

## N-Channel Super Junction Power MOSFET IV

### General Description

The series of devices use advanced trench gate super junction technology and design to provide excellent  $R_{DS(ON)}$  with low gate charge. This super junction MOSFET fits the industry's AC-DC SMPS requirements for PFC, AC/DC power conversion, and industrial power applications.

### Features

- Optimized body diode reverse recovery performance
- Low on-resistance and low conduction losses
- Small package
- Ultra Low Gate Charge cause lower driving requirements
- 100% Avalanche Tested
- ROHS compliant

### Application

- Power factor correction (PFC)
- Switched mode power supplies(SMPS)
- Uninterruptible Power Supply (UPS)
- LLC Half-bridge

|                        |     |            |
|------------------------|-----|------------|
| $V_{DS\ min@T_{jmax}}$ | 650 | V          |
| $R_{DS(ON)TYP}$        | 650 | m $\Omega$ |
| ID                     | 6.1 | A          |
| Qg                     | 9.6 | nC         |



Schematic diagram

### Package Marking And Ordering Information

| Device     | Device Package | Marking    |
|------------|----------------|------------|
| NCE60N700F | TO-220F        | NCE60N700F |



TO-220F

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 ( $f>1\text{ Hz}$ )       | $V_{GS}$        | $\pm 30$   | V                   |
| Gate-Source Voltage ( $V_{DS}=0V$ ) DC                           | $V_{GS}$        | $\pm 20$   | V                   |
| Continuous Drain Current at $T_c=25^\circ\text{C}$               | $I_{D(DC)}$     | 6.1        | A                   |
| Continuous Drain Current at $T_c=100^\circ\text{C}$              | $I_{D(DC)}$     | 4.27       | A                   |
| Pulsed drain current (Note 1)                                    | $I_{DM(pluse)}$ | 18.3       | A                   |
| Maximum Power Dissipation( $T_c=25^\circ\text{C}$ )              | $P_D$           | 31.2       | W                   |
| Derate above $25^\circ\text{C}$                                  |                 | 0.21       | W/ $^\circ\text{C}$ |
| Avalanche current(Note 1)  | $I_{AS}$        | 1.3        | A                   |
| Drain Source voltage slope, $V_{DS} \leq 480\text{ V}$ ,         | $dv/dt$         | 50         | V/ns                |
| Reverse diode $dv/dt$ , $V_{DS} \leq 480\text{ V}, I_{SD} < I_D$ | $dv/dt$         | 15         | V/ns                |
| Operating Junction and Storage Temperature Range                 | $T_J, T_{STG}$  | -55...+175 | $^\circ\text{C}$    |

\* limited by maximum junction temperature

**Table 2. Thermal Characteristic**

| Parameter   | Symbol     | Value | Unit                        |
|---|------------|-------|-----------------------------|
| Thermal Resistance, Junction-to-Case (Maximum)    | $R_{thJC}$ | 4.80  | $^{\circ}\text{C}/\text{W}$ |
| Thermal Resistance, Junction-to-Ambient (Maximum) | $R_{thJA}$ | 62    | $^{\circ}\text{C}/\text{W}$ |

