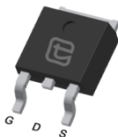
Applications

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

TO-220F



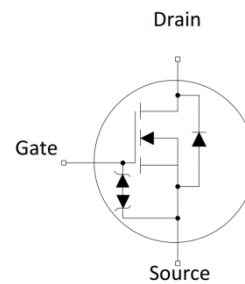
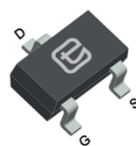
TO-252



TO-251



SOT-223-2L



Device Marking and Package Information

Device	Package	Marking
TPA65R1K5M	TO-220F	65R1K5M
TPD65R1K5M	TO-252	65R1K5M
TPU65R1K5M	TO-251	65R1K5M
TPY65R1K5MB	SOT-223-2L	65R1K5M

Key Performance Parameters

Parameter	Value	Unit
$V_{DS} @ T_{j,max}$	700	V
$R_{DS(on),max}$	1.5	Ω
$Q_{g,typ}$	7	nC
I_D	3	A
$I_{D,pulse}$	9	A
ESD class (HBM)	1C	
$E_{OSS} @ 400V$	0.79	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	3	A
	$T_C = 100^\circ\text{C}$		1.8	
Pulsed Drain Current	(note1)	$I_{D,pulse}$	9	A
Gate-Source Voltage		V_{GSS}	± 20	V
Single Pulse Avalanche Energy	(note2)	E_{AS}	26	mJ
Repetitive Avalanche Energy	(note2)	E_{AR}	0.10	mJ
Avalanche Current		I_{AR}	0.6	A
MOSFET dv/dt Ruggedness, $V_{DS} = 0 \dots 480\text{V}$		dv/dt	50	V/ns
Power Dissipation For TO-220F		P_D	25	W
Power Dissipation For TO-252,TO-251			28	
Power Dissipation For SOT-223-2L			6.2	
Continuous Diode Forward Current		I_S	2.5	A
Diode Pulsed Current	(note1)	$I_{S,pulse}$	33	
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				
Parameter		Symbol	Value	Unit
Thermal Resistance, Junction-to-Case		R_{thJC}	5	$^\circ\text{C}/\text{W}$
Thermal Resistance, Junction-to-Ambient		R_{thJA}	80	

Thermal Resistance For TO-252,TO-251				
Parameter		Symbol	Value	Unit
Thermal Resistance, Junction-to-Case		R_{thJC}	4.4	$^\circ\text{C}/\text{W}$
Thermal Resistance, Junction-to-Ambient		R_{thJA}	160	

Thermal Resistance For SOT-223-2L				
Parameter		Symbol	Value	Unit
Thermal Resistance, Junction-to-Case		R_{thJC}	20	$^\circ\text{C}/\text{W}$
Thermal Resistance, Junction-to-Ambient		R_{thJA}	160	



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	$V_{(BR)DSS}$	$V_{GS} = 0V, I_D = 250\mu\text{A}$	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}	$V_{GS} = \pm 20V$	--	--	± 1	μA
Gate-Source Threshold Voltage	$V_{GS(th)}$	$V_{DS} = V_{GS}, I_D = 250\mu\text{A}$	2.5	--	4.0	V
Drain-Source On-State-Resistance	$R_{DS(on)}$	$V_{GS} = 10V, I_D = 1.5A$	--	1.3	1.5	Ω
Gate Resistance	R_G	$f = 1.0\text{MHz}$ open drain	--	5.5	--	Ω
Dynamic Characteristics						
Input Capacitance	C_{iss}	$V_{GS} = 0V,$ $V_{DS} = 100V,$ $f = 1.0\text{MHz}$	--	225	--	pF
Output Capacitance	C_{oss}		--	10	--	
Reverse Transfer Capacitance	C_{rss}		--	0.4	--	
Total Gate Charge	Q_g	$V_{DD} = 560V, I_D = 3A,$ $V_{GS} = 10V$	--	7	--	nC
Gate-Source Charge	Q_{gs}		--	1.3	--	
Gate-Drain Charge	Q_{gd}		--	3.5	--	
Turn-on Delay Time	$t_{d(on)}$	$V_{DD} = 400V, I_D = 3A,$ $R_G = 25\Omega$	--	8.5	--	ns
Turn-on Rise Time	t_r		--	7.7	--	
Turn-off Delay Time	$t_{d(off)}$		--	19.0	--	
Turn-off Fall Time	t_f		--	16.5	--	
Drain-Source Body Diode Characteristics						
Body Diode Forward Voltage	V_{SD}	$T_J = 25^{\circ}\text{C}, I_{SD} = 1.5A, V_{GS} = 0V$	--	0.9	1.2	V
Reverse Recovery Time	t_{rr}	$V_R = 400V, I_F = 3A,$ $di_F/dt = 100A/\mu\text{s}$	--	155	--	ns
Reverse Recovery Charge	Q_{rr}		--	0.85	--	μC
Peak Reverse Recovery Current	I_{rrm}		--	11	--	A

Notes

1. Repetitive Rating: Pulse width limited by maximum junction temperature
2. $I_{AS} = 0.6A, V_{DD} = 50V, R_G = 25\Omega,$ 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

