

# 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 deep trench SJ MOSFET provide an extremely low switching, commutation and conduction losses device with highest robustness make especially resonant switching applications more reliable, more efficient, lighter and cooler.

## Features

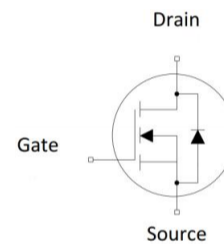
- Ultra-fast body diode
- Very low FOM  $R_{DS(on)} \times Q_g$
- Easy to use/drive
- 100% avalanche tested
- RoHS compliant



TO-247

## Applications

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



## Key Performance Parameters

Parameter	Value	Unit
$V_{DS} @ T_{j,max}$	650	V
$R_{DS(on),max}$	28	mΩ
$Q_{g,typ}$	149	nC
$I_D$	80	A
$I_{D,pulse}$	240	A
$E_{OSS} @ 400V$	20.76	μJ
$t_{rr}$	209.9	ns
$Q_{rr}$	1.55	μC
$I_{rm}$	14.3	A

<b>Absolute Maximum Ratings</b> $T_C = 25^\circ\text{C}$ , unless otherwise noted				
Parameter		Symbol	Values	Unit
Continuous Drain Current	$T_C = 25^\circ\text{C}$	$I_D$	80	A
	$T_C = 100^\circ\text{C}$		48	
Pulsed Drain Current	(note1)	$I_{D,pulse}$	240	A
Gate-Source Voltage		$V_{GSS}$	$\pm 30\text{V}$	V
Single Pulse Avalanche Energy	(note2)	$E_{AS}$	980	mJ
Repetitive Avalanche Energy	(note2)	$E_{AR}$	2.12	mJ
Avalanche Current		$I_{AS}$	14	A
MOSFET dv/dt Ruggedness, $V_{DS} = 0 \dots 650\text{V}$		dv/dt	50	V/ns
Power Dissipation For TO-247		$P_D$	450	W
Continuous Diode Forward Current		$I_S$	80	A
Diode Pulsed Current	(note1)	$I_{S,pulse}$	240	
Reverse Diode dv/dt	(note3)	dv/dt	50	V/ns
Operating Junction and Storage Temperature Range		$T_J, T_{stg}$	-55~+150	$^\circ\text{C}$

<b>Thermal Resistance For TO-247</b>			
Parameter	Symbol	Value	Unit
Thermal Resistance, Junction-to-Case	$R_{thJC}$	0.28	$^\circ\text{C/W}$
Thermal Resistance, Junction-to-Ambient	$R_{thJA}$	62	