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

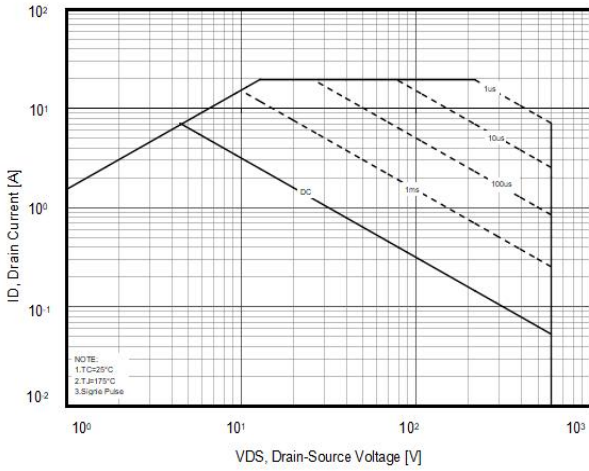
| Parameter                                  | Symbol       | Condition   | Min | Typ  | Max       | Unit          |
|--|--------------|---|-----|------|-----------|---------------|
| <b>On/off states</b>                       |              |   |     |      |           |               |
| Drain-Source Breakdown Voltage             | $BV_{DSS}$   | $V_{GS}=0V, I_D=250\mu A$                               | 600 |      |           | V             |
| Zero Gate Voltage Drain Current(Tc=25°C)   | $I_{DSS}$    | $V_{DS}=600V, V_{GS}=0V$                                |     |      | 1         | $\mu A$       |
| Zero Gate Voltage Drain Current(Tc=125°C)  | $I_{DSS}$    | $V_{DS}=600V, V_{GS}=0V$                                |     |      | 100       | $\mu A$       |
| Gate-Body Leakage Current                  | $I_{GSS}$    | $V_{GS}=\pm 20V, V_{DS}=0V$                             |     |      | $\pm 200$ | nA            |
| Gate Threshold Voltage                     | $V_{GS(th)}$ | $V_{DS}=V_{GS}, I_D=250\mu A$                           | 3   | 3.5  | 4         | V             |
| Drain-Source On-State Resistance           | $R_{DS(on)}$ | $V_{GS}=10V, I_D=3A$                                    |     | 650  | 700       | m $\Omega$    |
| <b>Dynamic Characteristics</b>             |              |   |     |      |           |               |
| Input Capacitance                          | $C_{iss}$    | $V_{DS}=50V, V_{GS}=0V,$<br>$F=1.0\text{MHz}$           |     | 250  |           | pF            |
| Output Capacitance                         | $C_{oss}$    |   |     | 21   |           | pF            |
| Reverse Transfer Capacitance               | $C_{rss}$    |   |     | 4    |           | pF            |
| Total Gate Charge                          | $Q_g$        | $V_{DS}=450V, I_D=3A,$<br>$V_{GS}=10V$                  |     | 9.6  |           | nC            |
| Gate-Source Charge                         | $Q_{gs}$     |   |     | 2.5  |           | nC            |
| Gate-Drain Charge                          | $Q_{gd}$     |   |     | 3.3  |           | nC            |
| Gate plateau voltage                       | $V_{gp}$     |   |     | 5.5  |           | V             |
| Intrinsic gate resistance                  | $R_G$        | $f = 1 \text{ MHz open drain}$                          |     | 43   |           | $\Omega$      |
| <b>Switching times</b>                     |              |   |     |      |           |               |
| Turn-on Delay Time                         | $t_{d(on)}$  | $V_{DD}=380V, I_D=3A,$<br>$R_G=1.7\Omega, V_{GS}=10V$   |     | 11   |           | nS            |
| Turn-on Rise Time                          | $t_r$        |   |     | 6    |           | nS            |
| Turn-Off Delay Time                        | $t_{d(off)}$ |   |     | 26   |           | nS            |
| Turn-Off Fall Time                         | $t_f$        |   |     | 10   |           | nS            |
| <b>Source- Drain Diode Characteristics</b> |              |   |     |      |           |               |
| Source-drain current(Body Diode)           | $I_{SD}$     | $T_C=25^{\circ}\text{C}$                                |     |      | 6.4       | A             |
| Pulsed Source-drain current(Body Diode)    | $I_{SDM}$    |   |     |      | 19.2      | A             |
| Forward On Voltage                         | $V_{SD}$     | $T_j=25^{\circ}\text{C}, I_{SD}=6.1A, V_{GS}=0V$        |     | 0.9  | 1.2       | V             |
| Reverse Recovery Time                      | $t_{rr}$     | $T_j=25^{\circ}\text{C}, I_F=3A,$<br>$di/dt=100A/\mu s$ |     | 140  |           | nS            |
| Reverse Recovery Charge                    | $Q_{rr}$     |   |     | 0.64 |           | $\mu\text{C}$ |
| Peak Reverse Recovery Current              | $I_{rrm}$    |   |     | 9    |           | A             |

Notes 1.Repetitive Rating: Pulse width limited by maximum junction temperature

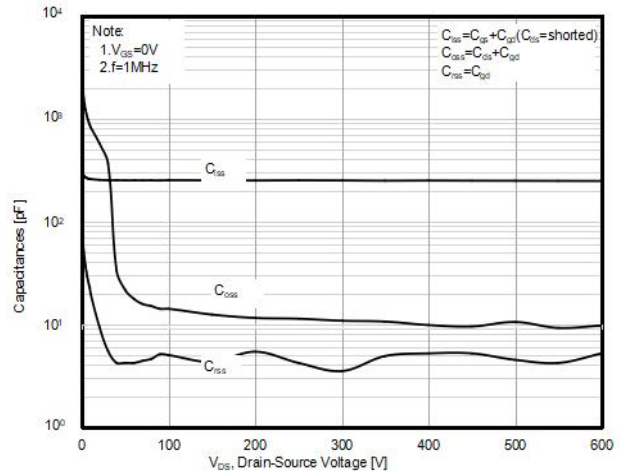
2.  $T_j=25^{\circ}\text{C}, V_{DD}=50V, V_G=10V, R_G=25\Omega$