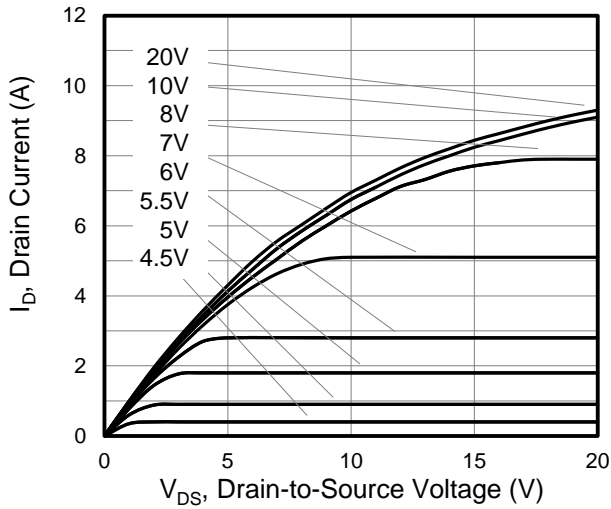


Figure 2. Transfer Characteristics

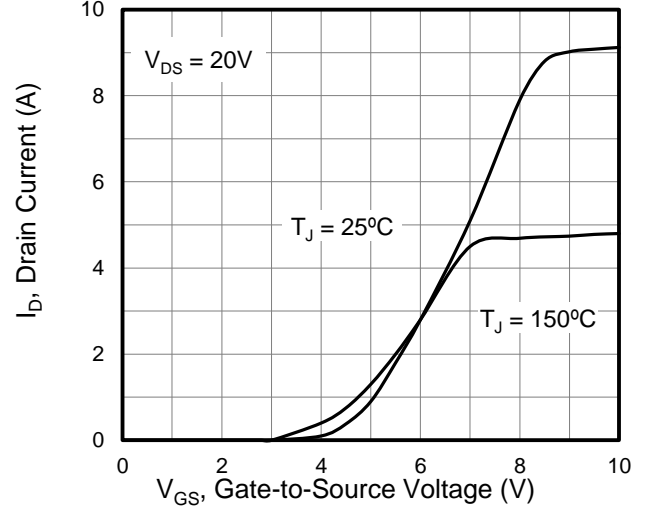


Figure 3. On-Resistance vs. Drain Current

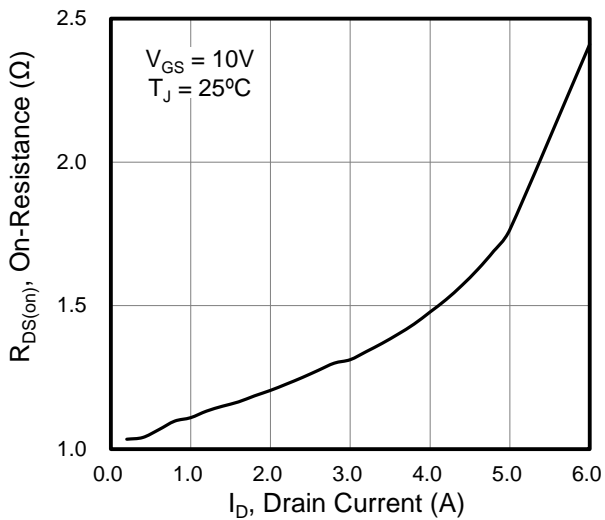


Figure 4. Capacitance

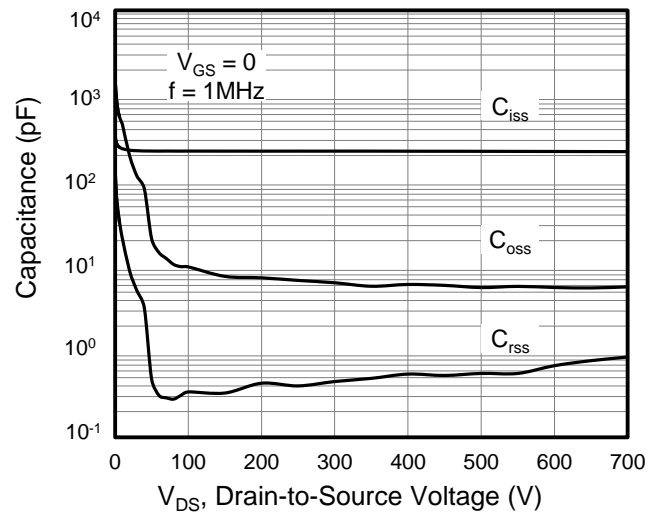


Figure 5. Gate Charge

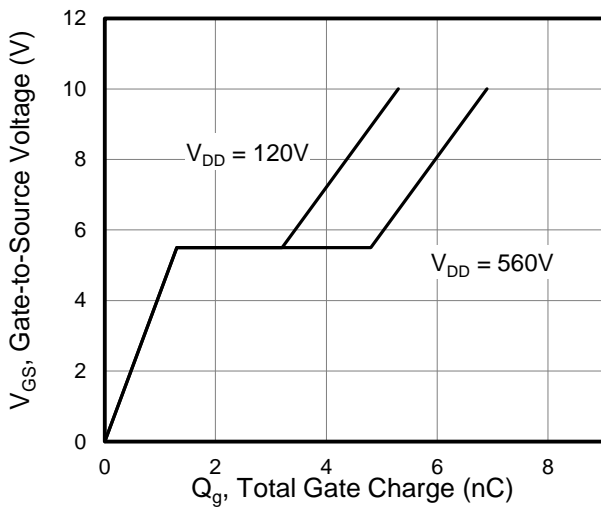
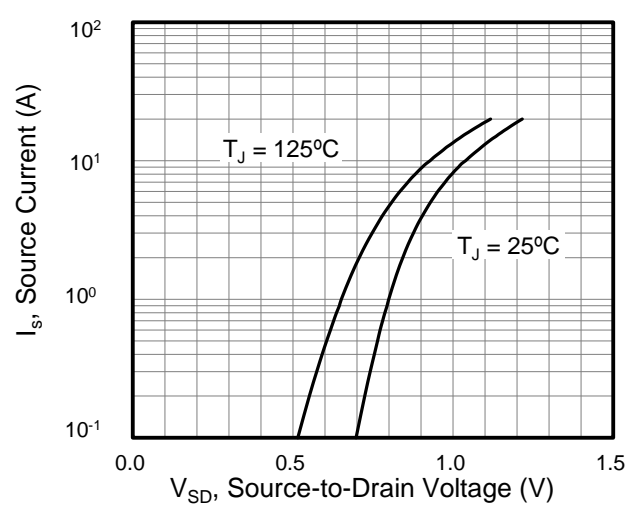