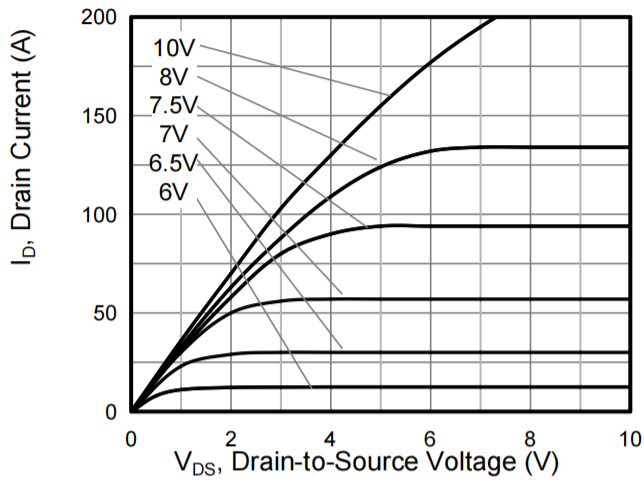
<b>Electrical Characteristics</b> $T_J = 25^\circ\text{C}$ , unless otherwise noted						
Parameter	Symbol	Test Conditions	Value			Unit
			Min.	Typ.	Max.	
<b>Static Characteristics</b>						
Drain-Source Breakdown Voltage	$V_{(BR)DSS}$	$V_{GS} = 0V, I_D = 250\mu A$	650	--	--	V
Zero Gate Voltage Drain Current	$I_{DSS}$	$V_{DS} = 600V, V_{GS} = 0V, T_J = 25^\circ\text{C}$	--	--	10	$\mu A$
		$V_{DS} = 600V, V_{GS} = 0V, T_J = 150^\circ\text{C}$	--	--	500	
Gate-Source Leakage Current	$I_{GSS}$	$V_{GS} = \pm 30V$	--	--	$\pm 100$	nA
Gate-Source Threshold Voltage	$V_{GS(th)}$	$V_{DS} = V_{GS}, I_D = 250\mu A$	2.5	--	4.5	V
Drain-Source On-State-Resistance	$R_{DS(on)}$	$V_{GS} = 10V, I_D = 40A$	--	26	28	m $\Omega$
Gate Resistance	$R_G$	$f = 1.0\text{MHz}$ open drain	--	890	--	m $\Omega$
<b>Dynamic Characteristics</b>						
Input Capacitance	$C_{iss}$	$V_{GS} = 0V,$ $V_{DS} = 50V,$ $f = 1.0\text{MHz}$	--	8911	--	pF
Output Capacitance	$C_{oss}$		--	390	--	
Reverse Transfer Capacitance	$C_{rss}$		--	1.38	--	
Total Gate Charge	$Q_g$	$V_{DD} = 400V, I_D = 40A,$ $V_{GS} = 10V$	--	149	--	nC
Gate-Source Charge	$Q_{gs}$		--	38.7	--	
Gate-Drain Charge	$Q_{gd}$		--	33.5	--	
Turn-on Delay Time	$t_{d(on)}$	$V_{DD} = 400V, I_D = 40A,$ $R_G = 2\Omega$	--	81	--	ns
Turn-on Rise Time	$t_r$		--	124.3	--	
Turn-off Delay Time	$t_{d(off)}$		--	213.1	--	
Turn-off Fall Time	$t_f$		--	158	--	
<b>Drain-Source Body Diode Characteristics</b>						
Body Diode Forward Voltage	$V_{SD}$	$T_J = 25^\circ\text{C}, I_{SD} = 40A, V_{GS} = 0V$	--	0.9	1.3	V
Reverse Recovery Time	$t_{rr}$	$V_R = 400V, I_S = 40A,$ $di_F/dt = 100A/\mu s$	--	209.9	--	ns
Reverse Recovery Charge	$Q_{rr}$		--	1.55	--	$\mu C$
Peak Reverse Recovery Current	$I_{rrm}$		--	14.3	--	A

**Notes**

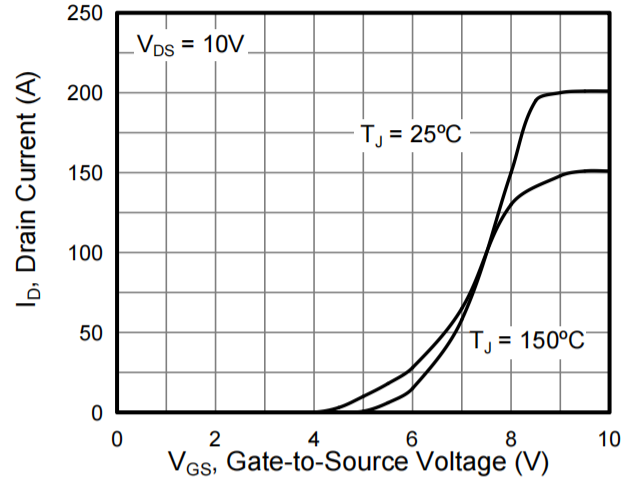
1. Repetitive Rating: Pulse width limited by maximum junction temperature
2.  $I_D = 40A, V_{DD} = 50V, R_G = 25\Omega$ , Starting  $T_J = 25^\circ\text{C}$
3. Identical low side and high side switch with identical  $R_G$