## TYPICAL ELECTRICAL AND THERMAL CHARACTERISTICS (curves)

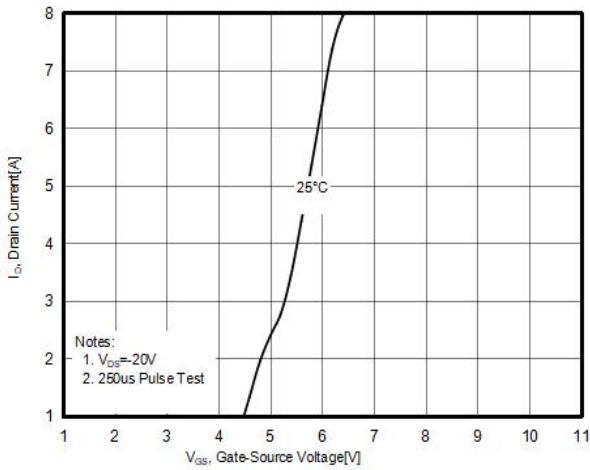
**Figure1. Safe operating area**



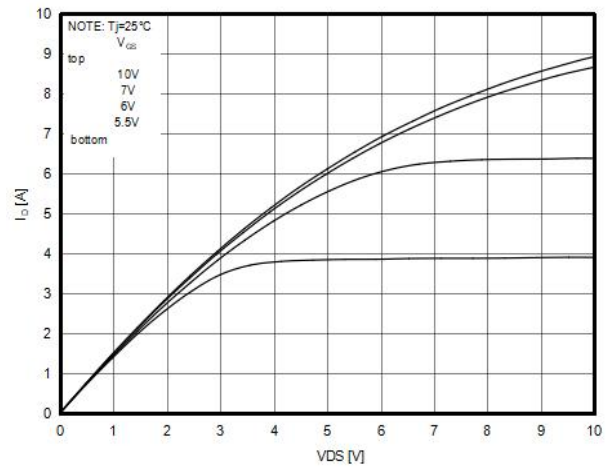
**Figure2. Capacitance**



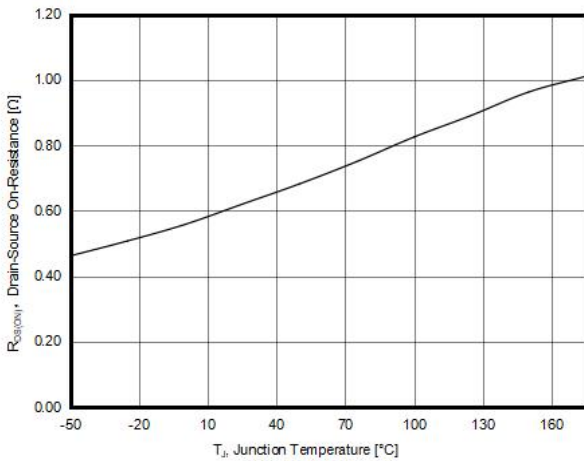
**Figure3. Transfer characteristics**



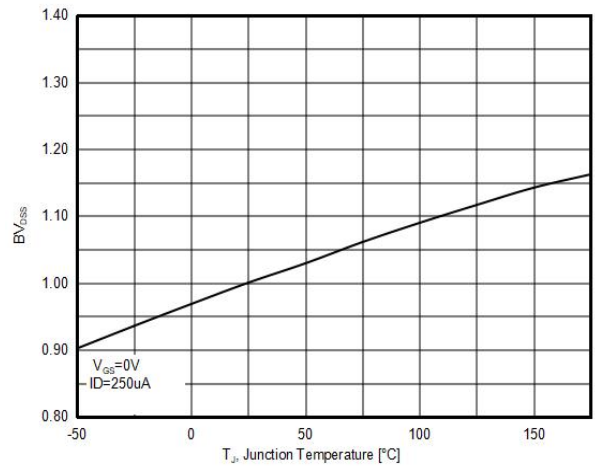