Figure 6. Body Diode Forward Voltage





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

Figure 7. On-Resistance vs. Temperature

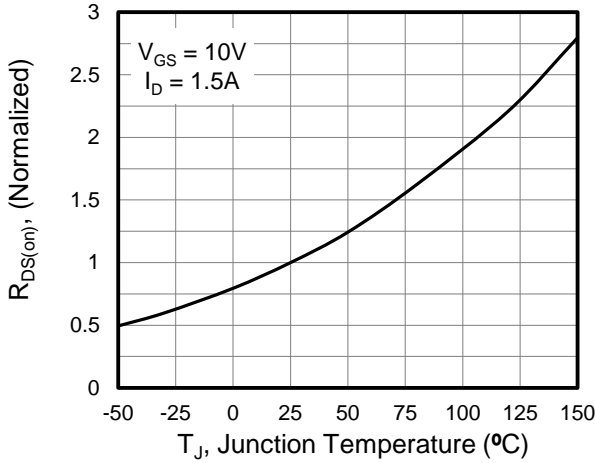


Figure 8. Breakdown voltage vs. Junction Temperature

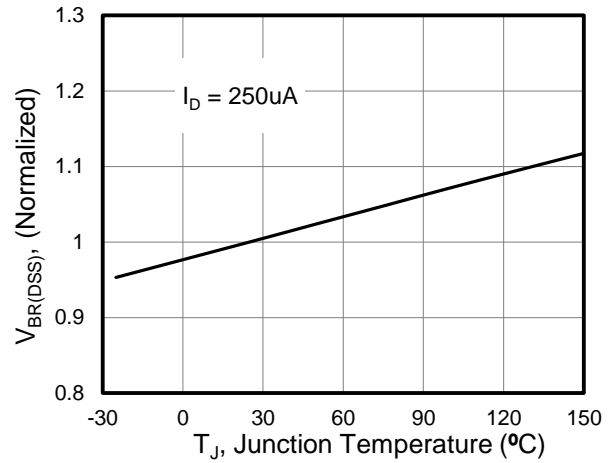


Figure 9. Transient Thermal Impedance For TO-220F

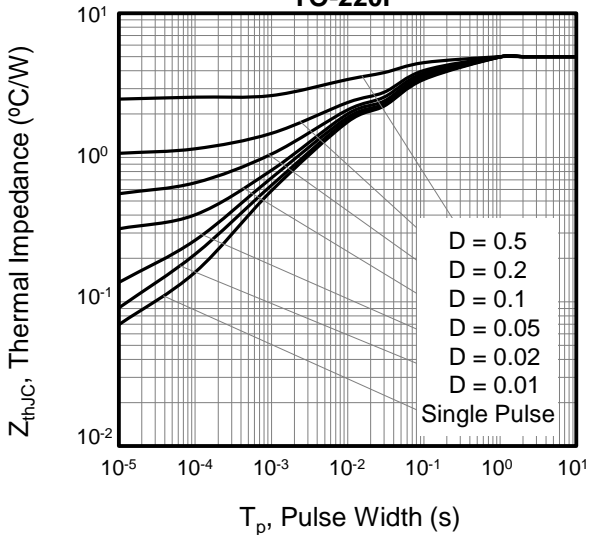


Figure 10. Safe Operation Area For TO-220F

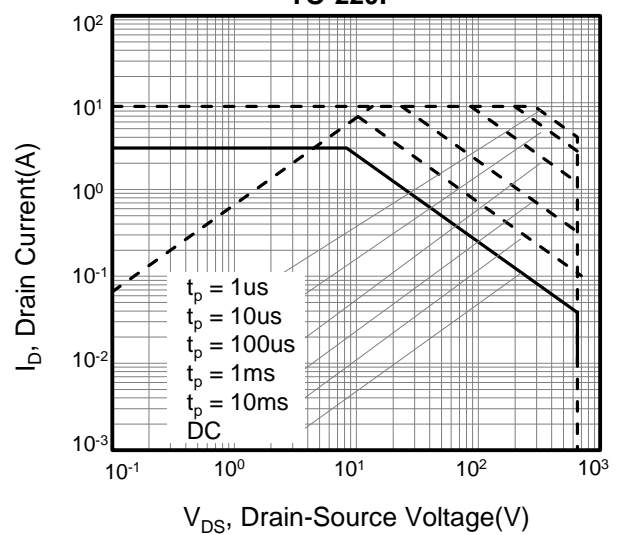


Figure 11. Transient Thermal Impedance For TO-252/TO-251

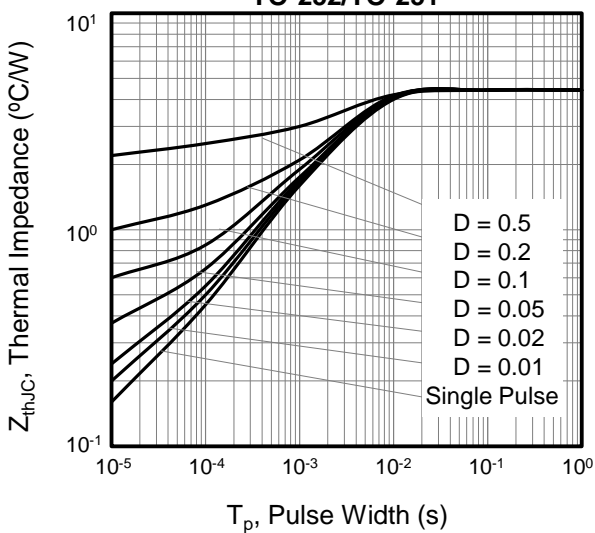
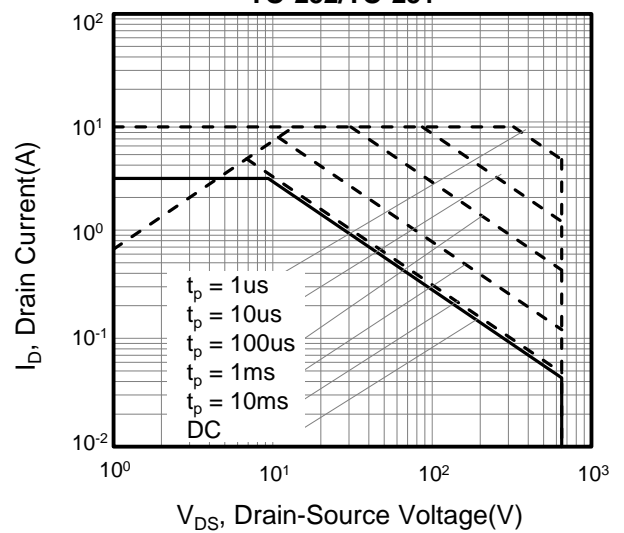


