



# 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 and pioneered. The Multi-EPI SJ MOSFET provide an extremely fast and robust body diode. Also 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

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

## Applications

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

TO-220F



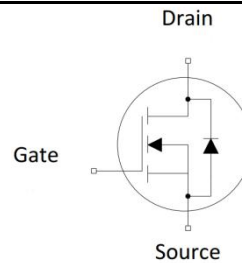
TO-263



TO-220



TO-247



## Device Marking and Package Information

Device	Package	Marking
TPA65R190MFD	TO-220F	65R190MFD
TPB65R190MFD	TO-263	65R190MFD
TPP65R190MFD	TO-220	65R190MFD
TPW65R190MFD	TO-247	65R190MFD

## Key Performance Parameters

Parameter	Value	Unit
$V_{DS} @ T_{j,max}$	700	V
$R_{DS(on),max}$	0.19	$\Omega$
$Q_{g,typ}$	42	nC
$I_D$	20	A
$I_{D,pulse}$	60	A
$E_{OSS} @ 400V$	4.98	$\mu J$
Body Diode $di_f/dt$	500	A/ $\mu s$
$t_{rr}$	112	ns
$Q_{rr}$	0.54	$\mu C$
$I_{rrm}$	9.6	A



<b>Absolute Maximum Ratings</b> $T_C = 25^\circ\text{C}$ , unless otherwise noted				
Parameter		Symbol	Value	Unit
Continuous Drain Current	$T_C = 25^\circ\text{C}$	$I_D$	20	A
	$T_C = 100^\circ\text{C}$		12	
Pulsed Drain Current	(note1)	$I_{D,pulse}$	60	A
Gate-Source Voltage		$V_{GSS}$	$\pm 30$	V
Single Pulse Avalanche Energy	(note2)	$E_{AS}$	484	mJ
Repetitive Avalanche Energy	(note2)	$E_{AR}$	0.7	mJ
Avalanche Current		$I_{AR}$	3.5	A
MOSFET dv/dt Ruggedness, $V_{DS} = 0 \dots 480\text{V}$		dv/dt	50	V/ns
Power Dissipation For TO-220F		$P_D$	34	W
Power Dissipation For TO-263, TO-220, TO-247			151	
Continuous Diode Forward Current		$I_S$	20	A
Diode Pulsed Current	(note1)	$I_{S,pulse}$	60	
Reverse Diode dv/dt	(note3)	dv/dt	50	V/ns
Maximum Diode Commutation Speed	(note3)	$di_f/dt$	900	A/ $\mu\text{s}$
Operating Junction and Storage Temperature Range		$T_J, T_{stg}$	-55~+150	$^\circ\text{C}$

<b>Thermal Resistance For TO-220F</b>			
Parameter	Symbol	Value	Unit
Thermal Resistance, Junction-to-Case	$R_{thJC}$	3.7	$^\circ\text{C/W}$
Thermal Resistance, Junction-to-Ambient	$R_{thJA}$	80	

<b>Thermal Resistance For TO-263, TO-220, TO-247</b>			
Parameter	Symbol	Value	Unit
Thermal Resistance, Junction-to-Case	$R_{thJC}$	0.83	$^\circ\text{C/W}$
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.	
<b>Static Characteristics</b>						
Drain-Source Breakdown Voltage	$V_{(BR)DSS}$	$V_{GS} = 0V, I_D = 250\mu A$	650	--	--	V
Zero Gate Voltage Drain Current	$I_{DSS}$	$V_{DS} = 650V, V_{GS} = 0V, T_J = 25^\circ\text{C}$	--	--	5	$\mu A$
		$V_{DS} = 650V, V_{GS} = 0V, T_J = 150^\circ\text{C}$	--	--	2500	
Gate-Source Leakage Current	$I_{GSS}$	$V_{GS} = \pm 30V$	--	--	$\pm 100$	nA
Gate-Source Threshold Voltage	$V_{GS(th)}$	$V_{DS} = V_{GS}, I_D = 250\mu A$	3	--	5	V
Drain-Source On-State-Resistance	$R_{DS(on)}$	$V_{GS} = 10V, I_D = 10A$	--	0.17	0.19	$\Omega$
Gate Resistance	$R_G$	$f = 1.0\text{MHz}$ open drain	--	12	--	$\Omega$
<b>Dynamic Characteristics</b>						
Input Capacitance	$C_{iss}$	$V_{GS} = 0V,$ $V_{DS} = 100V,$ $f = 1.0\text{MHz}$	--	1834	--	$\mu F$
Output Capacitance	$C_{oss}$		--	57	--	
Reverse Transfer Capacitance	$C_{rss}$		--	1.7	--	
Total Gate Charge	$Q_g$	$V_{DD} = 520V, I_D = 20A,$ $V_{GS} = 10V$	--	42	--	nC
Gate-Source Charge	$Q_{gs}$		--	10	--	
Gate-Drain Charge	$Q_{gd}$		--	17	--	
Turn-on Delay Time	$t_{d(on)}$	$V_{DD} = 400V, I_D = 20A,$ $R_G = 25\Omega$	--	34	--	ns
Turn-on Rise Time	$t_r$		--	72	--	
Turn-off Delay Time	$t_{d(off)}$		--	114	--	
Turn-off Fall Time	$t_f$		--	41	--	
<b>Drain-Source Body Diode Characteristics</b>						
Body Diode Forward Voltage	$V_{SD}$	$T_J = 25^\circ\text{C}, I_{SD} = 10A, V_{GS} = 0V$	--	1.0	1.5	V
Reverse Recovery Time	$t_{rr}$	$V_R = 400V, I_F = I_S,$ $di_F/dt = 100A/\mu s$	--	112	--	ns
Reverse Recovery Charge	$Q_{rr}$		--	0.54	--	$\mu C$
Peak Reverse Recovery Current	$I_{rrm}$		--	9.6	--	A