**Figure4. Output characteristics**



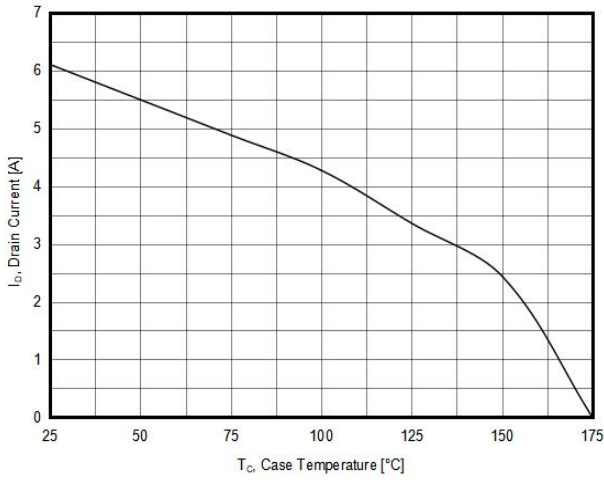
**Figure5. RDS(ON) vs Junction Temperature**



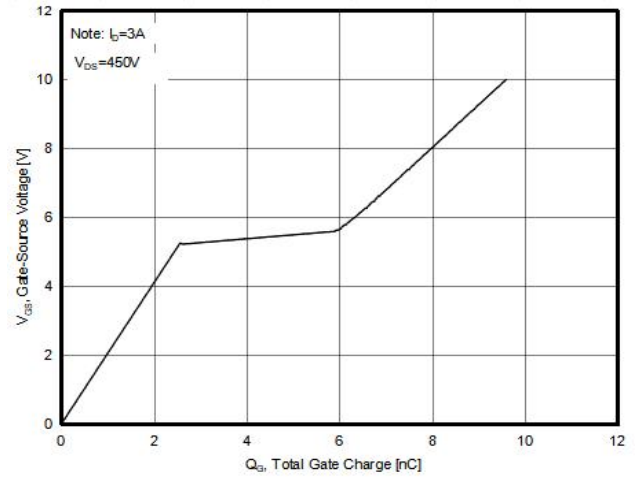
**Figure6. BVDS vs Junction Temperature**



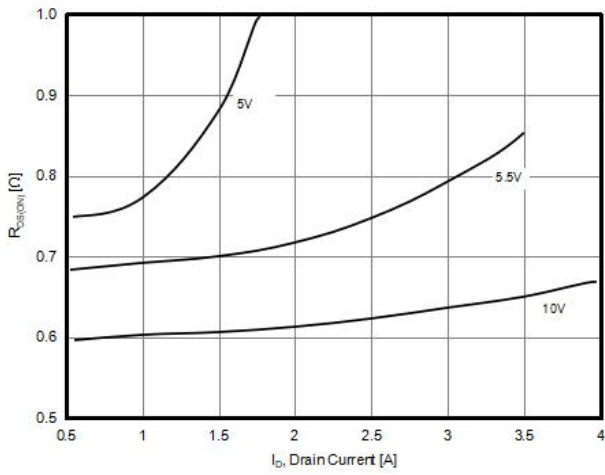
**Figure7. Maximum  $I_D$  vs Junction Temperature**



