

## N-Channel Super Junction Power MOSFET IV

### General Description

The series of devices use advanced trench gate super junction technology and design to provide ultra-low  $R_{DS(ON)}$  and low gate charge and With a rapid recovery body diode. This super junction MOSFET fits the industry's AC-DC SMPS requirements for PFC, AC/DC power conversion, industrial power applications, Fast charger, new energy vehicle charging pile, on-board OBC etc.

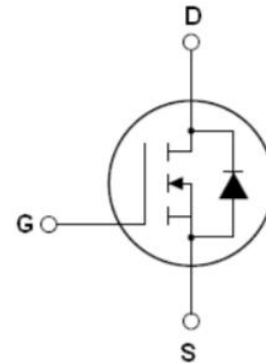
### Features

- New technology for high voltage device
- Ultra low on-resistance and ultra low conduction losses
- Ultra Low Gate Charge cause lower driving requirements
- Diode reverse recovery speed is super fast
- 100% Avalanche Tested and 100%  $T_{rr}$  Tested
- High reliability
- RoHS & Halogen Free

### Application

- Power factor correction (PFC)
- Switched mode power supplies (SMPS)
- Uninterruptible Power Supply (UPS)
- On-board charger (OBC)

$V_{DS, min@T_{jmax}}$	650	V
$R_{DS(ON)TYP.}$	23	m $\Omega$
$I_D$	81	A
$Q_g$	135	nC

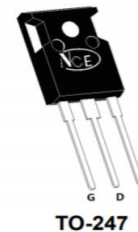


✧ Intrinsic fast-recovery body diode

Schematic diagram

### Package Marking And Ordering Information

Device	Device Package	Marking
NCE60NF031T	TO-247	NCE60NF031T



TO-247

Table 1. Absolute Maximum Ratings ( $T_c=25^\circ\text{C}$ )

Parameter	Symbol	Value	Unit
Drain-Source Voltage ( $V_{GS}=0V$ )	$V_{DS}$	600	V
Gate-Source Voltage ( $V_{DS}=0V$ ), AC ( $f>1$ Hz)	$V_{GS}$	$\pm 30$	V
Gate-Source Voltage ( $V_{DS}=0V$ ), DC	$V_{GS}$	$\pm 20$	V
Continuous Drain Current at $T_c=25^\circ\text{C}$	$I_{D(DC)}$	81	A
Continuous Drain Current at $T_c=100^\circ\text{C}$	$I_{D(DC)}$	56.7	A
Pulsed drain current (Note 1)	$I_{DM (pluse)}$	243	A
Maximum Power Dissipation ( $T_c=25^\circ\text{C}$ )	$P_D$	490	W
Derate above $25^\circ\text{C}$		3.2	W/ $^\circ\text{C}$
Single pulse avalanche energy (Note 2)	$E_{AS}$	1024	mJ
Single pulse avalanche current (Note 2)	$I_{AS}$	16	A
Repetitive Avalanche energy, $t_{AR}$ limited by $T_{jmax}$ (Note 1)	$E_{AR}$	0.9	mJ

Reverse diode dv/dt, $V_{DS} \leq 480V, I_{SD} < I_D$	dv/dt	50	V/ns
Drain Source voltage slope, $V_{DS} \leq 480V$	dv/dt	50	V/ns
Operating Junction and Storage Temperature Range	$T_J, T_{STG}$	-55...+175	°C

**Table 2. Thermal Characteristic**

Parameter	Symbol	Value	Unit
Thermal Resistance, Junction-to-Case (Maximum)	$R_{thJC}$	0.31	°C /W
Thermal Resistance, Junction-to-Ambient (Maximum)	$R_{thJA}$	62	°C /W

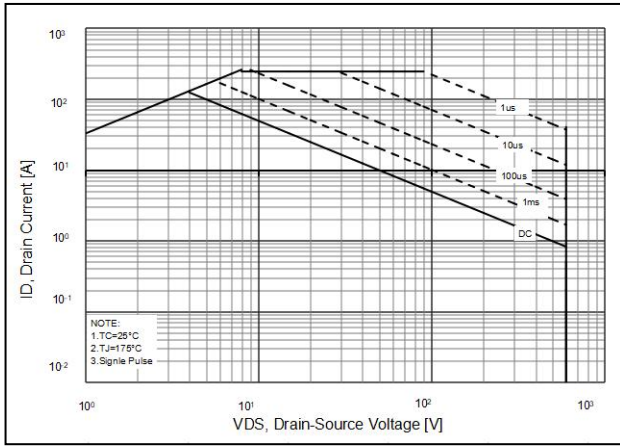
**Table 3. Electrical Characteristics (TA=25°C unless otherwise noted)**