**Notes**

1. Repetitive Rating: Pulse width limited by maximum junction temperature
2.  $I_{AS} = 3.5A, V_{DD} = 50V, R_G = 25\Omega,$  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

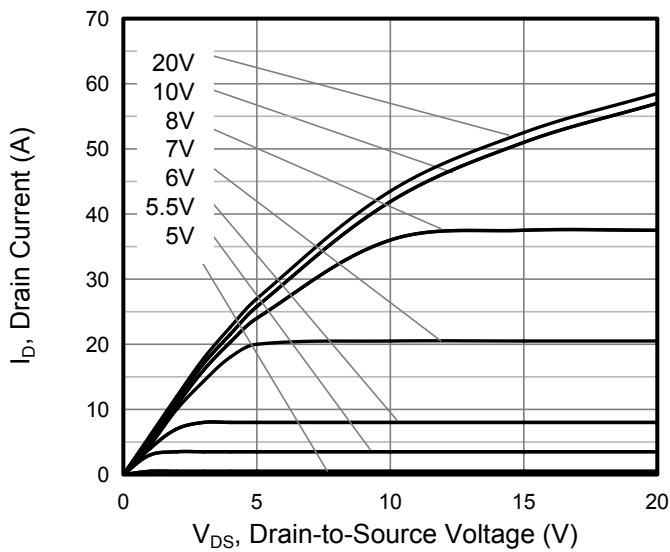


Figure 2. Transfer Characteristics

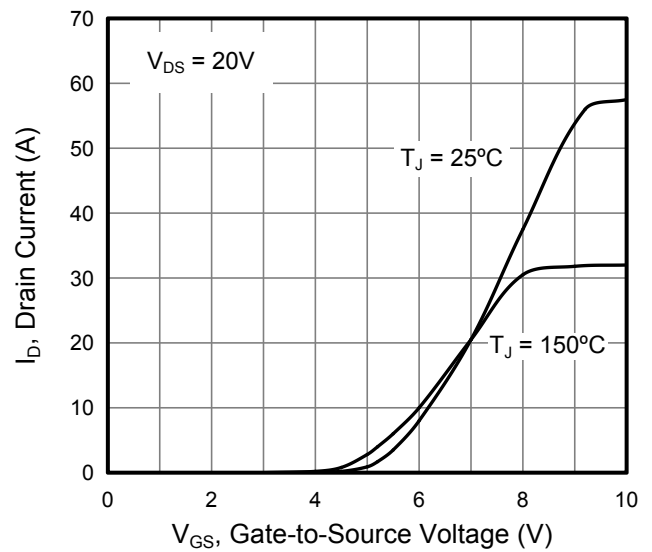


Figure 3. On-Resistance vs. Drain Current

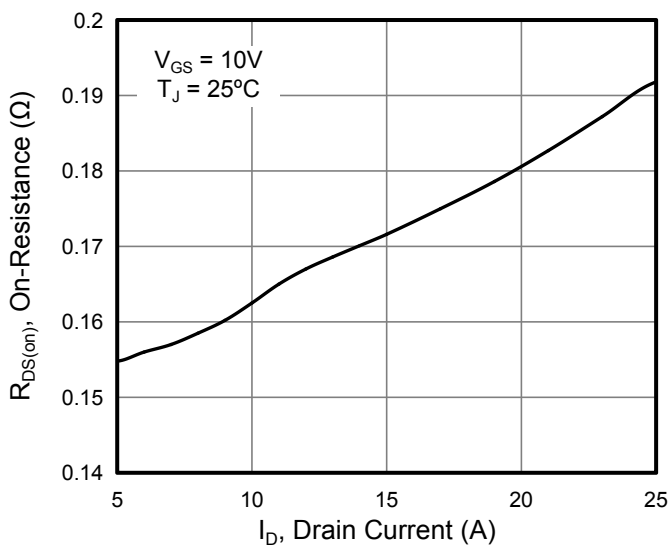


Figure 4. Capacitance

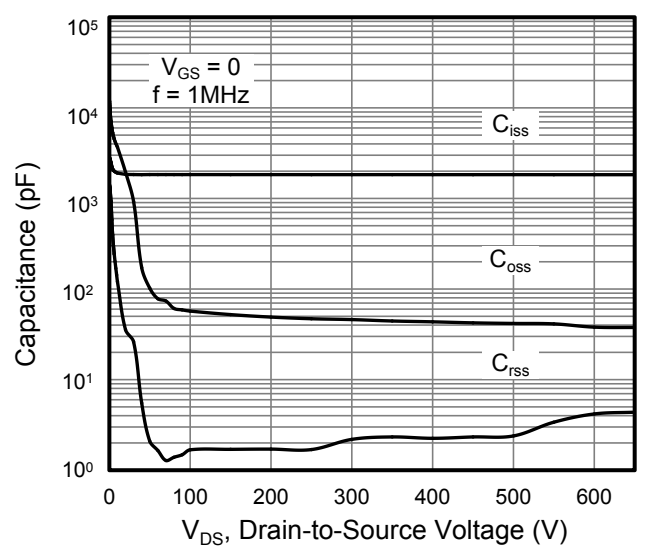


Figure 5. Gate Charge

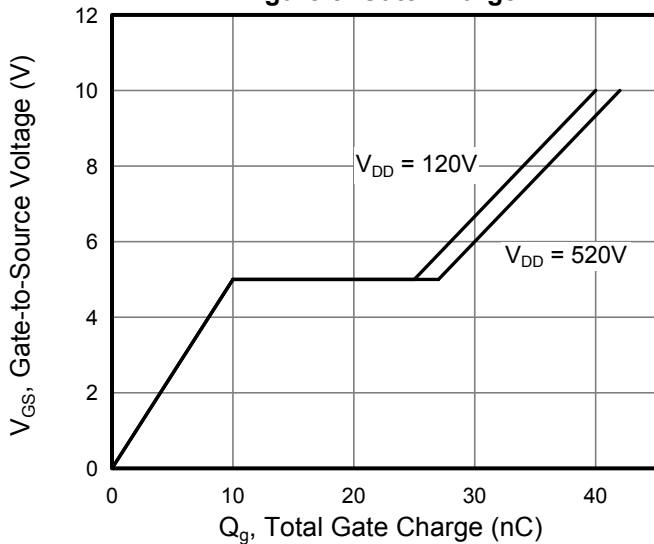
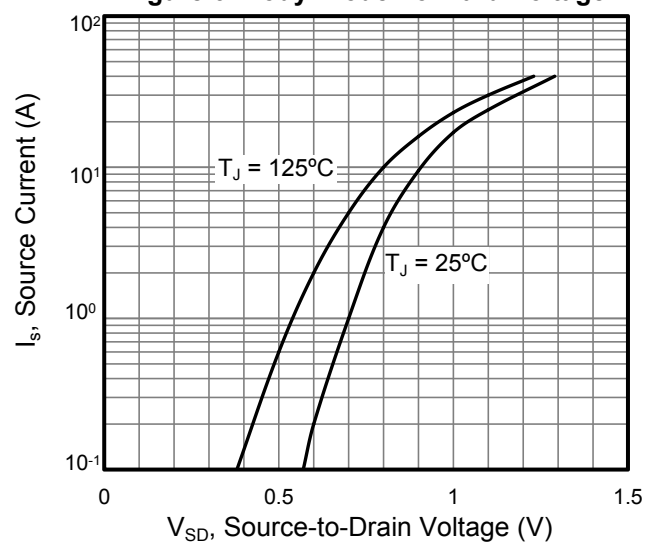