Figure 12. Safe Operation Area For TO-252/TO-251





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

Figure 13. Transient Thermal Impedance For SOT-223-2L

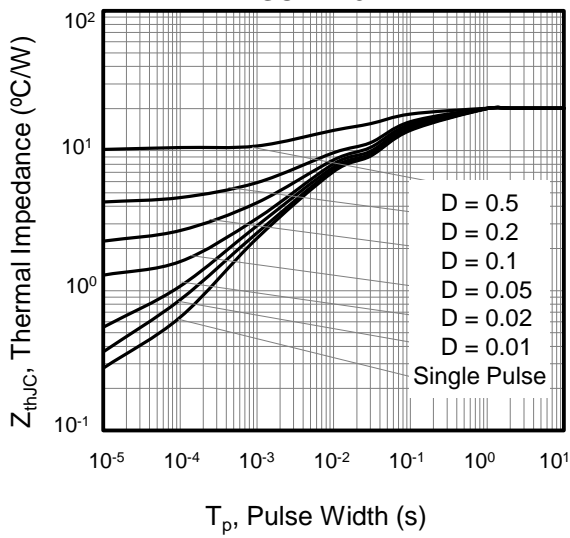


Figure 14. Safe Operation Area For SOT-223-2L

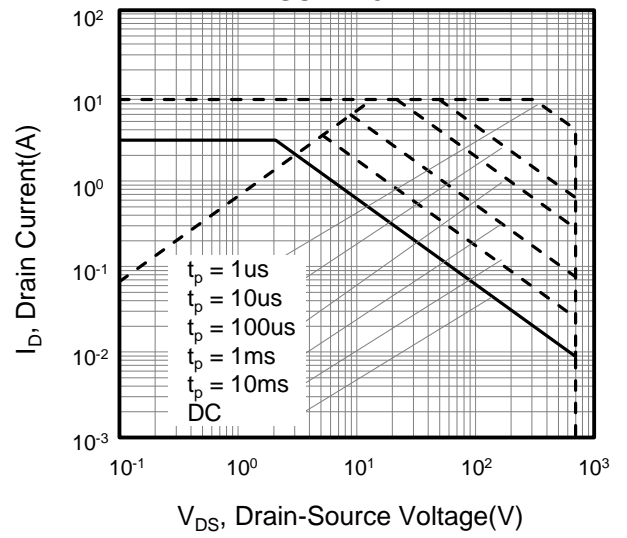


Figure 15. Typ. Coss Stored Energy