Parameter	Symbol	Condition	Min	Typ	Max	Unit
<b>On/off states</b>						
Drain-Source Breakdown Voltage	$BV_{DSS}$	$V_{GS}=0V, I_D=1mA$	600			V
Zero Gate Voltage Drain Current( $T_c=25^\circ C$ )	$I_{DSS}$	$V_{DS}=600V, V_{GS}=0V$			10	$\mu A$
Zero Gate Voltage Drain Current( $T_c=125^\circ C$ )	$I_{DSS}$	$V_{DS}=600V, V_{GS}=0V$			600	$\mu A$
Gate-Body Leakage Current	$I_{GSS}$	$V_{GS}=\pm 20V, V_{DS}=0V$			$\pm 200$	nA
Gate Threshold Voltage	$V_{GS(th)}$	$V_{DS}=V_{GS}, I_D=3mA$	3.5	4.2	5	V
Drain-Source On-State Resistance	$R_{DS(on)}$	$V_{GS}=10V, I_D=40A$		23	31	m $\Omega$
<b>Dynamic Characteristics</b>						
Gate Resistance	$R_g$	F=1MHZ, D-S short		3.5		$\Omega$
Input Capacitance	$C_{iss}$	$V_{DS}=50V, V_{GS}=0V,$ F=1MHz		8000		pF
Output Capacitance	$C_{oss}$			249		pF
Reverse Transfer Capacitance	$C_{rss}$			15		pF
Total Gate Charge	$Q_g$	$V_{DS}=400V, I_D=40A, V_{GS}=10V$		135	145	nC
Gate-Source Charge	$Q_{gs}$			54		nC
Gate-Drain Charge	$Q_{gd}$			46		nC
Gate plateau voltage	$V_{gp}$			7		V
<b>Switching times</b>						
Turn-on Delay Time	$t_{d(on)}$	$V_{DD}=380V, I_D=40A,$ $R_G=4\Omega, V_{GS}=10V$		55		nS
Turn-on Rise Time	$t_r$			16		nS
Turn-Off Delay Time	$t_{d(off)}$			125		nS
Turn-Off Fall Time	$t_f$			11		nS
<b>Source- Drain Diode Characteristics</b>						
Source-drain current(Body Diode)	$I_{SD}$	$T_c=25^\circ C$			81	A
Pulsed-Source-drain current(Body Diode)	$I_{SDM}$				243	A
Forward on voltage	$V_{SD}$	$T_j=25^\circ C, I_{SD}=81A, V_{GS}=0V$		1.0	1.2	V
Reverse Recovery Time	$t_{rr}$	$T_j=25^\circ C, I_F=40A,$ $di/dt=100A/\mu s$		170		nS
Reverse Recovery Charge	$Q_{rr}$			1.3		$\mu C$
Peak reverse recovery current	$I_{rrm}$			15.5		A

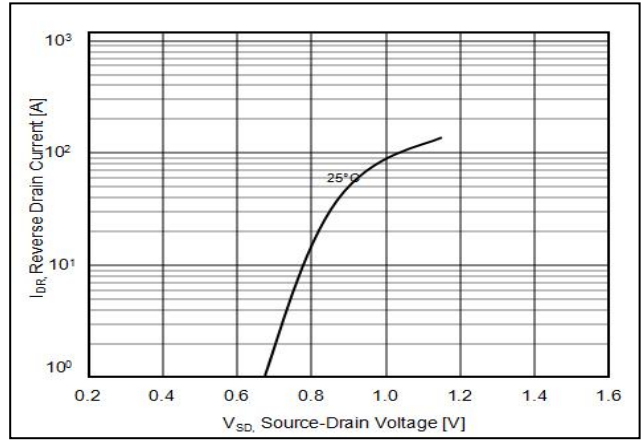
Notes: 1. Repetitive Rating: Pulse width limited by maximum junction temperature  
 2.  $T_j=25^\circ C, V_{DD}=50V, V_G=10V, R_G=25\Omega$

## TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS (curves)

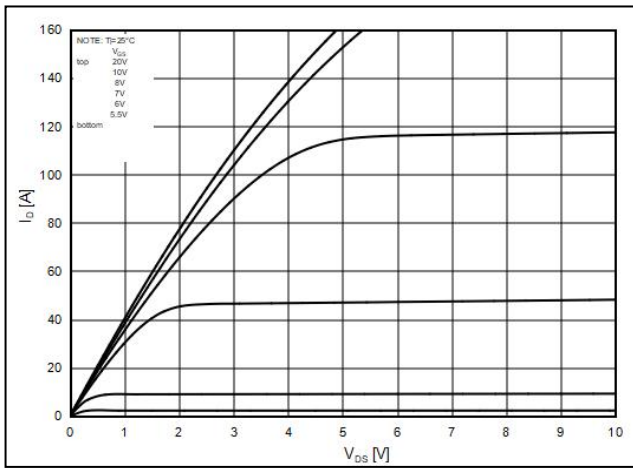
**Figure1. Safe operating area**



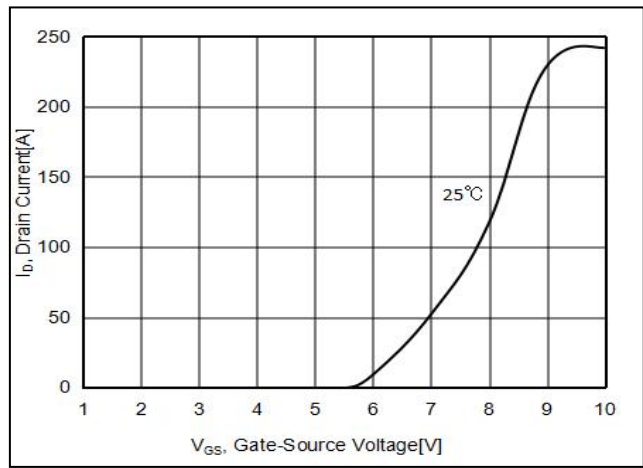
**Figure2. Source-Drain Diode Forward Voltage**