Figure 6. Body Diode Forward Voltage





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

Figure 7. On-Resistance vs. Temperature

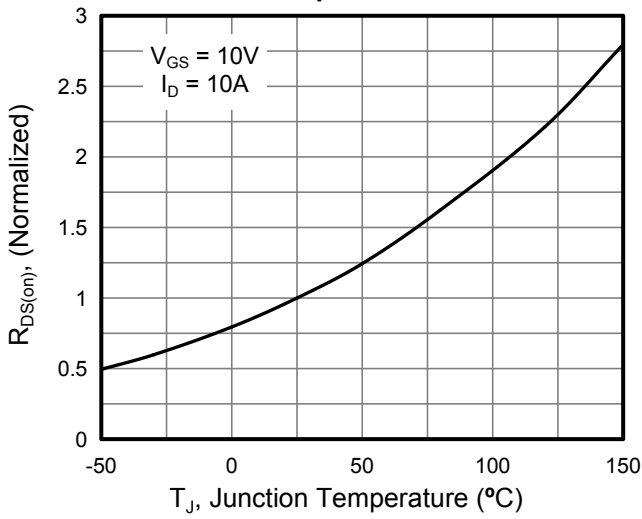


Figure 8. Breakdown voltage vs. Junction Temperature

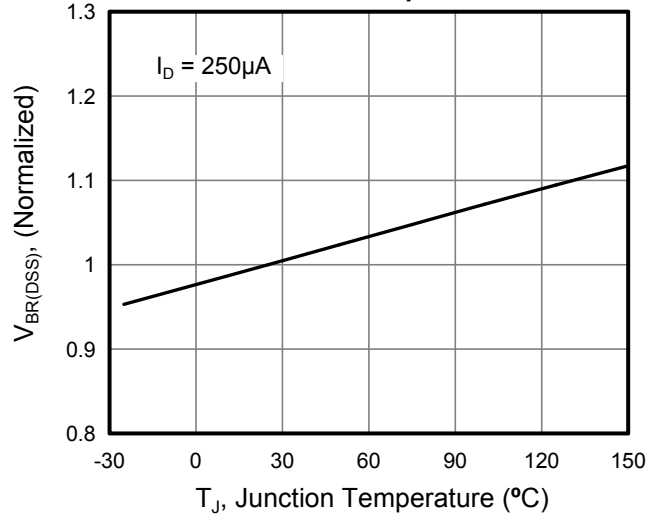


Figure9 . Transient Thermal Impedance For TO-220F

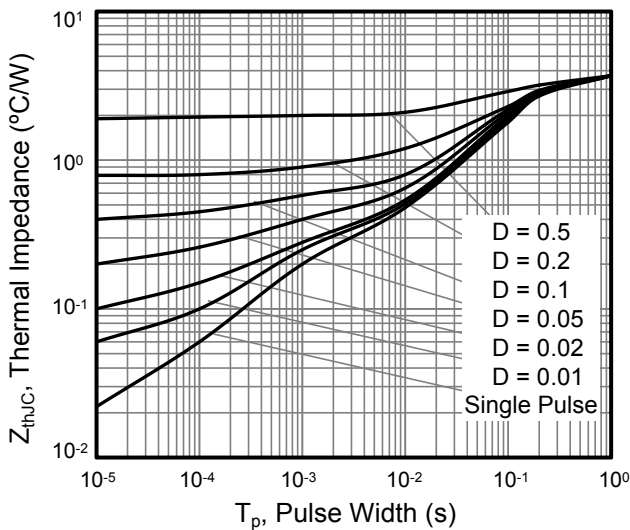


Figure10 . Transient Thermal Impedance For TO-263/TO-220/TO-247

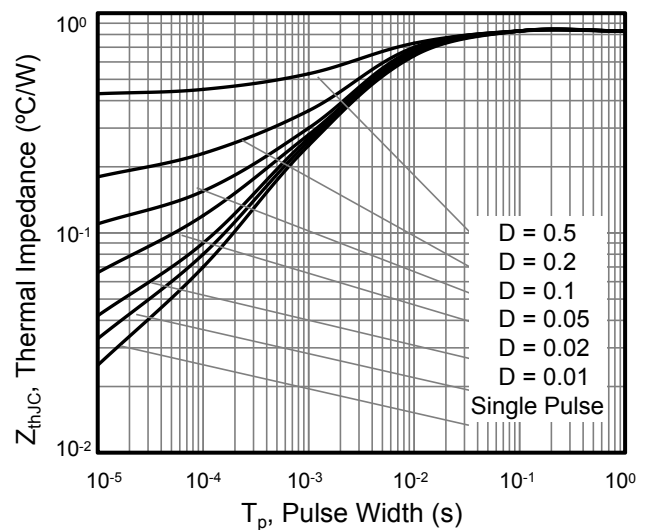


Figure 11. Safe Operation Area For TO-220F

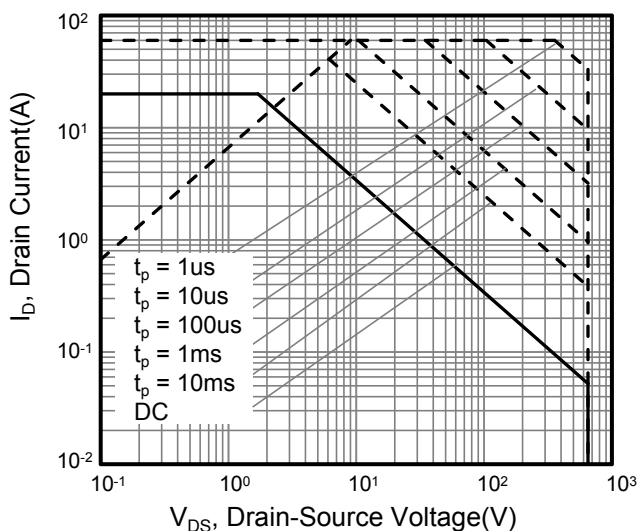
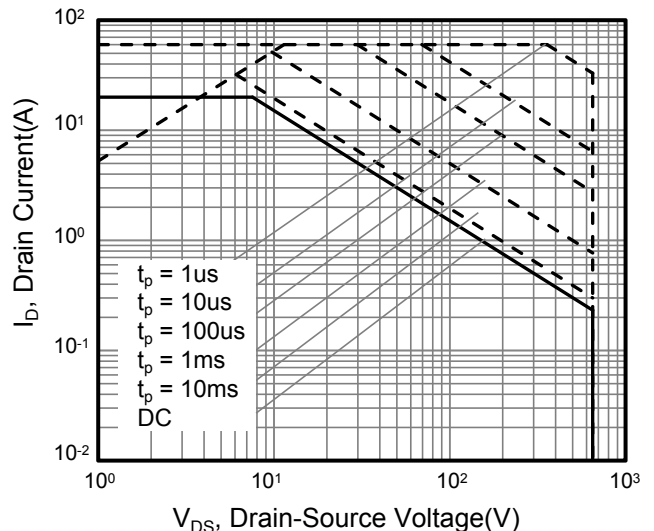