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

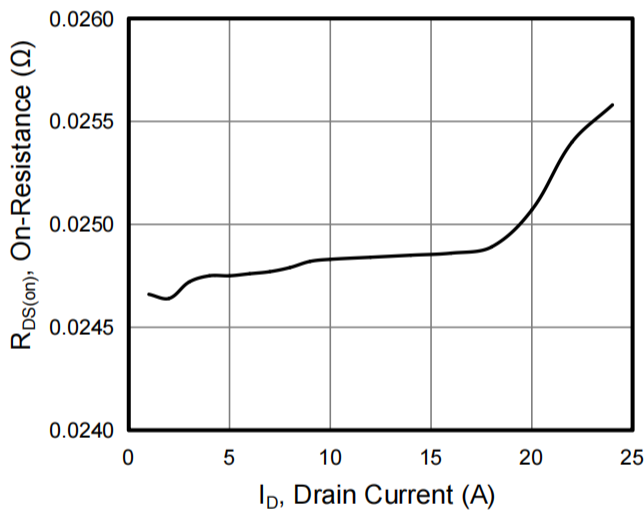
**Figure 1. Output Characteristics**



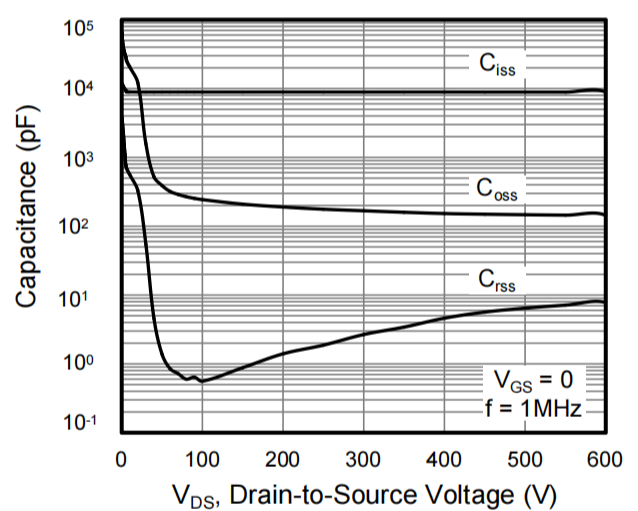
**Figure 2. Transfer Characteristics**



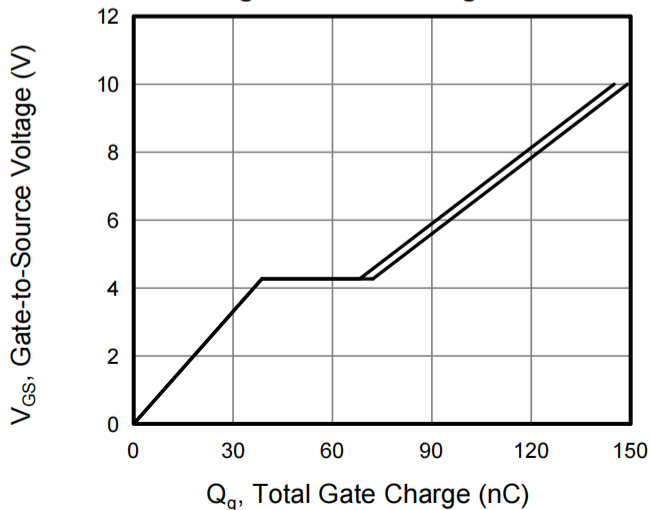
**Figure 3. On-Resistance vs. Drain Current**