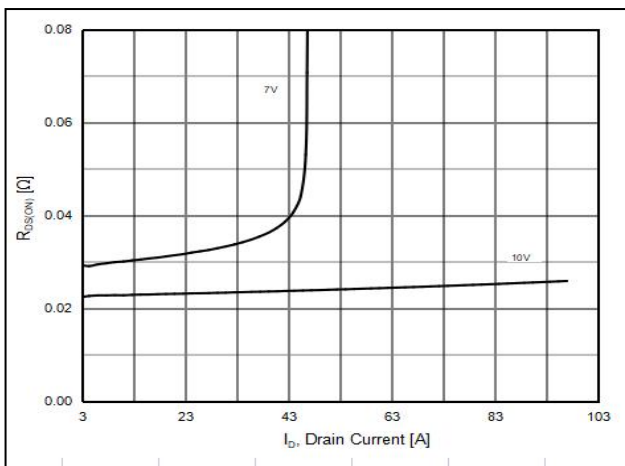
**Figure3. Output characteristics**



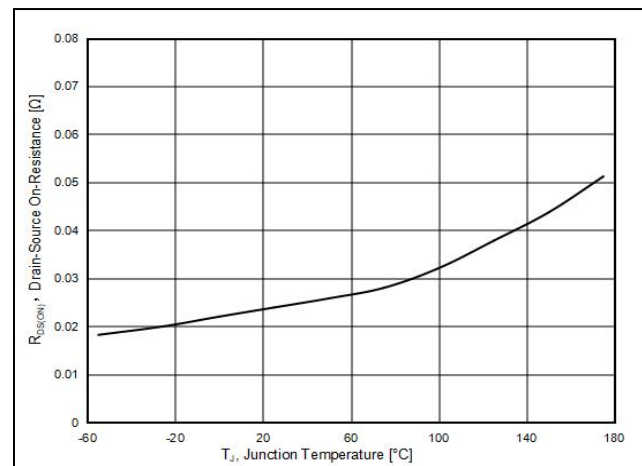
**Figure4. Transfer characteristics**



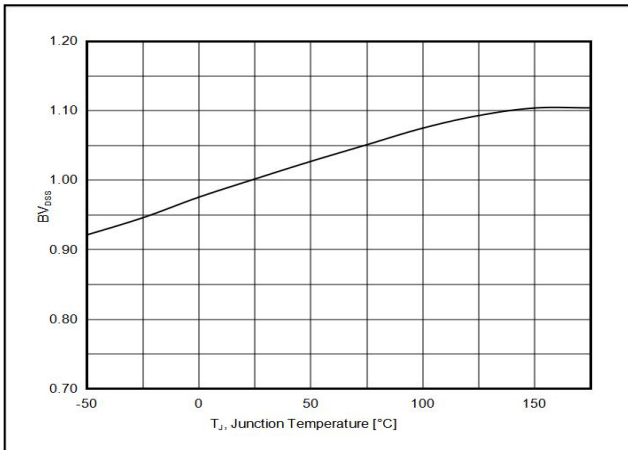
**Figure5. Static drain-source on resistance**



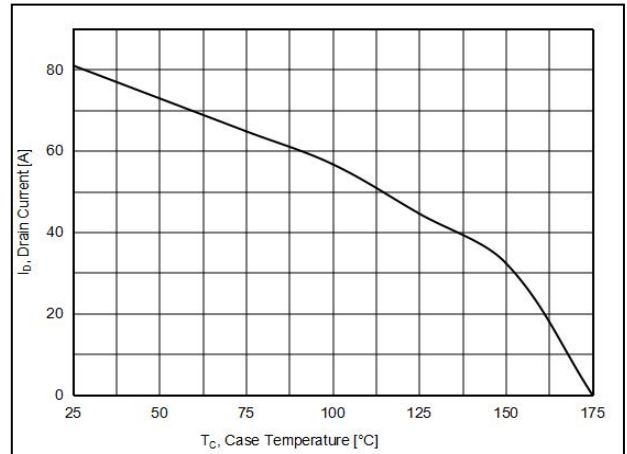
**Figure6. RDS(ON) vs Junction Temperature**



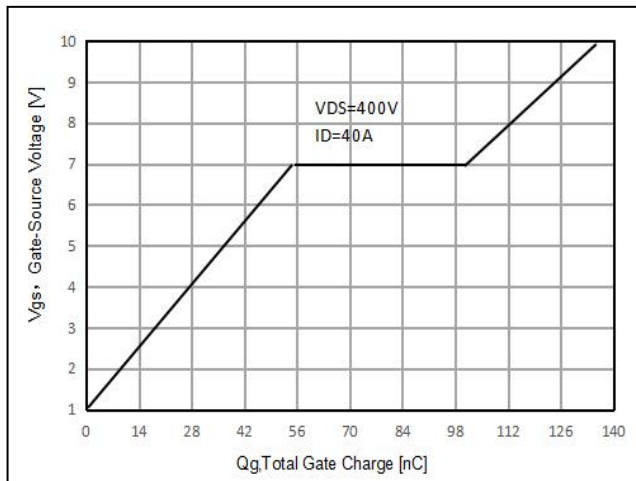
**Figure7.  $BV_{DSS}$  vs Junction Temperature**



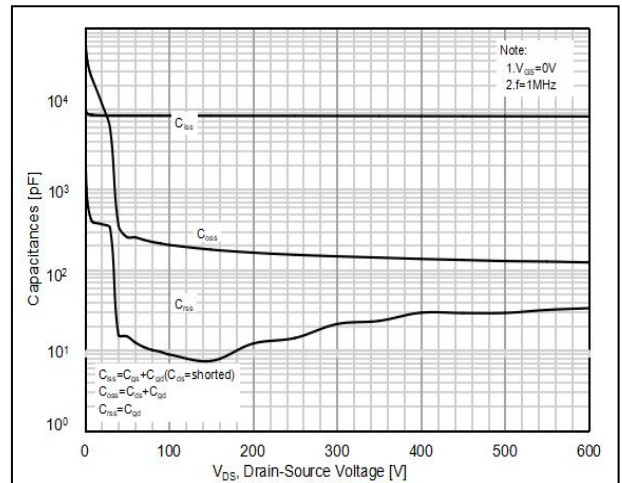
**Figure8. Maximum  $I_D$  vs Junction Temperature**