Figure 12. Safe Operation Area For TO-247/TO-263





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

Figure 13. Typ. Coss Stored Energy

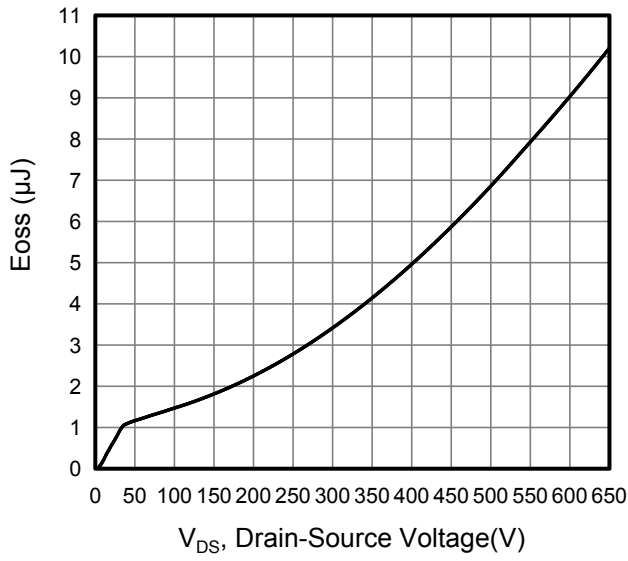




Figure A: Gate Charge Test Circuit and Waveform