**Figure 4. Capacitance**



**Figure 5. Gate Charge**



**Figure 6. Body Diode Forward Voltage**

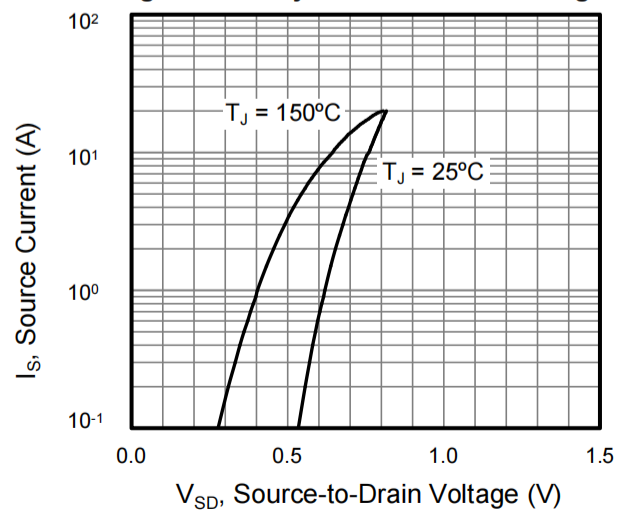


Figure 7. On-Resistance vs. Temperature

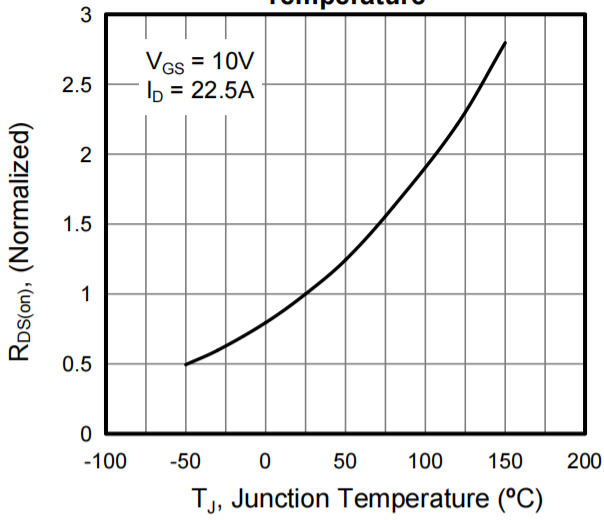


Figure 8. Breakdown voltage vs. Junction Temperature

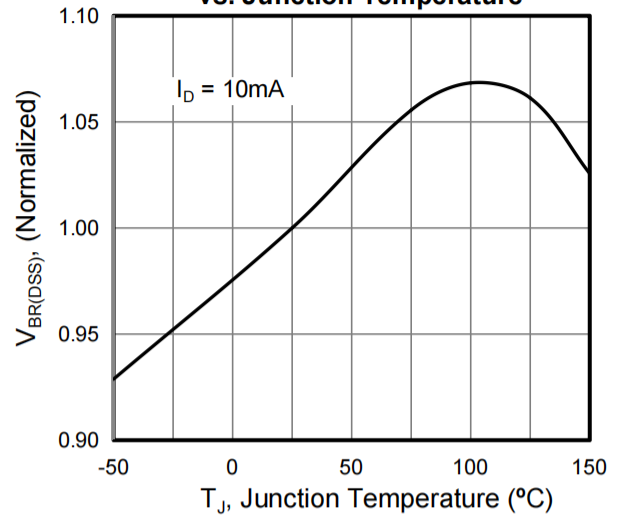


Figure 9. Transient Thermal Impedance For TO-247

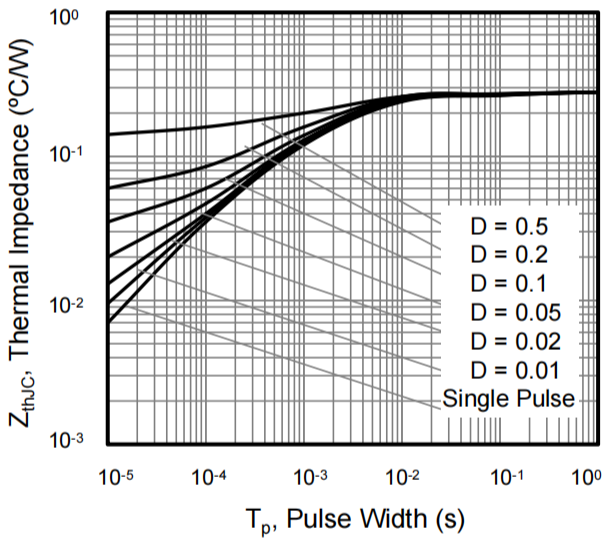