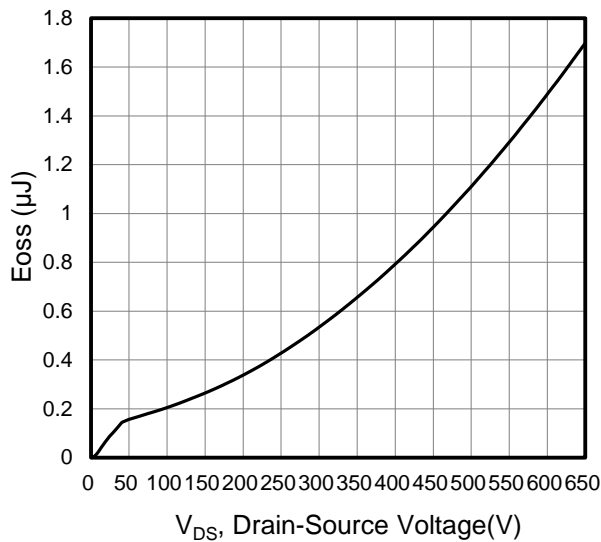




Figure A: Gate Charge Test Circuit and Waveform

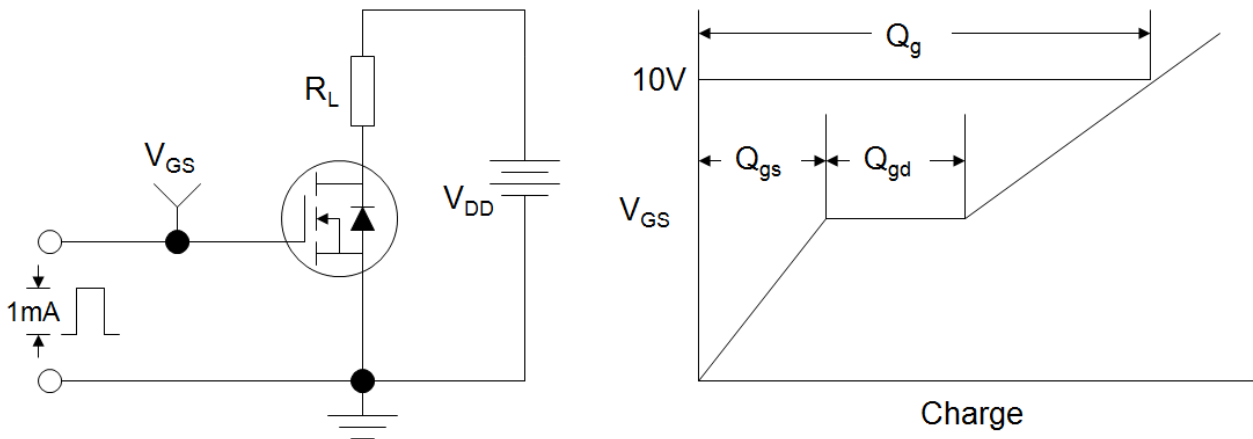


Figure B: Resistive Switching Test Circuit and Waveform

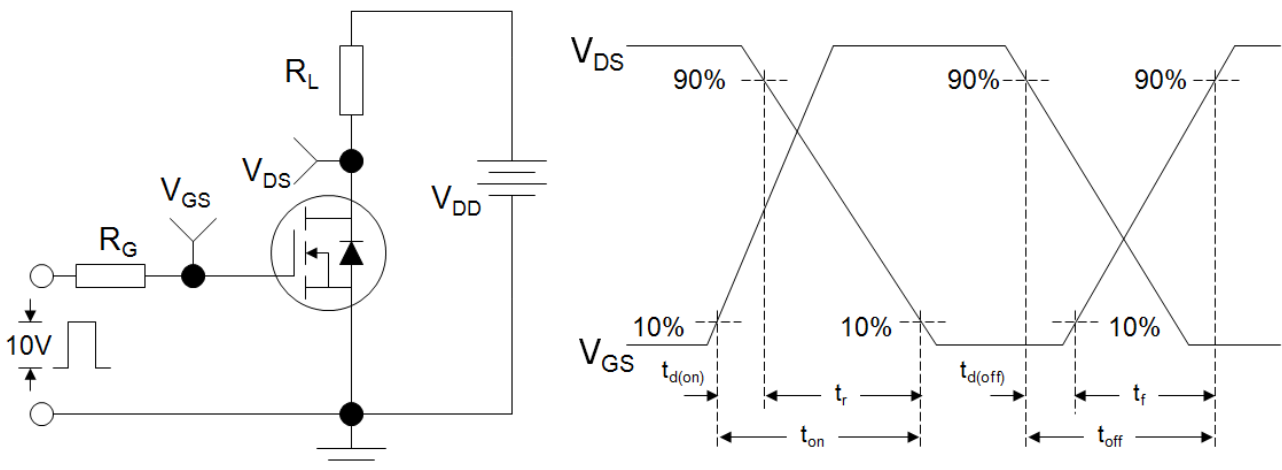
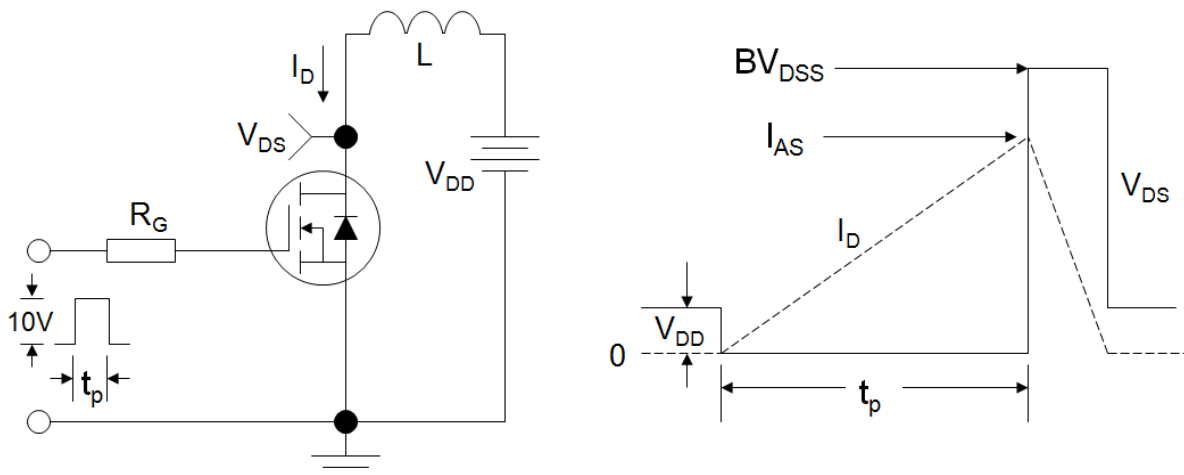
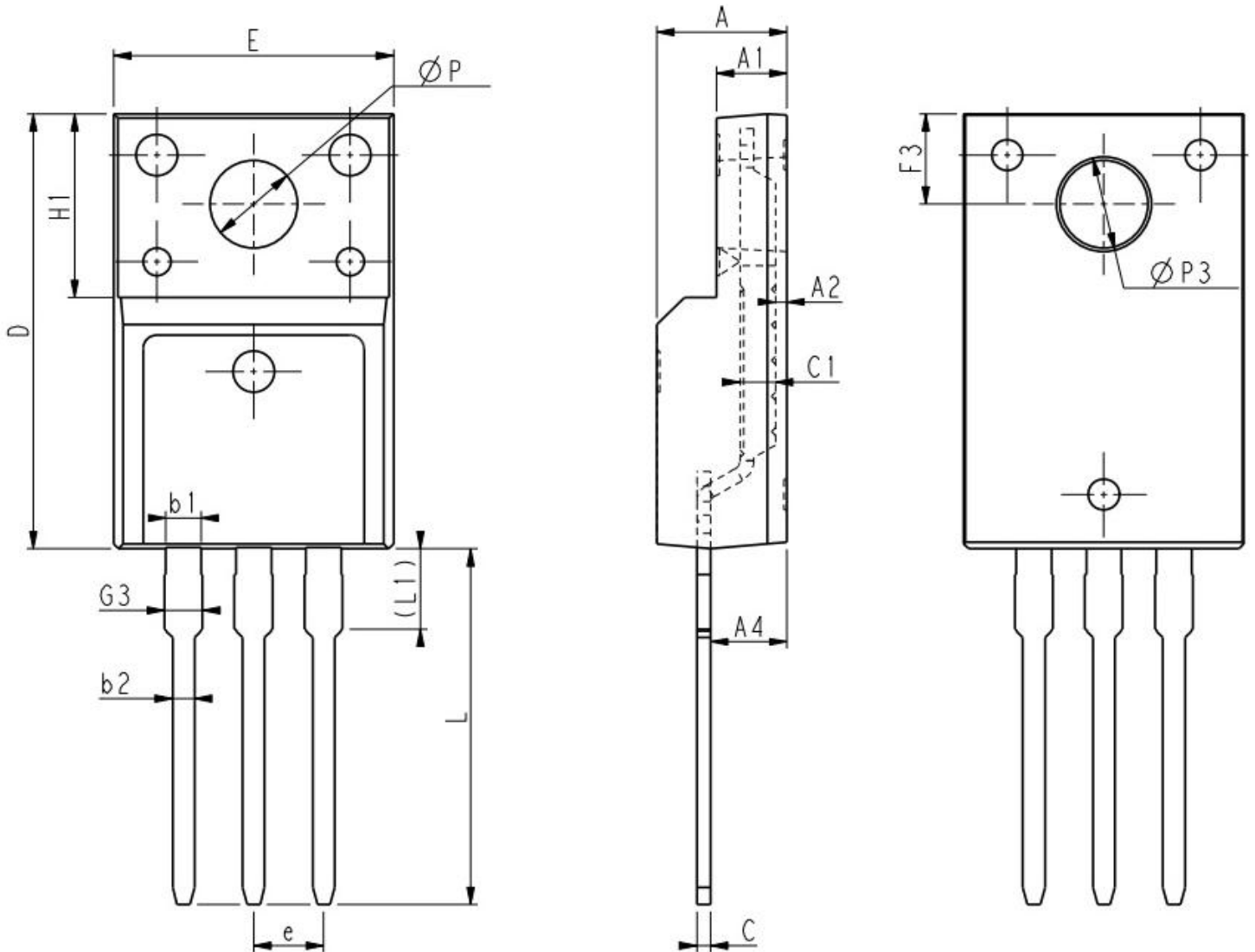