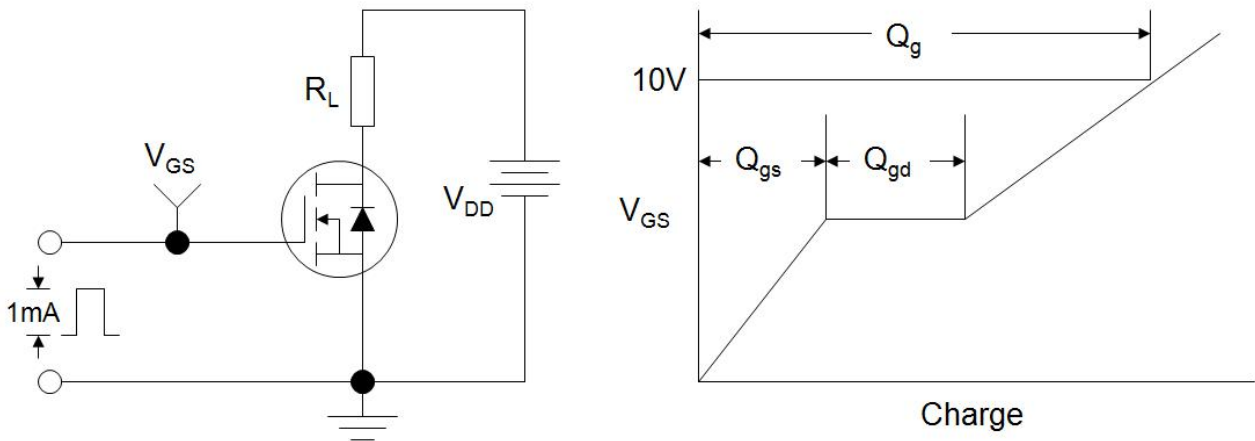


Figure B: Resistive Switching Test Circuit and Waveform

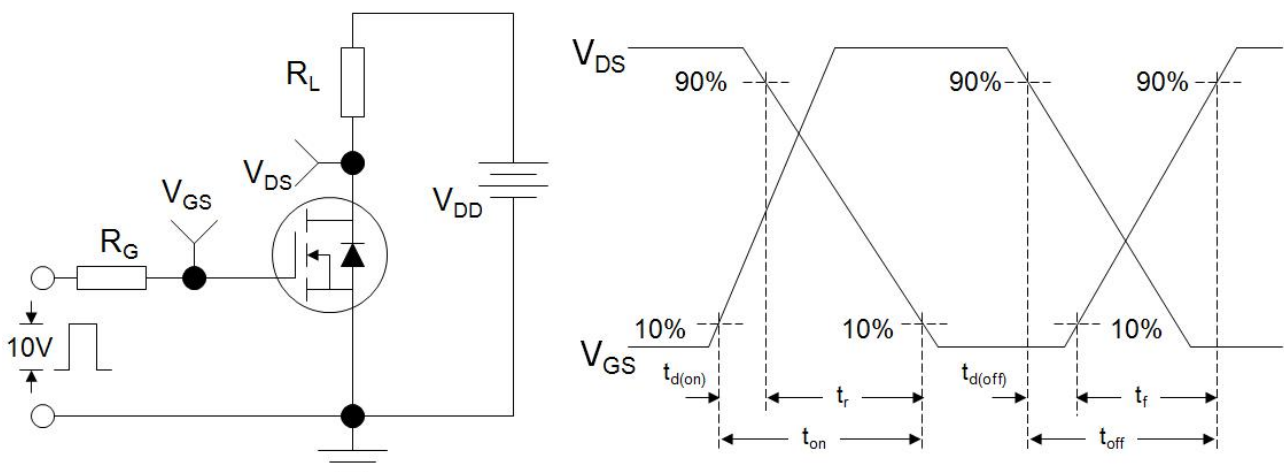
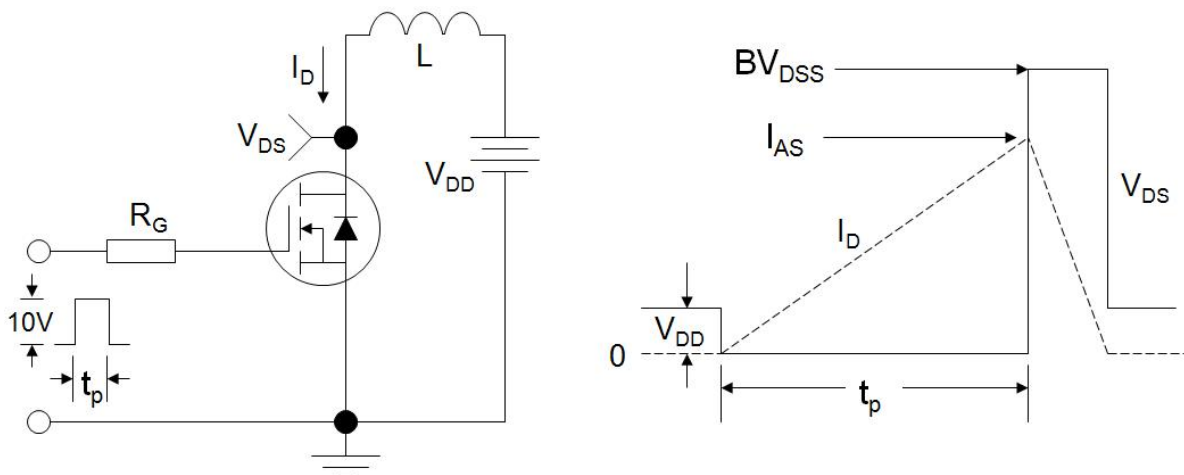
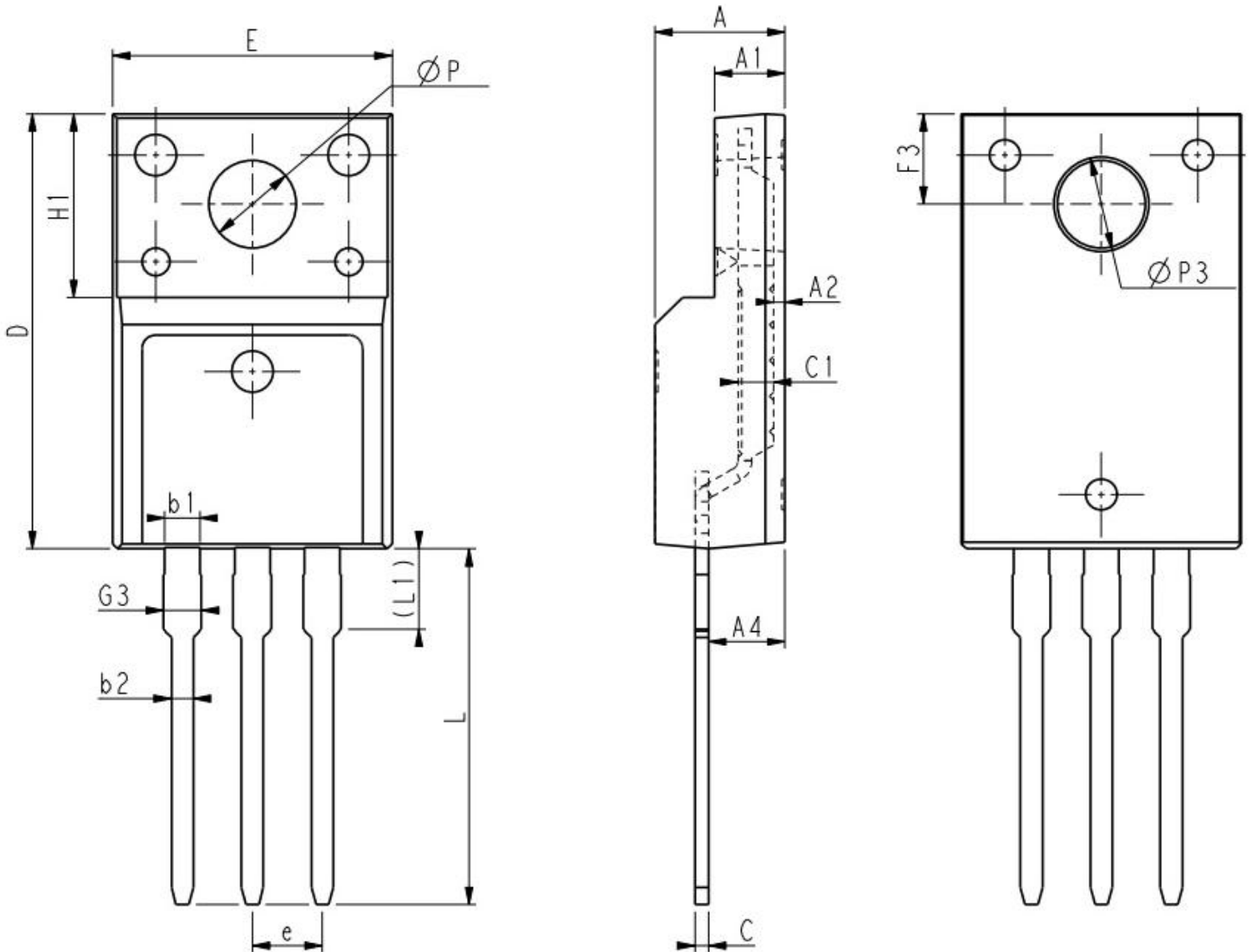