Figure 10. Safe Operation Area For TO-247

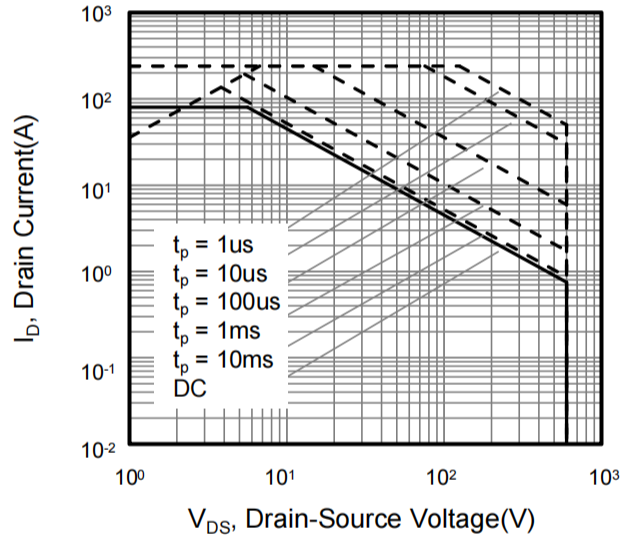


Figure 11. Typ. Coss Stored Energy

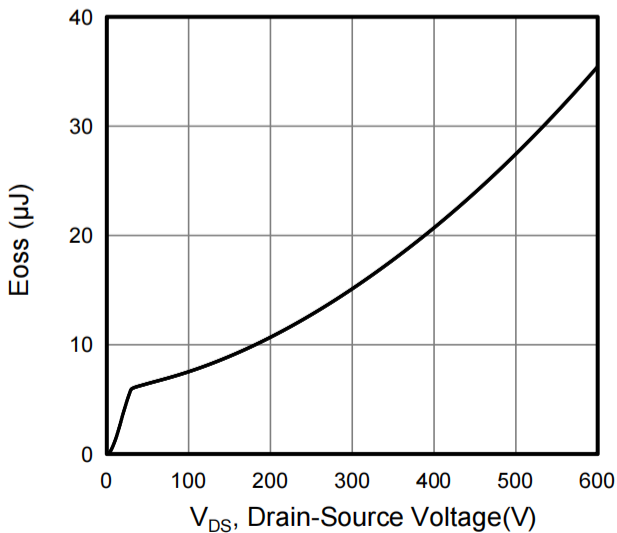


Figure A: Gate Charge Test Circuit and Waveform

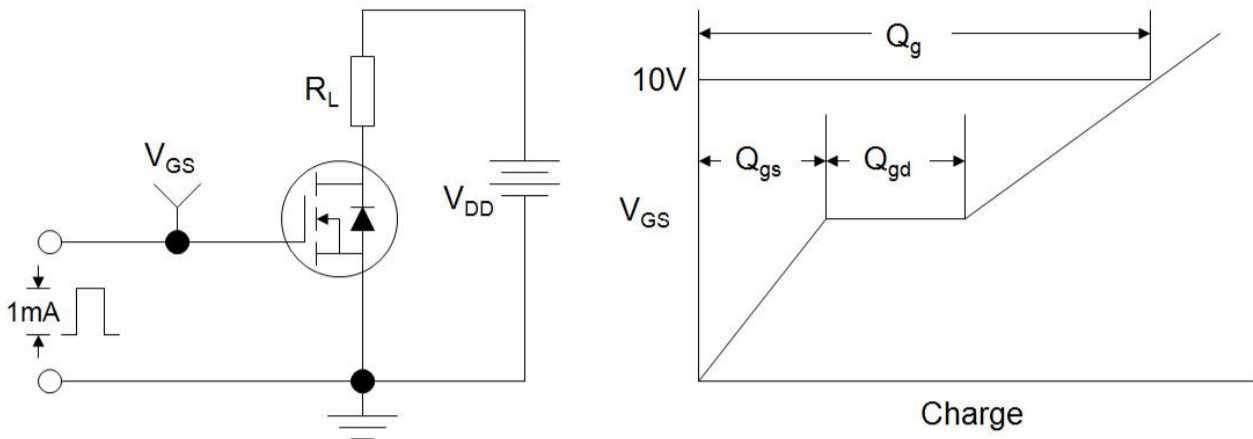


Figure B: Resistive Switching Test Circuit and Waveform

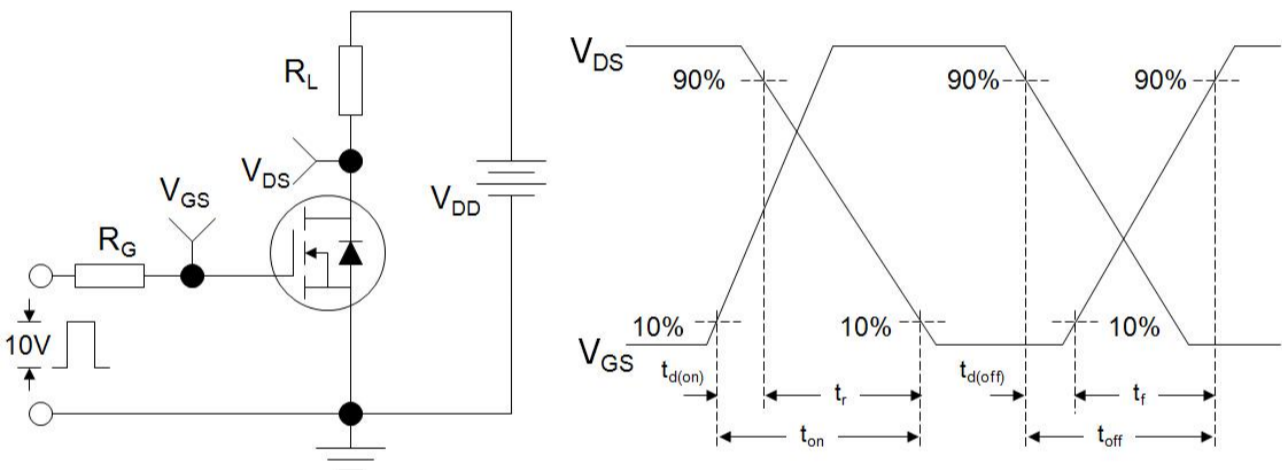
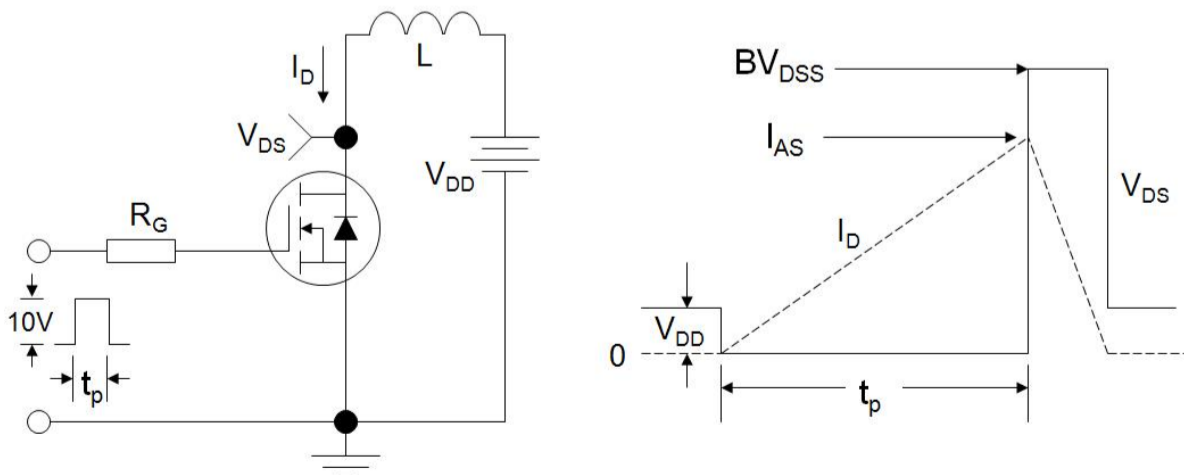
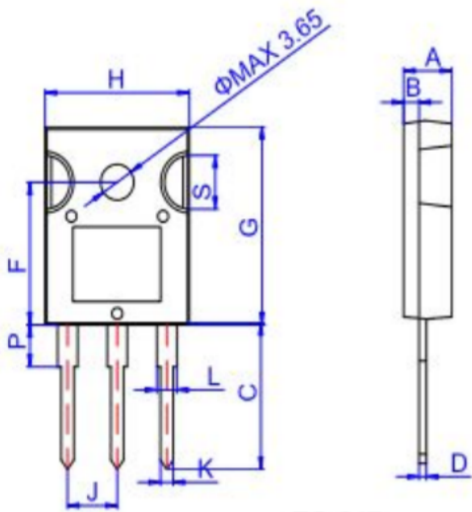


Figure C: Unclamped Inductive Switching Test Circuit and Waveform





TO-247

Ref.	Dimensions					
	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A	4.9		5.4	0.193		0.213
B	1.6		2.0	0.063		0.079
C	14.35		15.4	0.565		0.606
D	0.5		0.8	0.020		0.031
F	14.4		15.1	0.567		0.594
G	19.7		20.6	0.775		0.811
H	15.4		16.2	0.606		0.638
J	5.3		5.6	0.209		0.220
K	1.3		1.5	0.051		0.059
L	2.8		3.3	0.110		0.130
P	3.7		4.2	0.146		0.165
S	5.35		5.65	0.211		0.222