Figure C: Unclamped Inductive Switching Test Circuit and Waveform





TO-220F

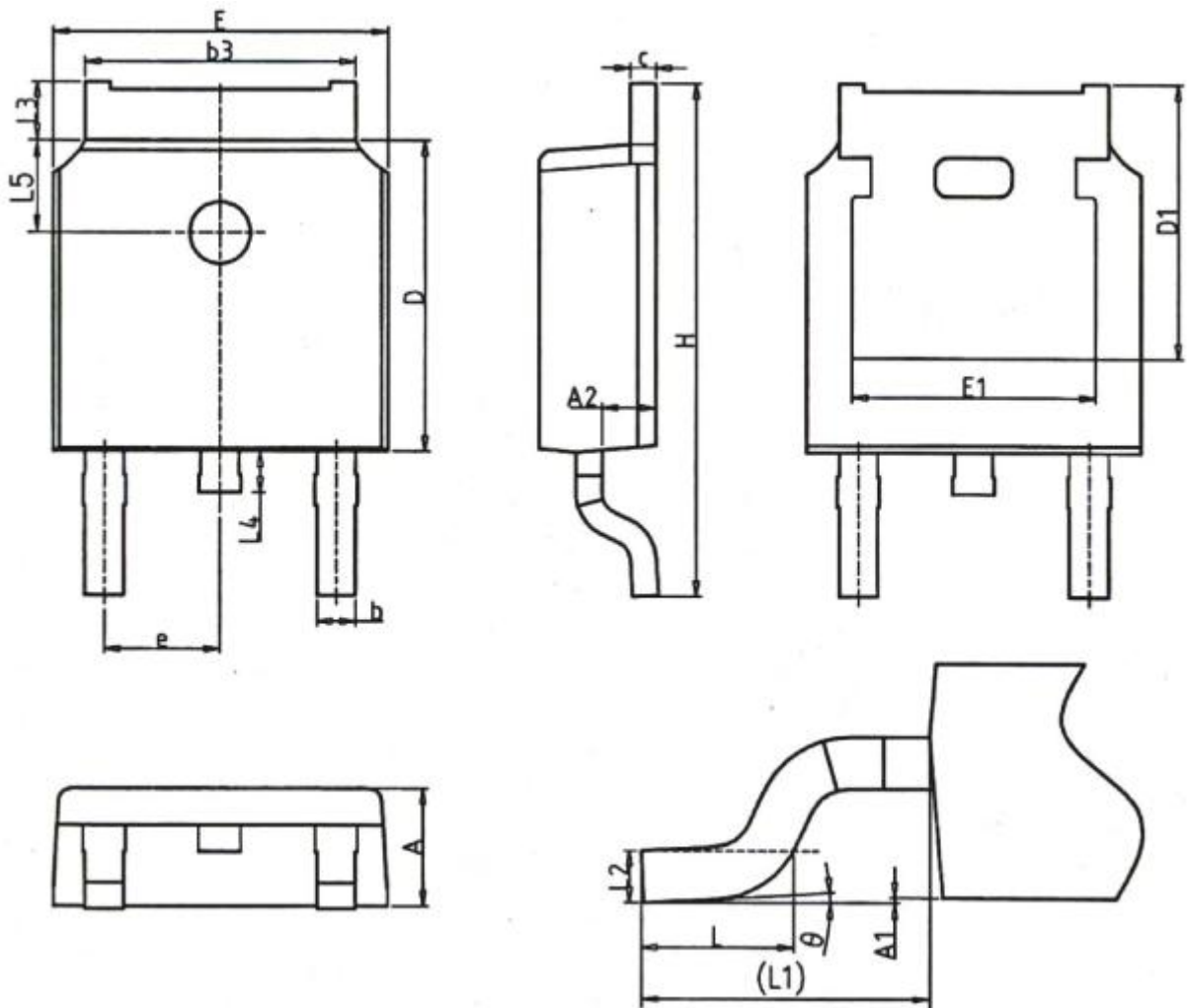


Unit:mm			
Symbol	Min.	Nom	Max.
E	9.96	10.16	10.36
A	4.50	4.70	4.90
A1	2.34	2.54	2.74
A2	0.30	0.45	0.60
A4	2.56	2.76	2.96
c	0.40	0.50	0.65
c1	1.20	1.30	1.35
D	15.57	15.87	16.17
H1	6.70REF		