Figure C: Unclamped Inductive Switching Test Circuit and Waveform





### TO-220F



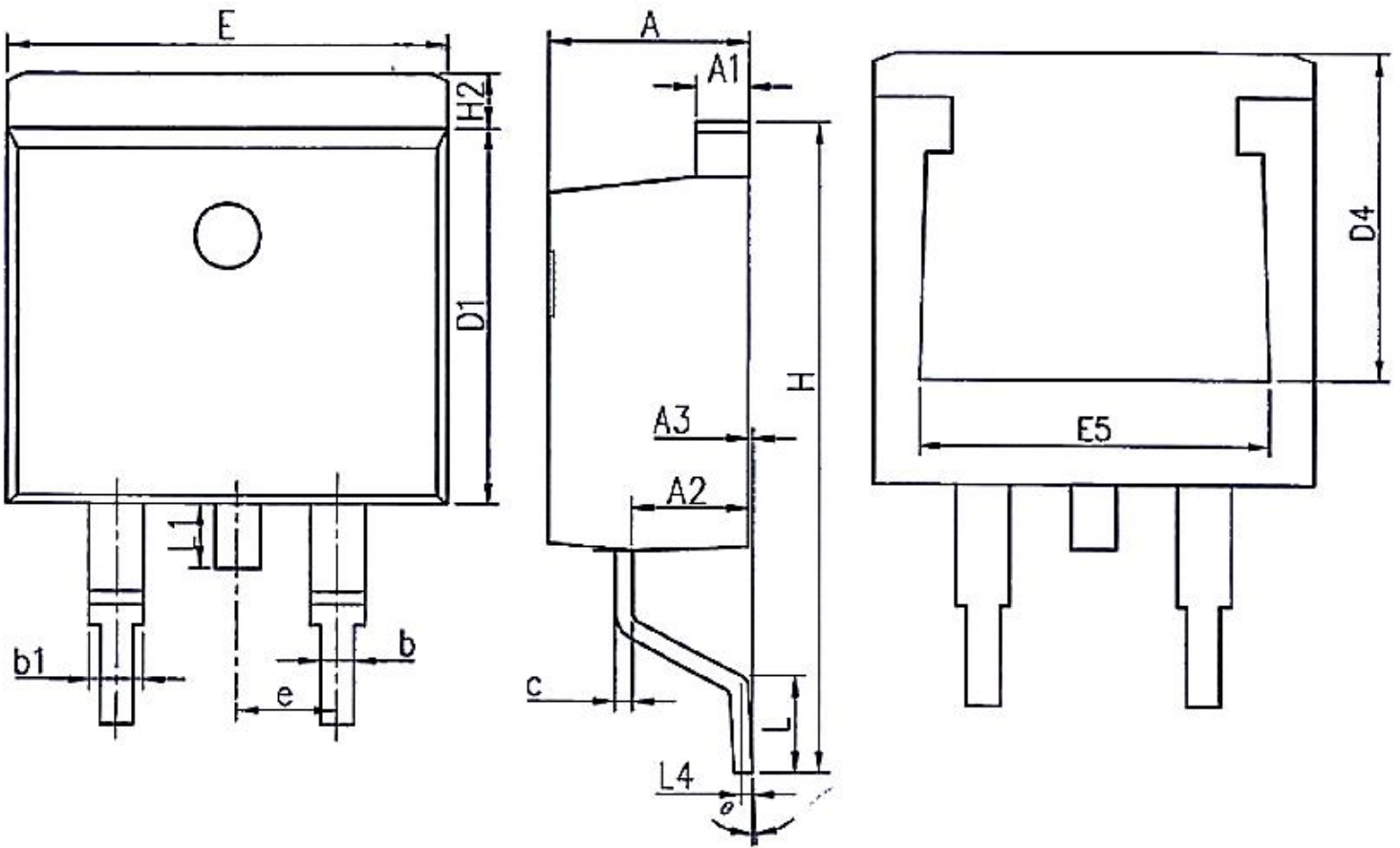
Unit:mm			
Symbol	Min.	Nom	Max.
E	9.96	10.16	10.36
A	4.50	4.70	4.90
A1	2.34	2.54	2.74
A2	0.30	0.45	0.60
A4	2.56	2.76	2.96
c	0.40	0.50	0.65
c1	1.20	1.30	1.35
D	15.57	15.87	16.17
H1	6.70REF		