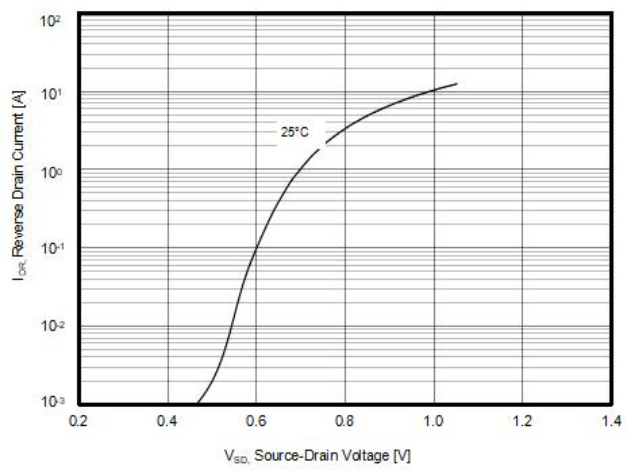
**Figure8. Gate charge waveforms**



**Figure9. Static drain-source on resistance**



**Figure10. Source-Drain Diode Forward Voltage**

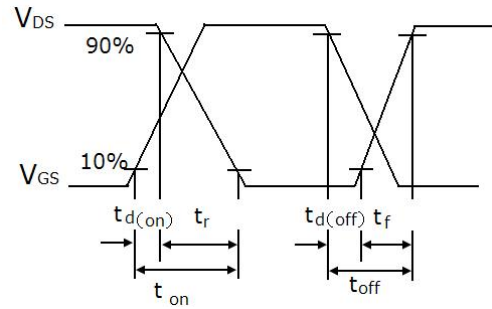


## Test circuit

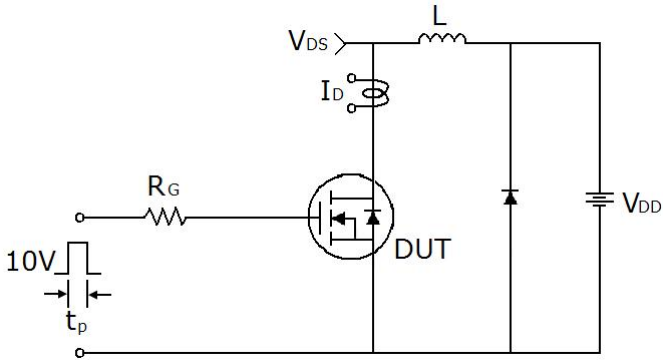
### 1) Gate charge test circuit & Waveform



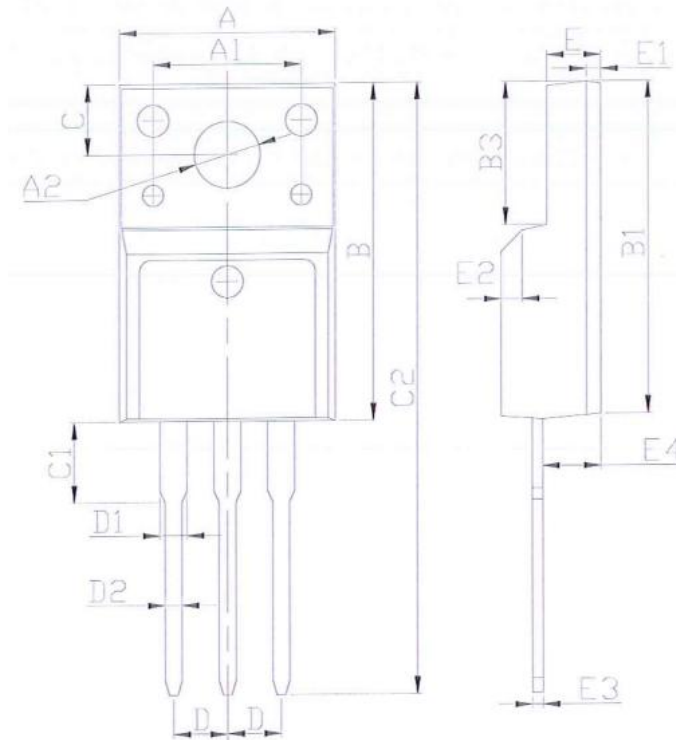
### 2) Switch Time Test Circuit:



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

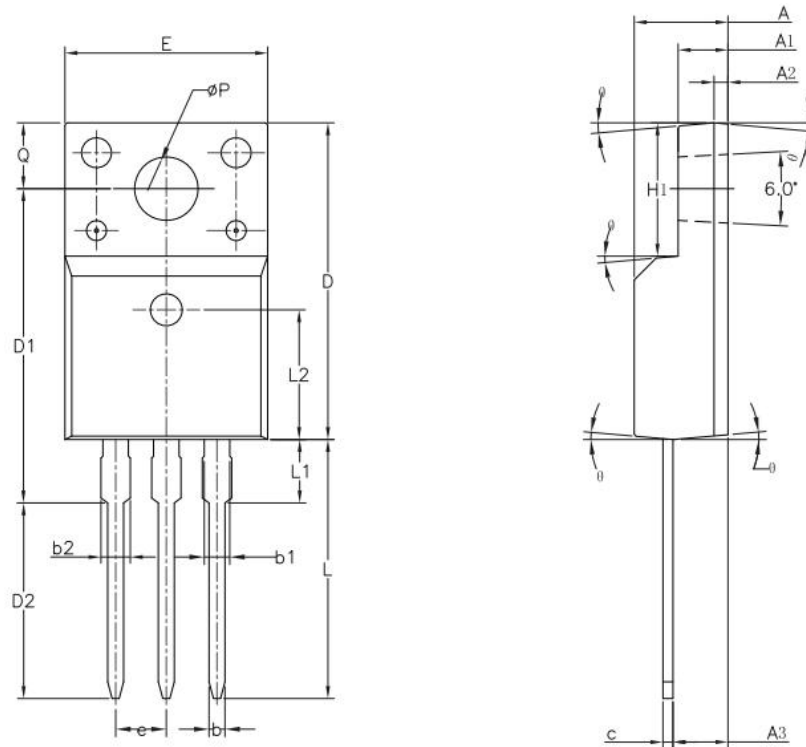


## TO-220F-3L-L Package Information



| Symbol | Dimensions In Millimeters |       | Dimensions In Inches |       |
|--------|---------------------------|-------|----------------------|-------|
|        | Min.                      | Max.  | Min.                 | Max.  |
| A      | 9.86                      | 10.46 | 0.387                | 0.411 |
| A1     | 6.80                      | 7.20  | 0.267                | 0.283 |
| A2     | 2.92                      | 3.32  | 0.115                | 0.130 |
| A3     | 9.40                      | 10.00 | 0.369                | 0.393 |
| B      | 15.40                     | 16.40 | 0.605                | 0.644 |
| B1     | 15.10                     | 16.10 | 0.593                | 0.633 |
| B2     | 4.40                      | 5.00  | 0.173                | 0.196 |
| B3     | 6.40                      | 7.00  | 0.251                | 0.275 |
| C      | 3.05                      | 3.55  | 0.120                | 0.139 |
| C1     | 2.95                      | 3.55  | 0.116                | 0.139 |
| C2     | 28.20                     | 29.20 | 1.108                | 1.147 |
| D      | 2.54 BSC                  |       | 0.100 BSC            |       |
| D1     | --                        | 1.47  | --                   | 0.058 |
| D2     | 0.60                      | 1.00  | 0.024                | 0.039 |
| E      | 2.30                      | 2.80  | 0.090                | 0.110 |
| E1     | 0.45                      | 0.95  | 0.018                | 0.037 |
| E2     | 45.0°                     |       | 45.00°               |       |
| E3     | 0.30                      | 0.70  | 0.012                | 0.028 |
| E4     | 2.45                      | 3.05  | 0.096                | 0.120 |

## TO-220F-3L-P Package Information



| Symbol | Dimensions In Millimeters |       | Dimensions In Inches |       |
|--------|---------------------------|-------|----------------------|-------|
|        | Min.                      | Max.  | Min.                 | Max.  |
| A      | 4.50                      | 4.83  | 0.177                | 0.190 |
| A1     | 2.34                      | 2.74  | 0.092                | 0.108 |
| A2     | 0.70 REF                  |       | 0.028 REF            |       |
| A3     | 2.56                      | 2.93  | 0.101                | 0.115 |
| b      | 0.70                      | 0.90  | 0.028                | 0.035 |
| b1     | 1.18                      | 1.38  | 0.046                | 0.054 |
| b2     | --                        | 1.47  | --                   | 0.058 |
| c      | 0.45                      | 0.60  | 0.018                | 0.024 |
| D      | 15.67                     | 16.07 | 0.616                | 0.631 |
| D1     | 15.55                     | 15.95 | 0.611                | 0.627 |
| D2     | 9.60                      | 10.00 | 0.377                | 0.393 |
| E      | 9.96                      | 10.36 | 0.391                | 0.407 |
| e      | 2.54 BSC                  |       | 0.100 BSC            |       |
| H1     | 6.48                      | 6.88  | 0.255                | 0.270 |
| L      | 12.68                     | 13.28 | 0.498                | 0.522 |
| L1     | --                        | 3.50  | --                   | 0.138 |
| L2     | 6.50 REF                  |       | 0.255 REF            |       |
| ∅ P    | 3.08                      | 3.28  | 0.121                | 0.129 |
| Q      | 3.20                      | 3.40  | 0.126                | 0.134 |

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