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-252

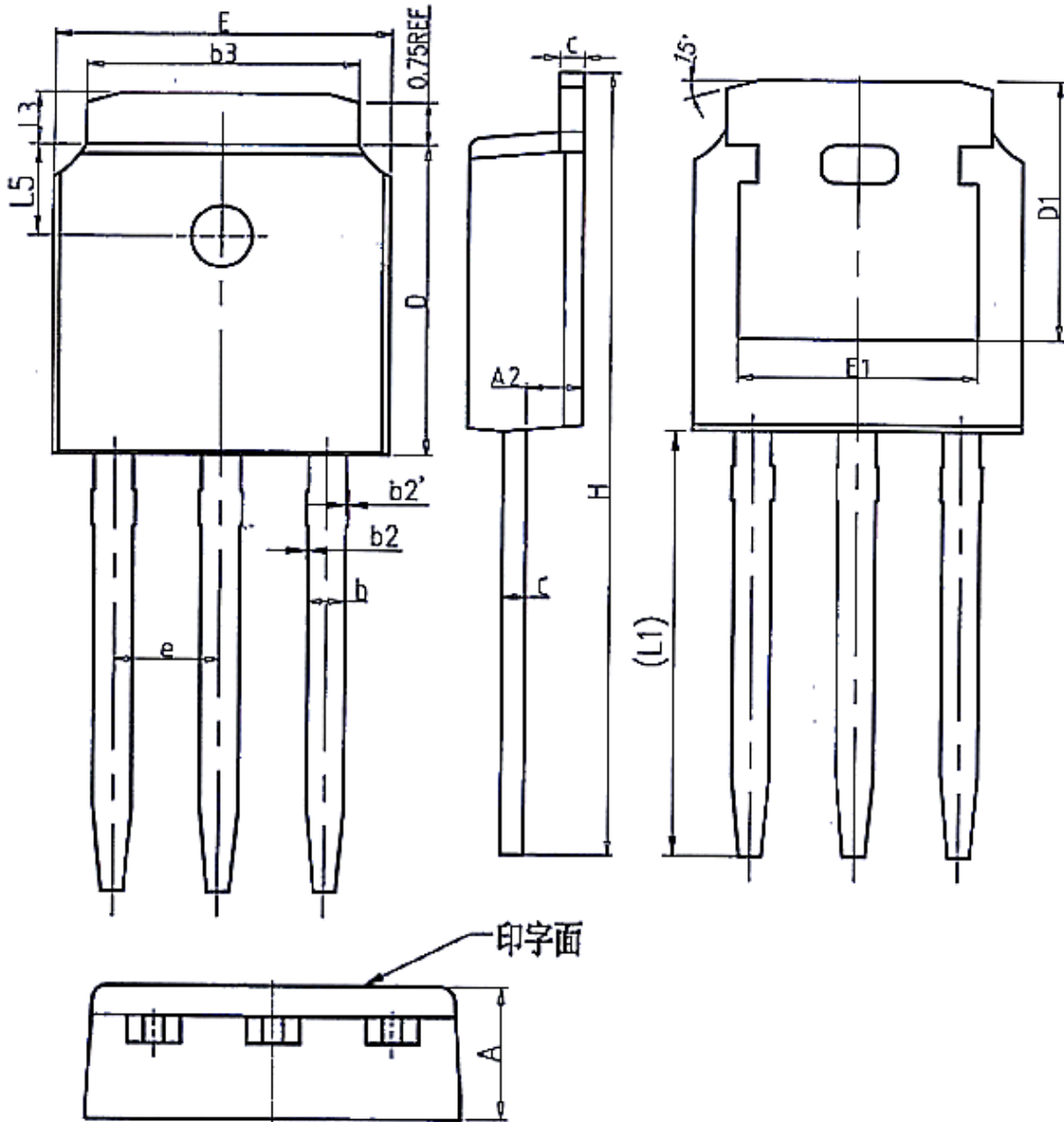


Unit:mm			
Symbol	Min.	Nom	Max.
A	2.20	2.30	2.40
A1	0.00	-	0.20
A2	0.97	1.07	1.17
b	0.68	0.78	0.90
b3	5.20	5.33	5.50
c	0.43	0.53	0.63
D	5.98	6.10	6.22
D1	5.30 REF		
E	6.40	6.60	6.80
E1	4.63	-	-

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-251

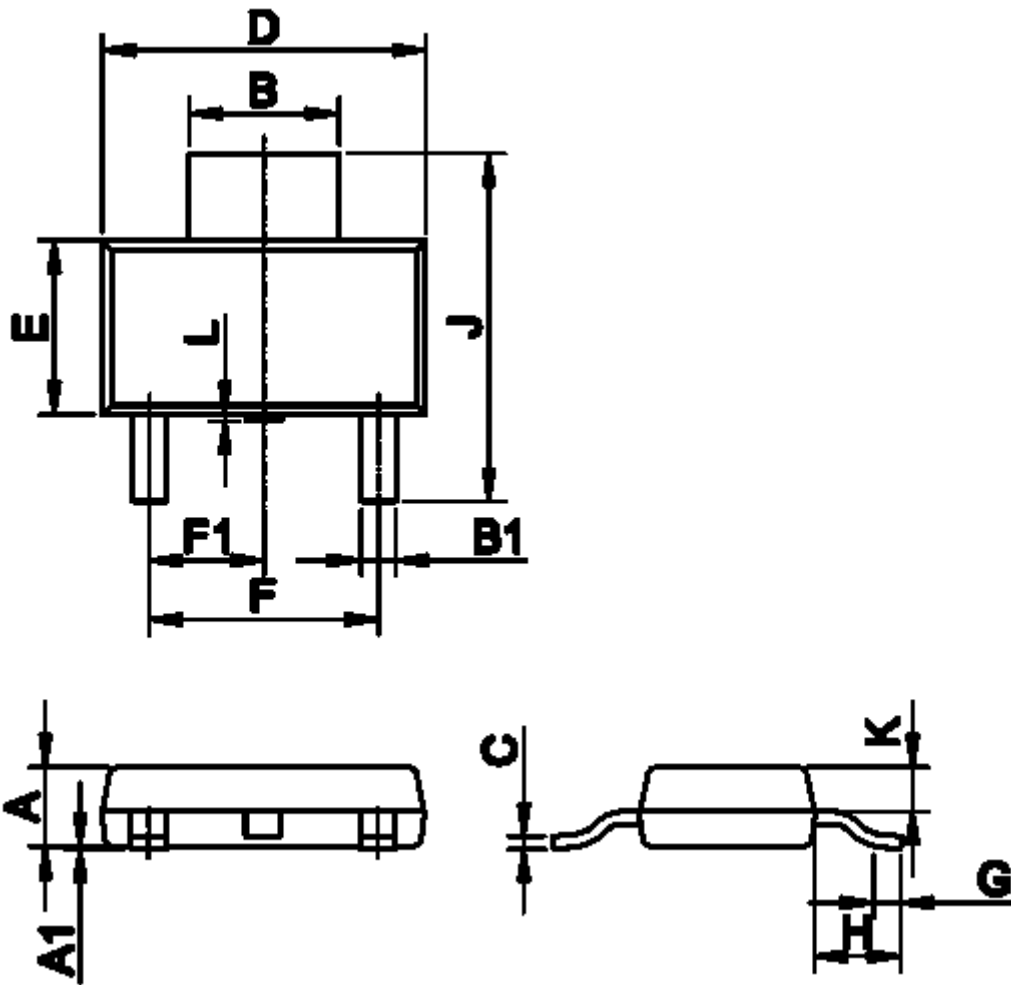


Unit:mm			
Symbol	Min.	Nom	Max.
A	2.20	2.30	2.40
A2	0.97	1.07	1.17
b	0.68	0.78	0.90
b2	0.00	0.04	0.10
b2'	0.00	0.04	0.10
b3	5.20	5.33	5.50
c	0.43	0.53	0.63
D	5.98	6.10	6.22

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



SOT-223-2L



Unit:mm			
Symbol	Min.	Typ.	Max.
A	1.50	1.60	1.80
A1	0.01	0.06	0.10
B	2.90	3.00	3.10
B1	0.60	0.07	0.80
C	0.22	0.254	0.32
D	6.30	6.50	6.70
E	3.30	3.50	3.70

Unit:mm			
Symbol	Min.	Typ.	Max.
F		4.60	
F1		2.30	
G	0.70	0.90	1.10
H	1.50	1.75	2.00
J	6.70	7.00	7.30
K		0.90	
L	0	0.10	0.20



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