Unit:mm			
Symbol	Min.	Nom	Max.
e	2.54BSC		
L	12.68	12.98	13.28
L1	2.93	3.03	3.13
$\Phi P$	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

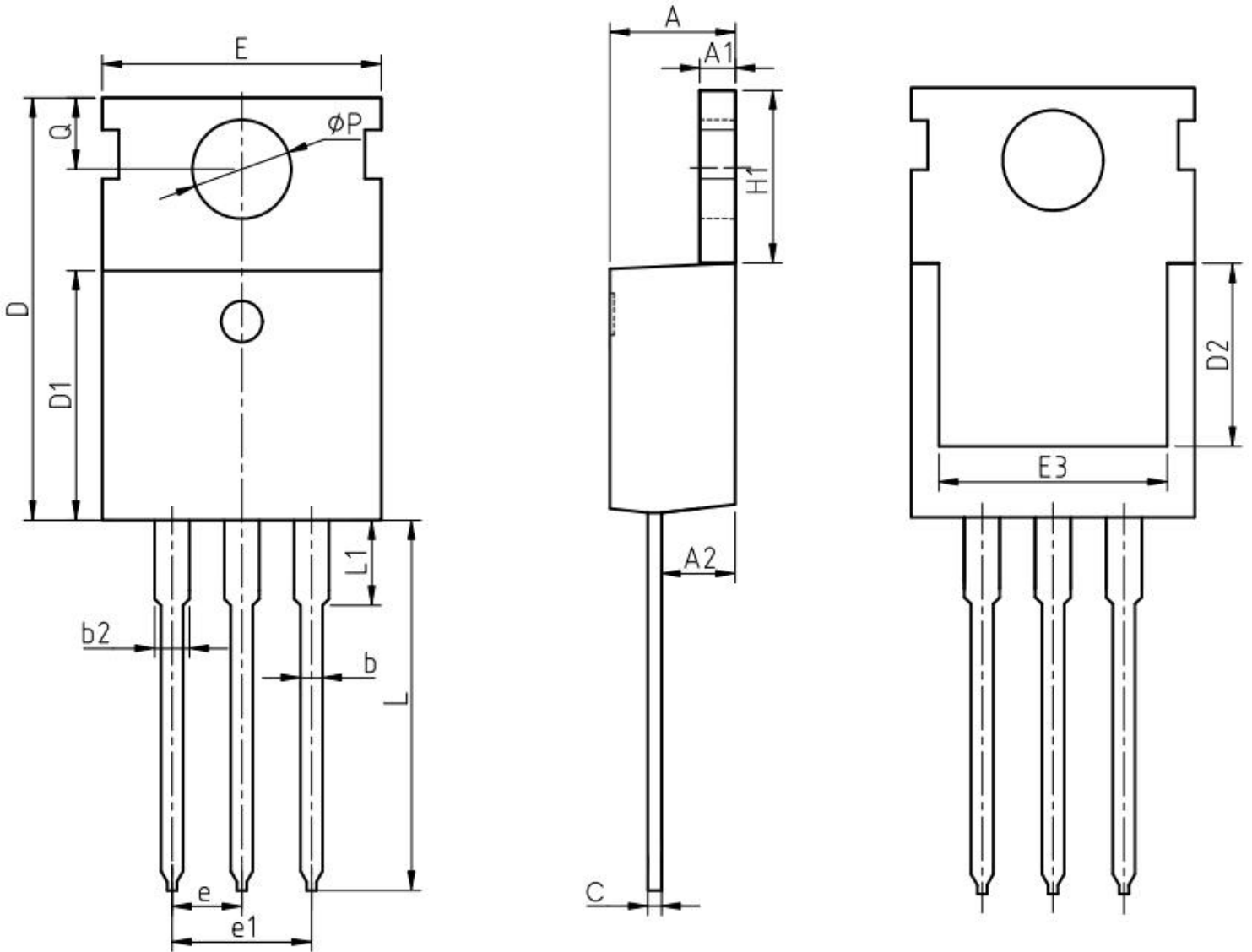


Unit:mm			
Symbol	Min.	Nom	Max.
A	4.37	4.57	4.77
A1	1.22	1.27	1.42
A2	2.49	2.69	2.89
A3	0.00	0.13	0.25
b	0.70	0.81	0.96
b1	1.17	1.27	1.47
c	0.30	0.38	0.53
D1	8.50	8.70	8.90
D4	6.60	-	-