**Figure9. Gate charge waveforms**



**Figure10. Capacitance**

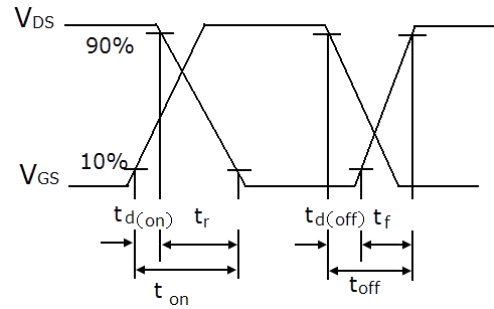


## Test circuit

### 1) Gate charge test circuit & Waveform



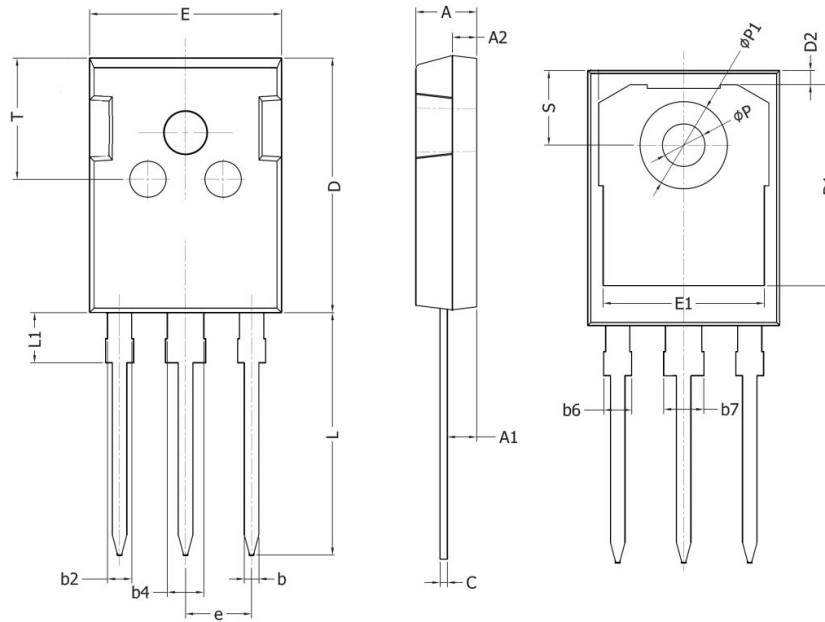
### 2) Switch Time Test Circuit:



### 3) Unclamped Inductive Switching Test Circuit & Waveforms

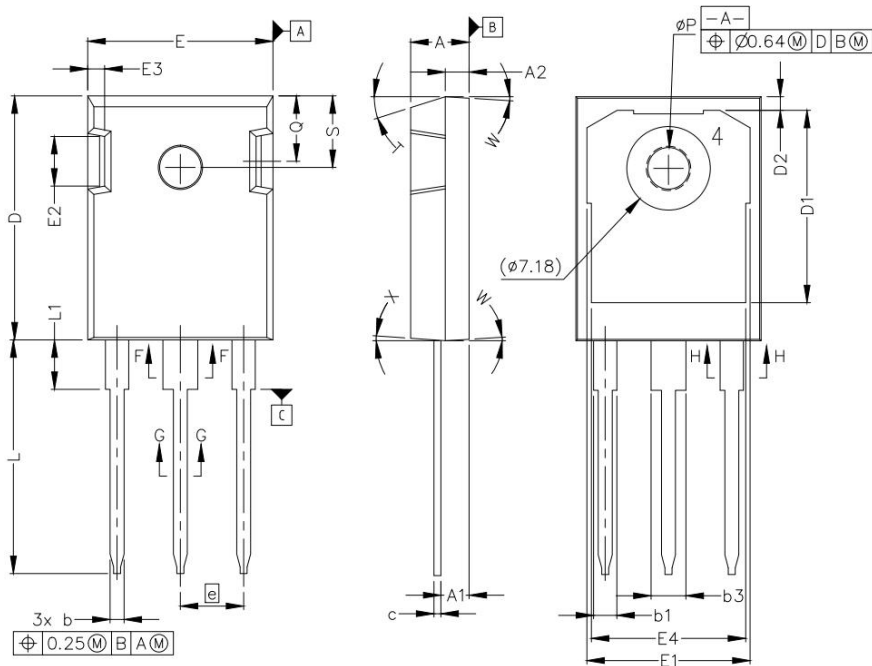


## TO-247 (P) Package Information



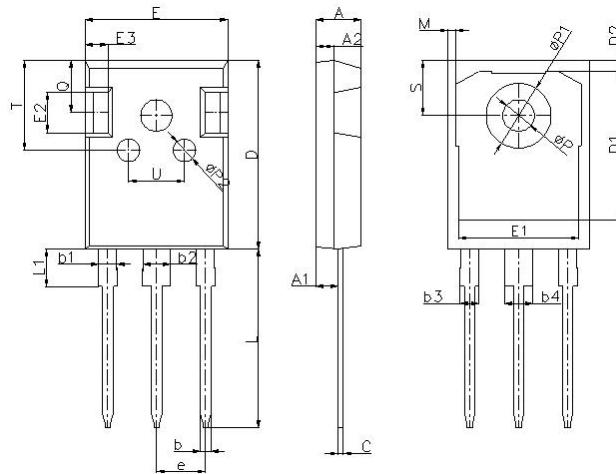
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min.	Max.	Min.	Max.
A	4.90	5.10	0.193	0.201
A1	2.31	2.51	0.091	0.099
A2	1.90	2.10	0.075	0.083
b	1.16	1.26	0.046	0.050
b2	1.96	2.06	0.077	0.081
b4	2.96	3.06	0.117	0.120
b6	-	2.25	-	0.089
b7	-	3.25	-	0.128
C	0.59	0.66	0.023	0.026
D	20.90	21.10	0.823	0.831
D1	16.25	16.85	0.640	0.663
D2	1.05	1.35	0.041	0.053
E	15.70	15.90	0.618	0.626
E1	13.10	13.50	0.516	0.531
e	5.436 BSC		0.214 BSC	
L	19.80	20.10	0.780	0.791
L1	-	4.30	-	0.169
P	3.40	3.60	0.134	0.142
P1	7.00	7.40	0.276	0.291
S	6.05	6.25	0.238	0.246
T	9.80	10.20	0.386	0.402

## TO-247-B Package Information



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min.	Max.	Min.	Max.
A	4.83	5.21	0.190	0.205
A1	2.29	2.54	0.090	0.100
A2	1.91	2.16	0.075	0.085
b	1.07	1.33	0.042	0.052
b1	1.91	2.41	0.075	0.095
b3	2.87	3.38	0.113	0.133
c	0.55	0.68	0.022	0.027
D	20.80	21.10	0.819	0.831
D1	16.25	17.65	0.640	0.695
D2	0.95	1.25	0.037	0.049
E	15.75	16.13	0.620	0.635
E1	13.10	14.15	0.516	0.557
E2	3.68	5.10	0.145	0.201
E3	1.00	1.90	0.039	0.075
E4	12.38	13.43	0.487	0.529
e	5.44 BSC		0.214 BSC	
N	3.00		0.118	
L	19.81	20.32	0.780	0.800
L1	4.10	4.40	0.161	0.173
P	3.51	3.65	0.138	0.144
Q	5.49	6.00	0.216	0.236
S	6.04	6.30	0.238	0.248

## TO-247-E Package Information



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min.	Max.	Min.	Max.
A	4.90	5.10	0.193	0.201
A1	2.31	2.51	0.091	0.099
A2	1.90	2.10	0.075	0.083
b	1.16	1.26	0.046	0.050
b1	1.96	2.06	0.077	0.081
b2	2.96	3.06	0.117	0.120
b3	-	2.25	-	0.089
b4	-	3.25	-	0.128
C	0.59	0.66	0.023	0.026
D	20.90	21.10	0.823	0.831
D1	16.25	16.85	0.640	0.663
D2	1.05	1.35	0.041	0.053
E	15.70	15.90	0.618	0.626
E1	13.10	13.50	0.516	0.531
E2	4.40	4.60	0.173	0.181
E3	2.40	2.60	0.094	0.102
e	5.436BSC		0.214BSC	
L	19.80	20.10	0.780	0.791
L1	-	4.30	-	0.169
M	0.35	0.95	0.014	0.037
P	3.40	3.60	0.134	0.142
P1	7.00	7.40	0.276	0.291
P2	2.40	2.60	0.094	0.102
Q	5.60	6.00	0.220	0.236
S	6.05	6.25	0.238	0.246
T	9.80	10.20	0.386	0.402
U	6.00	6.40	0.236	0.252

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