Unit:mm			
Symbol	Min.	Nom	Max.
E	9.86	10.16	10.36
E5	7.06	-	-
e	2.54BSC		
H	14.70	15.10	15.50
H2	1.07	1.27	1.47
L	2.00	2.30	2.60
L1	1.40	1.55	1.70
L4	0.25BSC		
$\theta$	0°	5°	9°



### TO-220

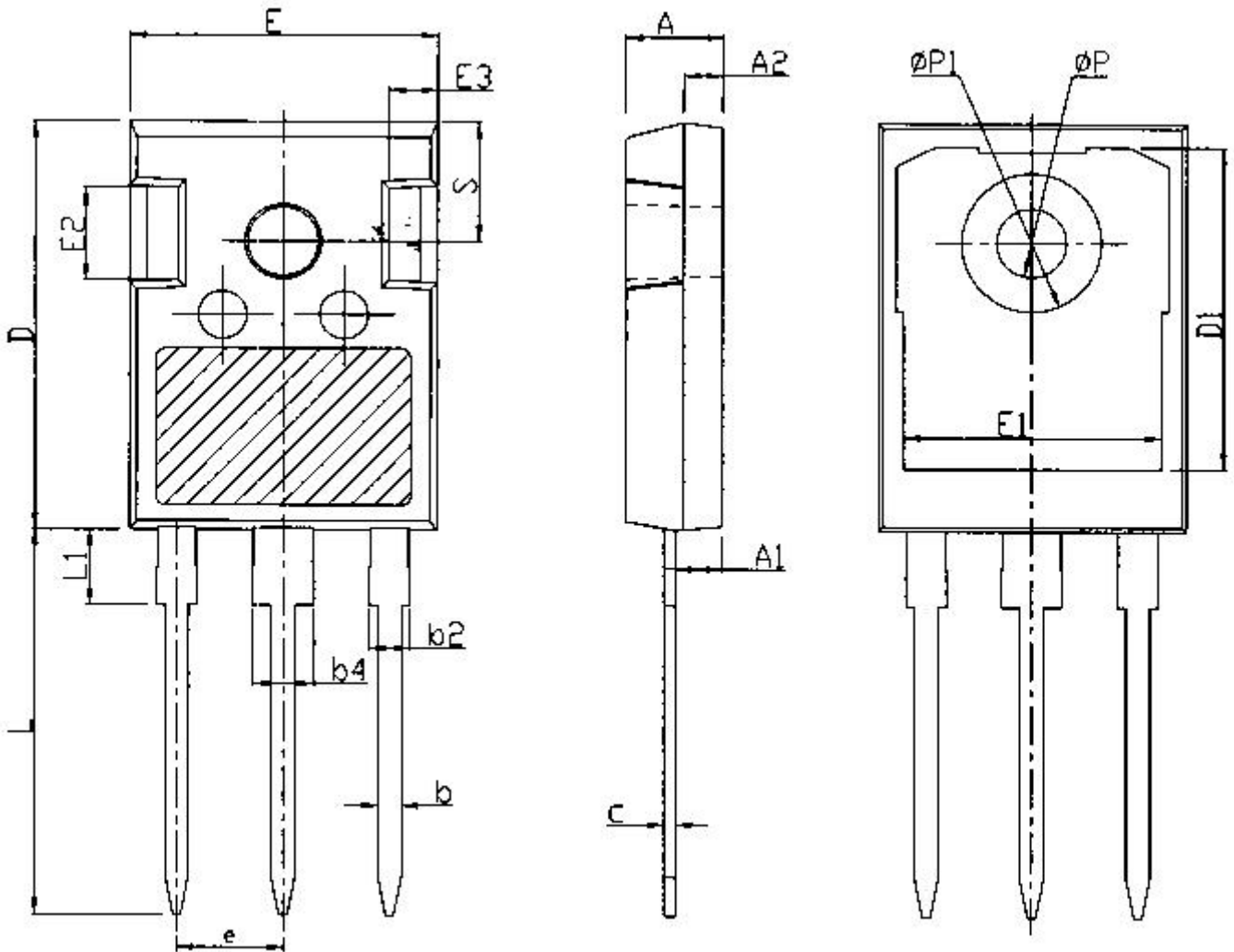


Unit:mm			
Symbol	Min.	Nom	Max.
A	4.37	4.57	4.77
A1	1.25	1.30	1.40
A2	2.20	2.40	2.60
b	0.70	0.80	0.95
b2	1.17	1.27	1.47
c	0.45	0.50	0.60
D	15.10	15.60	16.10
D1	8.80	9.10	9.40
D2	5.50	-	-

Unit:mm			
Symbol	Min.	Nom	Max.
E	9.70	10.00	10.30
E3	7.00	-	-
e	2.54 BSC		
e1	5.08 BSC		
H1	6.25	6.50	6.85
L	12.75	13.50	13.80
L1	-	3.10	3.40
phi P	3.40	3.60	3.80
Q	2.60	2.80	3.00



### TO-247



Unit:mm			
Symbol	Min.	Nom	Max.
A	4.80	5.00	5.20
A1	2.21	2.41	2.61
A2	1.85	2.00	2.15
b	1.11	1.21	1.36
b2	1.91	2.01	2.21
b4	2.91	3.01	3.21
c	0.51	0.61	0.75
D	20.70	21.00	21.30
D1	16.25	16.55	16.85

Unit:mm			
Symbol	Min.	Nom.	Max.
E	15.50	15.80	16.10
E1	13.00	13.30	13.60
E2	4.80	5.00	5.20
E3	2.30	2.50	2.70
e	5.44BSC		
L	19.62	19.92	20.22
L1	-	-	4.30
$\Phi P$	3.40	3.60	3.80
$\Phi P1$	-	-	7.30
S	6.15BSC		



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